Non-Essential Business Cycles

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Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Measurement

pirics

Model

ounterfactuals

The Engel curve: Non-essential spending shares increase with earnings



Non-essentials: income elasticity of demand > 1. CEX data 1995-1997

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Low income workers are more likely to work in non-essential sectors



CPS data 1982-2020

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Count

Non-essential consumption and earnings are more sensitive to the business cycle



BoE Survey

These facts interact to create a powerful amplification mechanism



These facts interact to create a powerful amplification mechanism



These facts interact to create a powerful amplification mechanism



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Non-essential consumption share has increased over time (the Engel curve again)



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Contributions

- New macro time series for essentials and non-essentials from micro data.
 - Consumption, prices, earnings constructed at national statistics standards.
- Identification of new channel of business cycle amplification.
 - Non-essentials + low income workers = amplification.
 - Estimate and model responses to monetary policy shocks.
- NK model with non-homothetic preferences and labour market heterogeneity.
 - Analytical proof that non-homotheticity does not matter for amplification in RANK.

Related literature

- Non-homothetic preferences: Engel (1857), Deaton and Muellbauer (1980), Deaton (1992), Stiglitz (1969), Stone (1954), Geary (1950), Aguiar and Bils (2015), Browning and Crossley (2000), Foellmi and Zweimüller (2008), Boppart (2014), Comin, Lashkari, and Mestieri (2021), Orchard (2022), Sonnervig (2022), De Nardi (2004), De Nardi and Fella (2017), Andreolli and Surico (2021), Clayton, Jaravel, and Schaab (2018), Comin, Mestieri, and Danieli (2020), Ait-Sahalia, Parker, and Yogo (2004), Wachter and Yogo (2010).
- Heterogeneity in spending: durables/non-durables (Barsky, House, and Kimball (2007), Monacelli (2009), Sterk (2010), McKay and Wieland (2019), and Beraja and Wolf (2021)), flexible/sticky prices (Anand, Prasad, and Zhang (2015), quality (Jaimovich, Rebelo, and Wong (2019))
- Heterogeneous households and monetary policy in GE: Bilbiie (2008), Bilbiie (2020), Debortoli and Galí (2017), Patterson (2023), McKay, Nakamura, and Steinsson (2016), Werning (2015), Auclert (2019), Kaplan, Moll, and Violante (2018) and Cloyne et al. (2020).
- Our paper: interaction spending heterogeneity-workers herogeneity in GE.

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2 Empirics

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4 Counterfactuals

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Consumption classification

Split consumption categories:

 $\blacksquare \text{ Non-essentials} \leftrightarrow \text{Income Elasticity of Demand} > 1$

Estimate Income Elasticity of Demand (IED) for consumption categories, using CEX data and the approach of Aguiar and Bils (2015). Method Estimated IEDs

Essentials

Rent, Used car purchases, Communications, telephone contracts, **Food at home**, Utilities, Children's clothing, Gas and vehicle maintenance, Health expenditures including insurance, Personal care

Non-essentials

Other car spending (leasing, financing, insurance), Entertainment equipment and subscription television, alcoholic beverages, Men's and women's clothing, **Food away from home**, Household appliances, Owner-occupied housing consumption, furniture and fixtures, Education, Domestic services and childcare, New car purchases, Public transport, Entertainment fees, admissions, reading, Cash contributions

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- Construct consumption and price series using PCE data.
 - 36% of expenditure is essential, 44% is non-essential, 20% is left unclassified.
 - Consumption share of non-essential is increasing over time: Figure

We classify industries into essentials and non-essentials:

- We classify all final consumption expenditures produced by industries.
- To classify intermediate industries, we take the Leontief inverse of the BEA input-output matrix to unpack the production network and calculate whether the downstream consumption of their industry is primarily essential or non-essential.
- Using CPS data, we build non-essential and essential employment & earnings series: 62% of employment is non-essential, 30% is essential, 8% is unclassified.

After Recessions Time-Series Descriptive Statistics State level evidence

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Empirical approach

Identify effects of monetary policy by:

- **1** Using high-frequency monetary policy instrument from Gertler and Karadi (2015).
- 2 Extracting monetary policy surprise series using a proxy-SVAR (as in Cloyne, Ferreira, Froemel and Surico, 2020) Surprise series

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Estimate IRFs using smooth local projection IV approach (Barnichon and Brownlees (2019)):

$$y_{t+h} = \alpha_{h,0} + \beta_h 1 y \text{ yield}_t + \sum_{l=1}^{12} Y_{t-l} \gamma_{h,l} + \epsilon_{t,h}$$
(1)

Instrument the 1y yield with the monetary policy surprise series.

Empirical approach

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(1)

- Instrument the 1y yield with the monetary policy surprise series.
- Controls: Lags of LHS variable, 1y yields, IP, excess bond premium, plus aggregate and disaggregated series for prices, consumption and earnings depending on LHS variable. Also add Michigan inflation expectations and dummy interacted with instrument for pre-1983 for price regressions.
- Sample: Maximum possible from 1973 for consumption, 1976 for employment, 1978 for prices, 1982 for earnings, until December 2019.

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Results - Consumption



IRFs to 100bp contractionary monetary policy shock. 90 and 68% confidence intervals.

• Non-essential consumption falls twice more than essential consumption.

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Results - Earnings



Earnings

IRFs to 100bp contractionary monetary policy shock. 90 and 68% confidence intervals.

Non-essential earnings fall four times more than essential earnings.

Prices

Double hit to non-essential workers

- 1 Non-essential workers paid less on average Earnings distribution
- **2** Strongest decline at the bottom of the non-essential earnings distribution.



Response of earnings percentiles, 3 years after shock

IRFs to 100bp contractionary monetary policy shock.

One explanation for countercyclicality of income inequality. Full IRF with CI

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Robustness

Alternative shocks:

Durables/Non-durables

- Accounting for information effect. Jarosinski Karadi
- Broader business cycle shocks Angeletos Collard Dellas

Not confounded with other consumption characteristics.

Alternative samples, including Covid. Including Covid

Other categories

- Standard local projections.
- Alternative approaches to industry classification.

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1 Measurement





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Model of the Non-Essential Business Cycles

New Keynesian model with two key additions:

Non-homothetic preferences:

$$U(C_{i,t}^{E}, C_{i,t}^{N}, N_{i,t}) = \frac{(C_{i,t}^{E})^{1-\frac{1}{\gamma^{E}}}}{1-\frac{1}{\gamma^{E}}} + \varphi \frac{(C_{i,t}^{N})^{1-\frac{1}{\gamma^{N}}}}{1-\frac{1}{\gamma^{N}}} - \xi \frac{N_{i,t}^{1+\chi}}{1+\chi}$$

- The good with the higher IES also has the higher income elasticity of demand, so is by definition a luxury, or non-essential, good: γ^E < γ^N
- Proved by Browning and Crossley (2000) for any utility additive in the two goods.

Model of the Non-Essential Business Cycles

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- Proved by Browning and Crossley (2000) for any utility additive in the two goods.
- Two types of workers Labour market details
 - **1** Low productivity/hand-to-mouth who are more likely to work in non-essential sector
 - 2 High productivity/Ricardian who are more likely to work in the essential sector.

- Household: sticky inattention, Ricardian agents receive profits.
- Firms: within each sector, there are wholesale firms who produce the good using a Cobb-Douglas production function, monopolistic competitive retailers who face Calvo frictions, and final good producers who repackage together the retail varieties.
- Government: central bank sets interest rates according to a Taylor rule, plus a transfer and profit rule.

Model details

- Non-essential goods are easier to postpone than essentials.
- Estimate difference in intertemporal elasticity of substitution: $\frac{IES^{N} - IES^{E}}{IES^{E}} = \gamma^{N} - \gamma^{E} = 0.686 \text{ (SE 0.183)}.$
- Model matches empirical IRFs. (IRF Matching)

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Counterfactual exercise plan

- Key features of the model:
 - 1 Non-homothetic preferences
 - 2 Hand-to-mouth households
 - **3** Earning inequality among workers
- In the counterfactual exercises, switch all features off and add back one by one.

MAIN TAKEAWAYS:

- Interaction between spending heterogeneity and earning inequality is key to account for our main findings on consumption AND earnings.
- 2 Non-homotheticity does not matter in representative agent model for aggregates. Details

Consumption			
	Representative Agent	Heterogeneous Agents	
		Proportional Earning	Earning Inequality
Homothetic Non-Homothetic			1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Counterfactual

Consumption			
	Representative Agent	Heterogeneous Agents	
		Proportional Earning	Earning Inequality
Homothetic	0.22		
Non-Homothetic			1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Model

Consumption			
	Representative Agent	Heterogeneous Agents	
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Homothetic	0.22		
Non-Homothetic	0.22		1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Consumption			
	Representative Agent	Heterogeneous Agents	
		Proportional Earning	Earning Inequality
Homothetic	0.22	0.35	
Non-Homothetic	0.22		1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Consumption			
	Representative Agent	Heterogeneous Agents	
		Proportional Earning	Earning Inequality
Homothetic	0.22	0.35	
Non-Homothetic	0.22	0.38	1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Consumption			
	Representative Agent	Heterogeneous Agents	
		Proportional Earning	Earning Inequality
Homothetic	0.22	0.35	0.47
Non-Homothetic	0.22	0.38	1.00

Note: Each cell display the ratio of the cumulative IRF of counterfactual model over the cumulative IRF of estimated model.



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Consumption			
	Representative Agent	Heterogeneous Agents	
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Summary and Policy Implications

- Measurement: new macro time series for essentials and non-essentials.
- Identification: new channel of business cycle amplification.
 - After a contractionary shock, non-essential consumption and earnings fall more.
 - Disproportionately affects low income households.
 - Non-essentials + low income workers = amplification.
- Theory: non-homothetic preferences and labour market heterogeneity in GE.
- Essentials and non-essentials are heterogeneous along many potential dimensions (EIS, labour markets, price stickiness, ect), each may have important implications for optimal monetary and fiscal policy. We leave this for future research.

Non-essentials are ESSENTIAL to understand (and manage!) business cycles.

Thank You!

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Non-Essential Business Cycles - Bank of England Survey

First response to a contraction? Cut non-essentials:

Bank of England survey on cost of living crisis:



ONS, survey conducted 6-17 July 2022 Back

Non-Essential Business Cycles - Bank of England Survey

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ONS, survey conducted 6-17 July 2022 Back

Essentials and non-essentials over the business cycle



Similar response for inflation and employment.

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	Consumption	Prices	Employment	Median Earnings
Correlation with Industrial Production				
Aggregate	0.51	-0.32	0.37	0.07
Essentials	0.46	-0.34	0.003	-0.08
Non-essentials	0.53	-0.30	0.42	0.09
St. dev relative to Industrial Production				
Aggregate	0.40	0.28	0.44	0.59
Essentials	0.37	0.51	0.35	0.66
Non-essentials	0.57	0.24	0.57	0.69

Notes: Descriptive statistics for essentials and non-essentials series. All variables are year-on-year log differences. Panel 1 shows the standard deviation of the series, divided by the standard deviation for industrial production. Panel 2 shows the correlation between the series and industrial production. Monthly data used, the sample period ends in March 2020, and begins at the earliest available point for each series; January 1960 for consumption and prices, January 1977 for employment and January 1983 for median earnings. Price and consumption are based on PCE data and employment and earnings are from CPS data, constructed as described in the text. Earnings refers to median usual weekly earnings.

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	Average	annual amount		Non-essential % of overall
	Overall	Essential	Non-essential	
Consumption per cap. (\$)	21,710	10,267	11,443	53%
Employment (mn)	93.4	30.6	62.9	67%
Median earnings	31,127	33,025	29,333	94%

Notes: The table shows the average annual amount of consumption, employment and median annual wages, in essentials and non-essentials, over the sample period. The final column shows the non-essential consumption and employment shares and the non-essential median wage as a % of overall median wages. Only the value of consumption and employment categorised into essentials and non-essentials is included in 'Overall', excluding uncategorised. Consumption is per capita chained PCE in 2012\$, median wages are deflated to 2012\$. Details of the calculations and data sources are included in text.

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Aguiar and Bils approach to estimating IEDs

Aguiar and Bils 2015's estimate the expenditure elasticities as β_j from:

$$\ln x_{hjt} - \ln \bar{x}_{hjt} = \alpha_{jt} + \beta_j \ln X_{ht} + \Gamma_j \mathbf{Z}_h + u_{hjt}$$
(2)

Where:

- x_{hjt} is the expenditure by household h on goods of type j in year t
- \bar{x}_{hit} is the equivalent average across households
- X_{ht} is total household expenditure, instrumented by household income (dummies for category and log real after-tax income)
- α_{jt} are good fixed effects and Z_h are household characteristics (age range, earners and household size).

We estimate using CEX data 1995-1997 and a slightly altered set of categories to Aguiar and Bils (2015).

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Estimated IEDs

_				
		CE share		
	Good category	1995-1997	Elasticity	SE
	Rent	5.5	-1.1	0.09
	Used car purchases	5.53	0.23	0.16
	Communication, telephone contracts	2.59	0.31	0.04
	Food at home	11.63	0.4	0.02
	Utilities	5.21	0.47	0.02
	Children's clothing	0.96	0.65	0.07
	Gas and vehicle maintenance	6.14	0.72	0.03
	Health expenditures including insurance	4.9	0.81	0.05
	Personal care	0.97	0.96	0.05
	Shoes and other apparel	1.47	1.07	0.09
	Other car spending	5.45	1.14	0.06
	(leasing, financing, insurance)			
	Entertainment equipment	4.01	1.22	0.07
	and subscription television			
	Alcoholic beverages	0.96	1.22	0.09
	Men's and women's clothing	2.47	1.36	0.05
	Food away from home	4.53	1.37	0.05
	Household appliances	2.3	1.42	0.07
	Owner occupied housing consumption	22.25	1.45	0.04
	Furniture and fixtures	1.51	1.5	0.11
	Education	1.31	1.58	0.18
	Domestic services and childcare	1.48	1.61	0.14
	New car purchases	3.91	1.74	0.2
	Public transport	1.25	1.78	0.13
	Entertainment fees, admissions, reading	2.17	1.78	0.07
	Cash contributions	2.18	1.78	0.17
-				

Notes: Replication of Table II of Aguiar and Bils 2015, for 1995-1997 and for revised categories. The elasticity is the estimated β_i from (2).

Non-Essential Business Cycles (Andreolli, Rickard, Surico)	Measurement	Empirics	Model		References
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Non-essential shares across households

Table: Non-essential consumption shares: by tenure type and across income distribution

	Non-essential share
By housing tenure type	
Mortgagor	63.9%
Owner occupier (without mortgage)	60.6%
Renter	33.6%
	Non-essential share
By income tercile	
First	44.3%
Second	56.1%] $ 2/2$ $ 60.2%$
Third	63.3% for 2/3: 60.3

Notes: Non-essential expenditure shares from CEX data. Income terciles are based on after tax income.

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Consumption share of non-essentials



Agents are consuming relatively more non-essentials over time.



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 Next, we dig into earning heterogeneity.



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- Next, we dig into earning heterogeneity.
- Non-essential workers tend to be paid less → *FOSD*

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Essentials and non-essentials across states



States with higher shares of non-essential experience larger recessions Subsamples

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Essentials and non-essentials across states



Robust to excluding covid and focusing only on recent period Back

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Monetary policy surprises



Notes: Monetary policy surprises, extracted from a proxy SVAR. The Gertler-Karadi surprises are extracted from a proxy SVAR estimated using the (updated) monetary policy instrument proposed by Gertler and Karadi (2015), while the Jarocinski-Karadi surprises are from using the monetary policy instrument robust to the information effect proposed by Jarocinski and Karadi (2020).

Measurement

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Results - Prices



IRFs to 100bp contractionary monetary policy shock. 90 and 68% confidence intervals.

• Weak evidence of non-essential prices declining relative to essential prices

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IRFs - Employment and median earnings



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IRFs - Matched IRFs



Matched variables

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IRFs - Macro aggregates



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IRFs - Total earnings



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Earning distributions



Notes: Earnings distributions within essential and non-essential industries. Underlying data is pooled Jan 1982 -December 2020, from the CPS, as described in the text Panel 1 shows the kernel density plot along the median of each distribution, panel 2 shows the corresponding CDF, and panel 3 shows the percent of employees working in essential industries for each decile of the income distribution (deciles computed annually). Back

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IRFs - Earning distribution



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IRF - Jarocinski and Karadi shocks - Consumption and prices



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IRF - Jarocinski and Karadi shocks - Earnings



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IRF - Jarocinski and Karadi shocks - Employment and median earnings



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IRF - Jarocinski and Karadi shocks - Earning distribution



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IRF - Jarocinski and Karadi shocks - Earning distribution



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IRF - Including Covid - Consumption and prices



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IRF - Including Covid - Earnings



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IRF - Including Covid - Earning distribution



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IRF - Angeletos, Collard and Dellas shocks - Consumption and prices



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IRF - Angeletos, Collard and Dellas shocks - Employment and median earnings



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IRF - Angeletos, Collard and Dellas shocks - Earning distribution



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Model

IRF - Angeletos, Collard and Dellas shocks - Earning distribution



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Model

Consumption shares	All	Durable goods	Non-durable goods and services
Essential	45.00	2.57	42.43
Non-essential	55.00	10.86	44.14
Both	100.00	13.43	86.57



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Figure: IRFs to contractionary monetary policy shock - Non-durables only Back

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	Durables	Non- durables	Goods	Services	Tradeables	Non- tradables
Share essential	21.8	48.8	49.2	41.2	36.9	48.2
Share non-essential	78.2	51.2	50.8	58.8	63.1	51.8
Share overall expenditure	15.3	84.7	44.6	55.4	29.8	70.2

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Consumption category examples



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Standard local projections - Consumption and prices



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Standard local projections - Earnings



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Standard local projections - Employment and median earnings



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Standard local projections - Earning distribution



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Labour market heterogeneity

 Wholesalers produce one type of good and they combine high-skill labour and low-skill labour.

$$Y_t^E = A_t^E (N_{L,t}^E)^{\alpha^E} (N_{H,t}^E)^{1-\alpha^E}$$
$$Y_t^N = A_t^N (N_{L,t}^N)^{\alpha^N} (N_{H,t}^N)^{1-\alpha^N}$$

• Low-skilled share in production is α^i .

 $\alpha^E < \alpha^N$

 Relatively more low-skilled workers in non-essential goods production than in essential goods production (*we will estimate these parameters*).

Back

Household problem - Ricardian

Ricardian household problem:

$$V(a_{H,t}) = \max_{\{C_{H,t+m,m}^{E}, C_{H,t+m,m}^{N}\}_{m=0}^{\infty}} \left(\sum_{m=0}^{\infty} \beta^{m} (1-\lambda)^{m} \left(\frac{\left(C_{H,t+m,m}^{E}\right)^{1-\frac{1}{\gamma^{E}}}}{1-\frac{1}{\gamma^{E}}} + \varphi \frac{\left(C_{H,t+m,m}^{N}\right)^{1-\frac{1}{\gamma^{N}}}}{1-\frac{1}{\gamma^{N}}} \right) + \beta \lambda \sum_{m=0}^{\infty} \beta^{m} (1-\lambda)^{m} \mathbb{E}_{t} V(a_{H,t+m+1}) \right)$$

s.t.

$$\begin{aligned} a_{H,t+m+1} &= \prod_{k=0}^{m} \tilde{R}_{t+k+1} a_{H,t} - \sum_{j=0}^{m} \prod_{k=j}^{m} \tilde{R}_{t+k+1} (C_{H,t+j}^{E} + p_{t+j}^{N} C_{H,t+j}^{N}) \\ a_{H,t} &\equiv b_{H,t-1} \frac{R_{t-1}}{\pi_{t}^{E}} + w_{H,t} N_{H,t} + \Pi_{H,t}^{r} + t_{H,t} \end{aligned}$$

Back

Counte

Household problem - Ricardian

Ricardian household equilibrium conditions:

$$(C_{H,t,0}^{E})^{-\frac{1}{\gamma^{E}}} = \beta \mathbb{E}_{t} \left((C_{H,t+1,0}^{E})^{-\frac{1}{\gamma^{E}}} \frac{R_{t}}{\pi_{t+1}^{E}} \right)$$

$$\varphi (C_{H,t,0}^{N})^{-\frac{1}{\gamma^{N}}} = p_{t}^{N} (C_{H,t,0}^{E})^{-\frac{1}{\gamma^{E}}}$$

$$(C_{H,t+j,j}^{E})^{-\frac{1}{\gamma^{E}}} = \mathbb{E}_{t} \left((C_{H,t+j,0}^{E})^{-\frac{1}{\gamma^{E}}} \right)$$

$$(C_{H,t+j,j}^{N})^{-\frac{1}{\gamma^{N}}} = \mathbb{E}_{t} \left((C_{H,t+j,0}^{N})^{-\frac{1}{\gamma^{N}}} \right)$$

$$C_{H,t}^{E} = \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} C_{H,t-j,j}^{E}$$

$$C_{H,t}^{N} = \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} C_{H,t-j,j}^{N}$$

Back

Model

Hand-to-mouth household problem:

$$V(a_{L,t}) = \max_{\{C_{L,t+m,m}^{E}, C_{L,t+m,m}^{N}\}_{m=0}^{\infty}} \sum_{m=0}^{\infty} \beta^{m} (1-\lambda)^{m} \left(\frac{\left(C_{L,t+m,m}^{E}\right)^{1-\frac{1}{\gamma^{E}}}}{1-\frac{1}{\gamma^{E}}} + \varphi \frac{\left(C_{L,t+m,m}^{N}\right)^{1-\frac{1}{\gamma^{N}}}}{1-\frac{1}{\gamma^{N}}} + \eta_{t+j} \mathbb{E}_{t} \left(a_{L,t+m} - C_{L,t+m,m}^{E} - C_{L,t+m,m}^{N} p_{t+m}^{N}\right) \right)$$
$$a_{L,t} \equiv w_{L,t} N_{L,t} + \Pi_{L,t}^{r} + t_{L,t}$$

Back

Household problem - Hand-to-mouth

Hand-to-mouth household equilibrium conditions:

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$$\begin{split} \rho(C_{L,t,0}^{E})^{-\frac{1}{\gamma^{E}}} &= (C_{L,t,0}^{N})^{-\frac{1}{\gamma^{N}}} \frac{1}{p_{t}^{N}} \\ C_{L,t+j,j}^{E})^{-\frac{1}{\gamma^{N}}} &= \mathbb{E}_{t} (C_{L,t+j,0}^{E})^{-\frac{1}{\gamma^{N}}} \\ C_{L,t+j,j}^{N})^{-\frac{1}{\gamma^{N}}} &= \mathbb{E}_{t} (C_{L,t+j,0}^{N})^{-\frac{1}{\gamma^{N}}} \\ C_{L,t}^{E} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} C_{L,t-j,j}^{E} \\ C_{L,t}^{N} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} C_{L,t-j,j}^{N} \end{split}$$

Back

Measurement

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Unions are perfectly competitive and fully attentive. One union per family:

$$\xi \frac{N_{L,t}^{\chi}}{\left(C_{L,t}^{E}\right)^{-\frac{1}{\gamma^{E}}}} = w_{L,t}$$

$$\xi \frac{N_{H,t}^{\chi}}{\left(C_{L,t}^{H}\right)^{-\frac{1}{\gamma^{E}}}} = w_{H,t}$$

Back

There are two sectors, essential and non-essential. Within each sector, we split the firm problem into three parts:

- 1 Wholesalers produce the good, using the two types of labour
- 2 Retailers monopolisitically competitive and subject to Calvo frictions, repackage the wholesale good into different varieties
- **3** Final goods combine the different retail varieties into a bundle, using a CES aggregator.

Back

Firm problems - Wholesaler

Wholesaler production function:

$$Y_t^E = A_t^E (N_{L,t}^E)^{\alpha^E} (N_{H,t}^E)^{1-\alpha^E}$$

 $\alpha^{E} < \alpha^{N}$: there are relatively more low-skilled workers in non-essential goods production than in essential goods production. The solution to their optimization problem is:

$$S_t^E \alpha^E \frac{Y_t^E}{N_{L,t}^E} = \frac{W_{L,t}}{P_t^E}$$
$$S_t^E (1 - \alpha^E) \frac{Y_t^E}{N_{H,t}^E} = \frac{W_{H,t}}{P_t^E}$$



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Model

Retailers:

- Buy a wholesale good of the same type at a wholesale price P_t^{E,w} and use it to produce the retail variety y_{k,t}^E with a linear technology
- Each variety is differentiated, so they have market power
- Calvo pricing: the probability of not being able to reset prices is equal to θ in each period

They choose current prices to maximise the net present value of profits:

$$\mathbb{E}_t \sum_{j=0}^{\infty} SDF_{t,t+j}(\theta)^j \left(\tilde{P}_t^E Y_{k,t+j}^E - P_{t+j}^E (1-\tau^E) \mathcal{S}_{t+j}^E Y_{k,t+j}^E - T_{t+j}^E \right)$$

Back

Model

Giving the equilibrium conditions:

$$\begin{split} \mathcal{K}_{t}^{E,f} &= \left(C_{H,t}^{E}\right)^{-\frac{1}{\gamma^{E}}} Y_{t}^{E} \mathcal{S}_{t}^{E} \frac{\varepsilon^{E}}{\varepsilon^{E} - 1} (1 - \tau^{E}) + \theta \beta \mathbb{E}_{t} (\pi_{t+1}^{E})^{\varepsilon^{E}} \mathcal{K}_{t+1}^{E,f} \\ \mathcal{F}_{t}^{E,f} &= \left(C_{H,t}^{E}\right)^{-\frac{1}{\gamma^{E}}} Y_{t}^{E} + \theta \beta \mathbb{E}_{t} (\pi_{t+1}^{E})^{\varepsilon^{E} - 1} \mathcal{F}_{t+1}^{E,f} \\ \frac{\mathcal{K}_{t}^{E,f}}{\mathcal{F}_{t}^{E,f}} &= \left(\frac{1 - \theta (\pi_{t}^{E})^{\varepsilon^{E} - 1}}{1 - \theta}\right)^{\frac{1}{1 - \varepsilon^{E}}} \end{split}$$

Back

Model

Firm problems - Final good producers

Final good producers operate in perfectly competitive markets, and combine together the retail varieties of a sector using a CES aggregator:

$$Y_t^E = \left(\int_0^1 (y_{k,t}^E)^{\frac{\varepsilon-1}{\varepsilon}} dk\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

Giving a demand function:

$$y_{k,t}^{E} = Y_{t}^{E} \left(\frac{P_{k,t}^{E}}{P_{t}^{E}}\right)^{-\varepsilon}$$

Back

Model

Model - Market clearing conditions

Population is divided in the two types of households with total mass equal to one:

Goods, labour, and bond market clearing:

$$\begin{split} Y_{t}^{E} &= C_{t}^{E} = \sum_{i = \{H, L\}} \mu_{i} C_{i,t}^{E} \\ Y_{t}^{N} &= C_{t}^{N} = \sum_{i = \{H, L\}} \mu_{i} C_{i,t}^{N} \\ N_{H,t}^{E} &+ N_{H,t}^{N} = \mu_{H} N_{H,t} \\ N_{L,t}^{E} &+ N_{L,t}^{N} = \mu_{L} N_{L,t} \\ \mu_{H} B_{H,t} &= 0 \end{split}$$

 $1 = \mu_{H} + \mu_{I}$

Real GDP and overall inflation rate:

$$\begin{split} \mathbf{Y}_{t} &= \mathbf{Y}_{t}^{E} + p^{N} \mathbf{Y}_{t}^{N} \\ \pi_{t, Lasp} &= \frac{P_{t}^{E} C_{t-1}^{E} + P_{t}^{N} C_{t-1}^{N}}{P_{t-1}^{E} C_{t-1}^{E} + P_{t-1}^{N} C_{t-1}^{N}} \\ \pi_{t, Paasche} &= \frac{P_{t}^{E} C_{t}^{E} + P_{t}^{N} C_{t}^{N}}{P_{t-1}^{E} C_{t}^{E} + P_{t-1}^{N} C_{t}^{N}} \\ \pi_{t, Fisher} &= (\pi_{t, Lasp} \pi_{t, Paasche})^{1/2} \end{split}$$

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Measurement

Model

Policy and profit rules

The central bank sets interest rates according to a Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left(\left(\mathbb{E}_t(\pi_{t+1})\right)^{\phi_\pi} \left(\frac{Y_t}{T}\right)^{\phi_Y} \right)^{1-\rho_R} \exp(\varepsilon_t^{mp})$$

Fiscal policy sets profits to zero in steady state:

$$\begin{split} T^E_t &= \tau^E P^E_t S^E_t Y^E_t \\ T^N_t &= \tau^N P^N_t S^N_t Y^N_t \\ \tau^E &= 1/\varepsilon^E \\ \tau^N &= 1/\varepsilon^N \end{split}$$

Profit allocation rule off steady state:

$$\Pi_{k,t} = \phi_{\Pi,k}^{\mathcal{E}} \Pi_t^{\mathcal{E}} + \phi_{\Pi,k}^{\mathcal{N}} \Pi_t^{\mathcal{N}} \quad k = \{H, L\}$$

Back

Non-Essential Business Cycles (Andreolli, Rickard, Surico)

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Model

Log-linearised equilibrium equations

$$\begin{split} -\frac{1}{\gamma^{E}} \hat{C}_{H,t,0}^{E} &+ \frac{1}{\gamma^{N}} \hat{C}_{H,t,0}^{N} = -\hat{\rho}_{t}^{N} \\ \frac{1}{\gamma^{E}} \mathbb{E}_{t} \left(\hat{C}_{H,t+1,0}^{E} \right) &= \frac{1}{\gamma^{E}} \hat{C}_{H,t,0}^{E} - \mathbb{E}_{t} (\hat{\pi}_{t+1}^{E}) + \hat{R}_{t} \\ \hat{C}_{H,t}^{E} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} \mathbb{E}_{t-j} \left(\hat{C}_{H,t,0}^{E} \right) \\ \hat{C}_{H,t}^{N} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} \mathbb{E}_{t-j} \left(\hat{C}_{H,t,0}^{N} \right) \\ -\frac{1}{\gamma^{E}} \hat{C}_{L,t,0}^{E} + \frac{1}{\gamma^{N}} \hat{C}_{L,t,0}^{N} &= -\hat{\rho}_{t}^{N} \\ C_{L}^{E} \hat{C}_{L,t}^{E} + \rho^{N} C_{L}^{N} (\hat{\rho}_{t}^{N} + \hat{C}_{L,t}^{N}) &= w_{L} N_{L} (\hat{w}_{L,t} + \hat{N}_{L,t}) + \frac{\hat{\Pi}_{L,t}'}{\mu_{L}} \\ \hat{C}_{L,t}^{E} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} \mathbb{E}_{t-j} \left(\hat{C}_{L,t,0}^{E} \right) \\ \hat{C}_{L,t}^{N} &= \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j} \mathbb{E}_{t-j} \left(\hat{C}_{L,t,0}^{N} \right) \end{split}$$

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Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Model

Log-linearised equilibrium equations

$$\begin{split} \chi \hat{N}_{H,t} &+ \frac{1}{\gamma^{E}} \hat{C}_{H,t}^{E} = \hat{w}_{H,t} \\ \chi \hat{N}_{L,t} &+ \frac{1}{\gamma^{E}} \hat{C}_{L,t}^{E} = \hat{w}_{L,t} \\ & \hat{\pi}_{t}^{N} = \beta \mathbb{E}_{t} (\hat{\pi}_{t+1}^{N}) + \kappa^{N} \hat{S}_{t}^{N} \\ & \hat{\pi}_{t}^{E} = \beta \mathbb{E}_{t} (\hat{\pi}_{t+1}^{E}) + \kappa^{E} \hat{S}_{t}^{E} \\ & \pi_{t}^{N} = \pi_{t}^{E} + p_{t}^{N} - p_{t-1}^{N} \\ & \hat{Y}_{t}^{N} = \hat{A}_{t}^{N} + \alpha^{N} \hat{N}_{L,t}^{N} + (1 - \alpha^{N}) \hat{N}_{H,t}^{N} \\ \hat{S}_{t}^{N} + \hat{Y}_{t}^{N} - \hat{N}_{H,t}^{N} = \hat{w}_{H,t} - \hat{p}_{t}^{N} \\ & \hat{S}_{t}^{R} + \hat{Y}_{t}^{E} - \hat{N}_{L,t}^{R} = \hat{w}_{H,t} \\ \hat{S}_{t}^{E} + \hat{Y}_{t}^{E} - \hat{N}_{H,t}^{E} = \hat{w}_{H,t} \\ \hat{S}_{t}^{E} + \hat{Y}_{t}^{E} - \hat{N}_{L,t}^{E} = \hat{w}_{L,t} \\ \hat{S}_{t}^{E} + \hat{Y}_{t}^{E} - \hat{N}_{L,t}^{E} = \hat{w}_{L,t} \\ N_{H}^{E} \hat{N}_{H,t}^{E} + N_{H}^{N} \hat{N}_{N,t}^{N} = \mu_{H} N_{H} \hat{N}_{H,t} \\ N_{L}^{E} \hat{N}_{L,t}^{E} + N_{L}^{N} \hat{N}_{L,t}^{N} = \mu_{L} N_{L} \hat{N}_{L,t} \end{split}$$

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Log-linearised equilibrium equations

$$\begin{split} \hat{\pi}_{t} &= \frac{C^{E}}{C^{E} + p^{N}C^{N}} \hat{\pi}_{t}^{E} + \frac{p^{N}C^{N}}{C^{E} + p^{N}C^{N}} \hat{\pi}_{t}^{N} \\ Y \hat{Y}_{t} &= Y^{E} \hat{Y}_{t}^{E} + p^{N}Y^{N} \hat{y}_{t}^{N} \\ \hat{R}_{t} &= \rho_{R} \hat{R}_{t-1} + (1 - \rho_{R}) \left(\phi_{\pi} \left(\mathbb{E}_{t}(\hat{\pi}_{t+1}) \right) + \phi_{Y} \hat{y}_{t} \right) + \varepsilon_{t}^{mp} \\ \hat{\Pi}_{L,t}^{r} &= \delta_{\Pi,t}^{E} \hat{\Pi}_{t}^{r,E} + \phi_{\Pi,L}^{N} \hat{\Pi}_{t}^{r,N} \\ \hat{\Pi}_{t}^{r,E} &= -Y^{E} \hat{S}_{t}^{E} \\ \hat{\Pi}_{t}^{r,N} &= -Y^{N} p^{N} \hat{S}_{t}^{N} \\ C^{E} \hat{C}_{t}^{E} &= \mu_{H} C_{H}^{E} \hat{C}_{H,t}^{E} + \mu_{L} C_{L}^{E} \hat{C}_{L,t}^{E} \\ \hat{Y}_{t}^{E} &= \hat{C}_{t}^{E} \\ \hat{Y}_{t}^{N} &= \hat{C}_{t}^{N} \\ E \hat{a} rn_{t}^{E} &= \frac{w_{H} N_{H}^{E}}{w_{H} N_{H}^{E} + w_{L} N_{L}^{E}} (\hat{w}_{H,t} + \hat{N}_{H,t}^{E}) + \frac{w_{L} N_{L}^{E}}{w_{H} N_{H}^{E} + w_{L} N_{L}^{E}} (\hat{w}_{L,t} + \hat{N}_{L,t}^{E}) \\ E \hat{a} rn_{t}^{N} &= \frac{w_{H} N_{H}^{N}}{w_{H} N_{H}^{N} + w_{L} N_{L}^{N}} (\hat{w}_{H,t} + \hat{N}_{H,t}^{N}) + \frac{w_{L} N_{L}^{N}}{w_{H} N_{H}^{N} + w_{L} N_{L}^{N}} (\hat{w}_{L,t} + \hat{N}_{L,t}^{L}) \end{split}$$

Back

Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Model

Description	Parameter	Posterior		Prior		Distribution	
		Mean	SE	Mean	SE		
IES for essentials	γ^E	0.197	0.111	0.250	0.050	Normal	
IES difference for non-essentials	$\gamma^{N} - \gamma^{E}$	0.686	0.183	1.000	1.000	Normal	
Low skilled share in essentials	α^E	0.019	0.078	0.100	0.004	Beta	
Low skilled share difference in non-essentials	$\alpha^{N} - \alpha^{E}$	0.310	0.084	0.100	0.004	Beta	
Inattentiveness	λ	0.013	0.028	0.050	1.000	Normal	
Interest rate smoothing	ρ_R	0.952	0.007	0.900	0.040	Beta	
Price stickiness	θ	0.958	0.010	0.900	1.000	Beta	

Calibration (

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Estimation method Back

Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Measurement

Model

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Calibration)

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Estimation method Back

Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Measurement

Model

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Calibration Estimation method Back

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Model

Calibrated parameters

Parameter	Value	Description
β	0.99	Time preference
η	0.1	Inverse of the macro Frisch elasticity
ξ	1	Dis-utility of working scaling parameter
ϕ_{π}	1.5	Coefficient of the Taylor rule on expected inflation
ϕ_Y	0.125	Coefficient of the Taylor rule on output
$\phi_{H}^{\Pi,E}$	1	Share of profits by essential retailers going to high skilled households
$\phi_L^{\Pi,E}$	1	Share of profits by essential retailers going to low skilled households
$\phi_{H}^{\Pi,N}$	0	Share of profits by non-essential retailers going to high skilled households
$\phi_L^{\Pi,N}$	0	Share of profits by non-essential retailers going to low skilled households
μ^L	1/3	Fraction of low skilled hand-to-mouth households
\bar{c}_{H}^{E}	0.43	Steady state share of essential good consumption by high skilled households
\bar{C}_L^E	0.56	Steady state share of non-essential good consumption by high skilled households
π^E	1	Steady state inflation in essential goods
π^N	1	Steady state inflation in non-essential goods

Notes: The first column shows the parameter or steady state value calibrated. The scaling parameter for the relative utility of non-essential good (φ) and the relative productivity between essential good production and non-essential good production ($a^E = A^E/A^N$) are computed to with the aid of other parameters to match the steady state share of essential good consumption by high skilled households (\tilde{C}_H^E).



Estimation of model via Maximum a posteriori:

- Maximise the posterior: the sum of the likelihood plus prior distribution over estimated parameters.
- Wide priors for estimation of parameters we would like to be most informed by the macro data, particularly:
 - Heterogeneity in IES between non-essential and essential
 - Inattentiveness
 - Price stickiness
- Likelihood maps difference in empirical and model based IRFs and uses weighting based on empirical IRF SEs following Guerron-Quintana, Inoue, and Kilian (2017)
- Delta method for standard errors.

Back

Strategy to isolate the contribution of each channel

Using our estimated parameters, we start from a simplified New Keynesian model:

- Representative agent: share of constrained, $\mu_L = 0$
- Homothetic preferences: $\gamma_E = \gamma_N = \text{Average IES in estimated model}$
- No labour market heterogeneity: $\alpha_E = \alpha_N$ (=0 in representative agent)
Strategy to isolate the contribution of each channel

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Then, we add back the key features of our model:

Non-homothetic preferences, $\gamma_E < \gamma_N$ (second row)

Strategy to isolate the contribution of each channel

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Then, we add back the key features of our model:

- Non-homothetic preferences, $\gamma_E < \gamma_N$ (second row)
- Heterogenous agents
 - **1** High income and Ricardian
 - 2 Low income and constrained

With two different features:

- The income of both type of HHs moves proportionately $\alpha_E = \alpha_N > 0$ (column 2)
- The low-income type works more in the non-essential sector, $\alpha_N > \alpha_E$ (column 3)

On the sources amplification



Non-Essential Business Cycles (Andreolli, Rickard, Surico)

Measurement

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Mod

Counterfactuals

Non-homotheticity does not matter in representative agent model for aggregates.

$$\begin{array}{l} \mathsf{Homothetic} \to \frac{\partial \hat{\mathcal{C}}_{t}}{\partial \varepsilon_{t}^{mp}} = -\mathit{IES} \\ \mathsf{Non-Homothetic} \to \frac{\partial \hat{\mathcal{C}}_{t}}{\partial \varepsilon_{t}^{mp}} = -(\underbrace{\gamma^{\mathsf{E}}(1 - \overbrace{\bar{\mathcal{C}}^{\mathsf{N}}}) + \gamma^{\mathsf{N}} \overline{\mathcal{C}}^{\mathsf{N}}}_{\mathit{Average IES}}) \end{array}$$

Here for simplicity, expression for textbook model: Full model Proposition Back

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Model

Amplification in consumption categories in representative agent

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	Representative Agent		
	С	CE	C ^N
Homothetic	1.00	1.00	1.00
Non-Homothetic	1.00	0.34	1.51

Panel	А	-	CONSUMPTION
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Panel B - Earnings					
	Representative Agent				
	С	CE	C ^N		
Homothetic	1.00	1.00	1.00		
Non-Homothetic	1.00	0.77	1.18		

Note: Each cell display the ratio of the cumulative IRF over the cumulative IRF of representative agent total consumption (earning) in panel A (B).

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Counterfac

Counterfactual simulations (relative to our estimated model): inequality

	Representative Agent	Heterogeneous Agents				
		Proportional Earning	Earning Inequality			
Homothetic	0	0.22	0.32			
Non-Homothetic	0	0.31	1			
Panel B - Earning						
	Representative Agent	Heterogeneous Agents				
		Proportional Earning	Earning Inequality			
Homothetic	0	0	0.17			
Non-Homothetic	0	0	1			

PANEL A - CONSUMPTION

Note: The object of interest is the cumulative of the change in economic size of high-skilled vs low-skilled households (e.g. for consumption $\frac{C^H}{C^L}(\hat{c}_t^H - \hat{c}_t^L))$. Each cell displays the ratio of the object of interest of counterfactual model over the object of interest of the estimated model.

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Non-Essential Business Cycles (Andreolli, Rickard, Surice

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Non-homotheticity does not matter in RANK: a proposition

 $PROPOSITION \ 1 \ \text{Consider a simplified version of the model of the Non-Essential Business Cycles. Take an attentive representative agent version with non-homothetic utility:}$

$$U(C_t^E, C_t^N, N_t) = \frac{(C_t^E)^{1 - \frac{1}{\gamma^E}}}{1 - \frac{1}{\gamma^E}} + \varphi \frac{(C_t^N)^{1 - \frac{1}{\gamma^N}}}{1 - \frac{1}{\gamma^N}} - \xi \frac{N_t^{1 + \chi}}{1 + \chi}$$

and a simplified Taylor rule of the form $R_t = \phi_\pi \mathbb{E}_t(\pi_{t+1}) + \varepsilon_t^{mp}$. The impact of the monetary policy shock on total consumption is characterised by the average intertemporal elasticity of substitution and on CPI inflation by the average intertemporal elasticity of substitution and the slope of the Phillips curves:



Back

Model

Non-homotheticity does not matter in RANK: a corollary

COROLLARY 1 Consider a simplified version of the model of the Non-Essential Business Cycles. Take an attentive representative agent version with homothetic utility:

$$U(C_t^E, C_t^N, N_t) = \frac{(C_t^E)^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} + \varphi \frac{(C_t^N)^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} - \xi \frac{N_t^{1+\chi}}{1+\chi}$$

such that the intertemporal elasticity of substitution γ is equal to $\gamma^{\mathcal{E}}(1-\bar{C}^{N}) + \gamma^{N}\bar{C}^{N})$ of the model presented in Proposition 1, and a simplified Taylor rule of the form $R_t = \phi_{\pi} \mathbb{E}_t(\pi_{t+1}) + \varepsilon_t^{mp}$. The impact of the monetary policy shock on total consumption is characterised by the intertemporal elasticity of substitution and on CPI inflation by the intertemporal elasticity of substitution and the slope of the Phillips curves:



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Model

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