A tail of labor supply and a tale of monetary policy

Banca D'Italia - Online

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The views expressed in this paper are those of the authors and are not necessarily reflective of views at the Bank of England, the Federal Reserve Bank of Chicago or the Federal Reserve System.

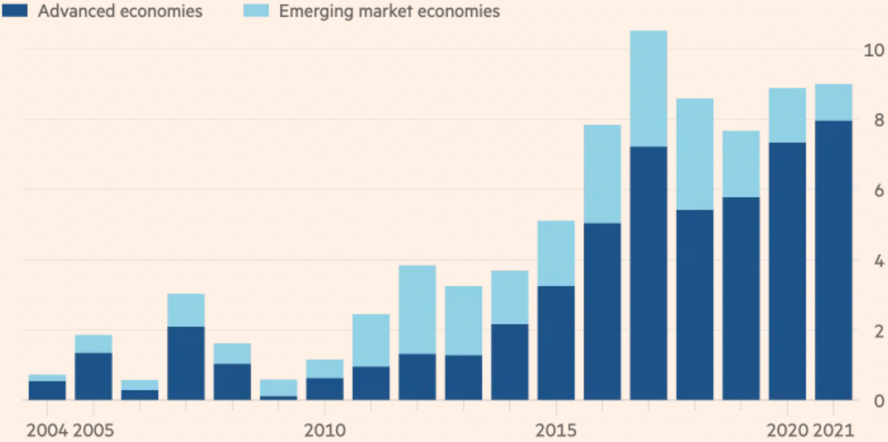
Roadmap

- Introduction
- Empirical Evidence
- Theory
- Conclusions
- Appendix

Introduction

Central bankers become increasingly 'woke' on inequality

Central bankers' speeches: per cent mentioning 'inequality' or 'distributional impact/consequences'



Source: BIS

Motivation

- Relative to the inter-temporal channel (**Euler equation**), the intra-temporal allocation between consumption and leisure (**Labor Supply equation**) has received much less attention.
- We study the effect of **monetary policy** (MP) on **labor supply** decisions at the household level (HH).
- Revisit the implications of **inequality** on the effectiveness of **monetary policy**.

Preview of the results

1. The **left tail** of the income distribution (in US and the UK) represents a **non negligible %** of total private hours and exhibits a **strong income effect on labor supply**:
   - Conditional on keeping the job they **increase their labor supply** after an $\Uparrow R$.
   - Larger elasticity of labor supply.
2. Two-agent New Keynesian (**TANK**) set up with **poor HtM**
   - Allow for: **IES heterogeneity** (increasing with income)
3. **Implications of inequality for MP effectiveness**.
   - Homogeneous IES: $\Uparrow$ inequality $\Rightarrow$ amplifies MP.
   - **Heterogeneous IES**: $\Uparrow$ inequality $\Rightarrow$ **dampens MP.**

- **Heterogenous effects of Monetary Policy in the data**:
  - **MPC and income**: Cloyne, Ferreira, and Surico, 2020; Auclert, 2019; Andersen et al., 2020; Holm, Paul, and Tischbirek, 2020; Amberg et al., 2021.
  - **Labor mkt**: Kehoe et al., 2020; Bergman, Matsa, and Weber, 2021; Jasova et al., 2021.
- **Heterogenous effects of Monetary Policy in theory**:
  - **HANK**: Athreya, Owens, and Schwartzman, 2017, McKay, Nakamura, and Steinsson, 2016, Guerrieri and Lorenzoni, 2017, Kaplan, Moll, and Violante, 2018, Auclert, 2019, Wong, 2020
  - **TANK**: F. Bilbiie, 2008, Debortoli and Galí, 2017, F. Bilbiie, 2020, F. O. Bilbiie, Monacelli, and Perotti, 2013, F. Bilbiie, 2021
- **Heterogenous IES due to Income & Asset market participation**:
  - Mankiw and Zeldes, 1991, Blundell, Browning, and Meghir, 1994, Attanasio and Browning, 1995, Attanasio, Banks, and Tanner, 2002, Vissing-Jørgensen, 2002, Calvet et al., 2021
- **Marginal propensity to consume/earn**:
  - **MPC:** Patterson, 2021
  - **MPE:** Golosov et al., 2021, Cesarini et al., 2017, Powell, 2016, Domeij and Flodén, 2006, Imbens, Rubin, and Sacerdote, 2001
- **Monetary Policy/Agg. Demand and Inequality**:
  - Coibion et al., 2017, Mumtaz and Theophilopoulou, 2017, Auclert and Rognlie, 2020, Broer, Kramer, and Mitman, 2021

Poor Hand to Mouth

- Literature on **consumption heterogeneity** has stressed the importance of **borrowing constraints** and **wealthy HtM** (Kaplan, Violante, and Weidner, 2014).
- We show that focusing on **labor supply heterogeneity** puts the focus back on the **poor HtM** with preference **heterogeneity**.
- ▸ Cross-sectional variance contribution of the left tail of the earnings/income distribution:

	Hours	Consumption	Relative
CPS bottom 20%	24%	-	-
CEX bottom 25%	18%	12%	1.5

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Empirical Evidence

Data

- **Individual & Household survey data** for US (CEX/CPS) and UK (FES/LFS) working age population to study decisions by percentile of gross **income/earnings**.
- Individuals/HH are assigned to each month/quarter of the year by their date of interview (see Cloyne and Surico, 2016) and sorted into multiple bins by gross earning/income.
- We look at **hours worked** and **labor income** (CEX/FES) or **hourly wages** (CPS/LFS). ▸ details ▸ aggregate
- Averages are computed in each of these groups using survey weights.
- Repeat this for each year in the sample to get a monthly/quarterly time-series for each group.

Empirics

- **FAVAR with IV identification** (in levels). details
- X_t (Macro-Financial plus Survey): real activity, employment, inflation, money, credit, spreads and asset prices.

  US : CEX 238 series, 1984Q1 to 2018Q4
  CPS 137 series, 1994m1 to 2019m12.

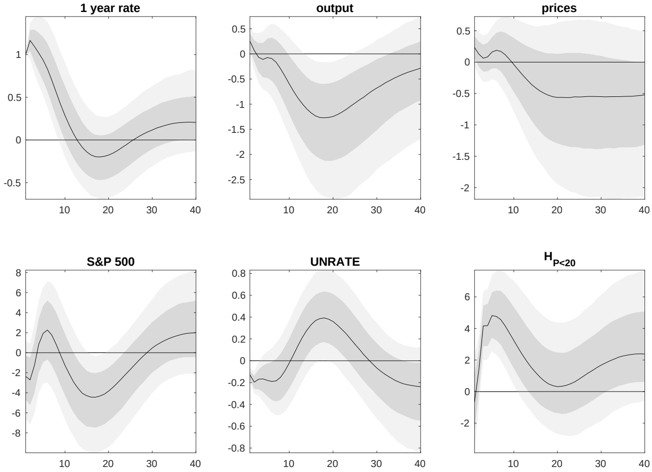
  UK : FES 75 series, 1979Q1 to 2019Q4.
  LFS 103 series, 1994Q1 to 2019Q4.
- m_t (instrument): intraday variation of interest rates to MP announcements

  US : Gertler and Karadi, 2015, Miranda-Agrippino and Ricco, 2020

  UK : Gerko and Rey, 2017, Cesa-Bianchi, Thwaites, and Vicondoa, 2020
- Why FAVAR? structural vs idiosyncratic shocks (and ME) [De Giorgi and Gambetti, 2017].

US: CEX

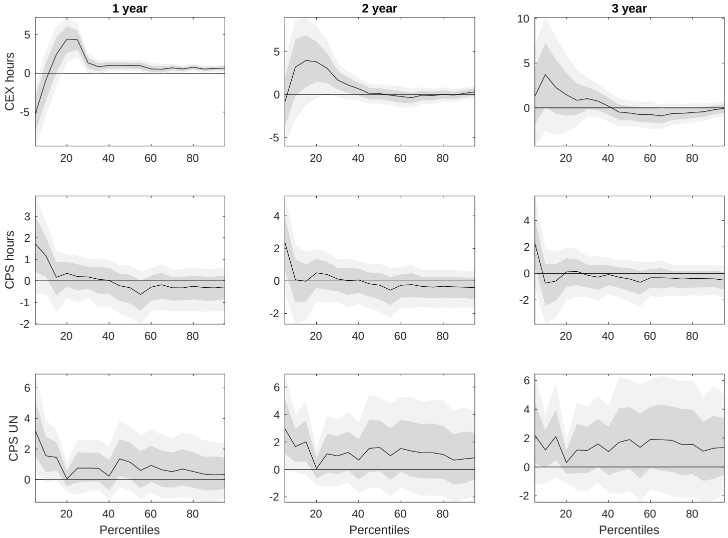
UK



US: Hours and Unemployment

▸ CEX ▸ CPS ▸ Unempl ▸ UK

across the income/earnings distribution

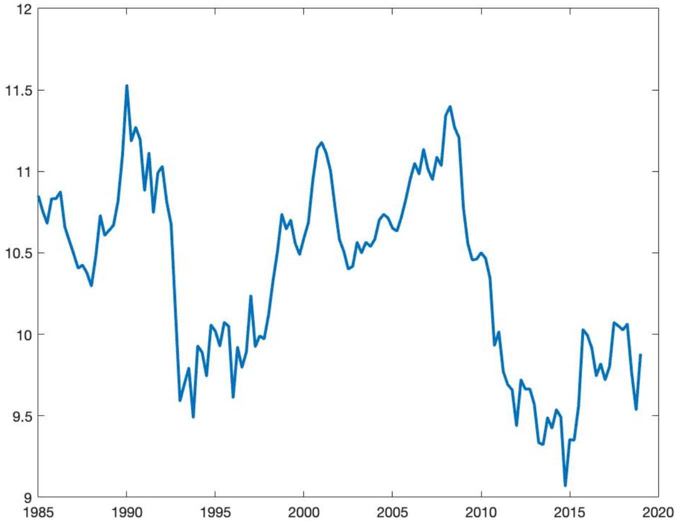


Robustness

- Alternative Monetary policy shock ▸ identification
- Response by ▸ industry
- Response by ▸ occupation
- Response by Housing ▸ tenure
- Asymmetric effects: easing vs tightening.

US: Hours proportion of the bottom 25% CEX

▸ CPS ▸ pHtM



Roadmap

Theory

Two-agents NK (TANK) models

- Permanent Income Hypothesis: after a rate hike $\Downarrow C$ & $\Downarrow H$.
  (**return on savings** $>$ **return on working**)
- We need to move away from the PIH.
- TANK models where a fraction of HH cannot optimize intertemporally
  - Poor HtM with standard homogenous IES F. Bilbiie, 2008
  - Poor HtM with heterogeneous IES (Attanasio, Banks, and Tanner, 2002; Vissing-Jørgensen, 2002).
    1. IES bondholders=0.8
    2. IES non bondholders=0.1
- Key is to have **income** $>$ **substitution effect**

Simple TANK model

F. Bilbiie, 2008, F. Bilbiie, 2020

- Discrete time, infinite horizon model;
- Real quantities are in terms of the consumption good (x_t) while nominal variables (X_t).
- Log-linear variables in deviation from their steady state ($\hat{x}_t$).
- The economy consists of households, firms and a central bank.
- The firm sector is standard. Only labor used in production and Rotemberg price adjustment costs. No technology shocks.
- The central bank follows a Taylor type rule to choose the *real* interest rate. Monetary policy shock.

Households

- There is a continuum of households $[0, 1]$.
- There are two types of households: A share λ of households are HtM (**H**) who work and consume all of their income.
- The remaining $1 - \lambda$ are savers (**S**) who hold bonds and shares in monopolistic firms and get firm profits.
- Both the same utility function $\left(\frac{(c_t^j - \bar{c})^{1-\frac{1}{\sigma_j}}}{1-\frac{1}{\sigma_j}} - \nu \frac{(H_t^j)^2}{2} \right)$ (with j=S,H) allowing for RA decreasing with income. non-homothetic preferences
- Savers price all assets and get all returns, thus there is limited asset market participation.
- The savers problem is the one of a standard permanent income hypothesis/ricardian agent.

details

Log-linearized Conditions of TANK with HtM		
1:	Aggregate Condition	$(1-\lambda)\hat{H}_t^S + \lambda \hat{H}_t^H = \hat{H}_t = \hat{c}_t = (1-\lambda)\hat{c}_t^S + \lambda \hat{c}_t^H$
2:	Euler	$\hat{c}_t^S = \hat{c}_{t+1\|t}^S - \sigma_S \left(\hat{R}_t - \hat{\Pi}_{t+1\|t}\right)$
3-4:	Labor Supply $j = S, H$	$\varphi \hat{H}_t^j = \hat{w}_t - \frac{1}{\sigma_j}\hat{c}_t^j$
5:	Budget constraint H	$\hat{c}_t^H = \hat{H}_t^H + \hat{w}_t$
6:	Phillips Curve	$\hat{\Pi}_t = \beta \hat{\Pi}_{t+1\|t} + \kappa \hat{w}_t$
7:	Taylor Rule	$\hat{R}_t = \hat{\Pi}_{t+1\|t} + \epsilon_t^m$

Table: TANKs: S PIH *Savers*; H poor HtM. Symmetric steady state: $c^H = c^S = H^H = H^S = 1$

Analytical results

- **Savers**: $\hat{c}_t^S = -\sigma_S \epsilon_t^m$
- **HtM**: $\hat{H}_t^H = \frac{\sigma_H - 1}{\sigma_H \varphi + 1} \hat{w}_t;\;\; \hat{c}_t^H = \frac{\sigma_H (\varphi + 1)}{\sigma_H \varphi + 1} \hat{w}_t$
- **Proposition:** *Under SADL ($\lambda < \frac{1}{1+\varphi}$) and with a sufficiently low IES of the HtM (e.g. $\sigma_H < 1$), a rate hike induces a decline in total hours worked and an increase in the HtM labor supply.*
- ▸ Labor supply elasticities

MP *amplification* or *dampening*?

- $\chi = \frac{\hat{c}_t^H}{\hat{y}_t}$ as the **elasticity of HtM consumption to aggregate income**.
- F. Bilbiie, 2008: $\chi > 1 \Rightarrow$ MP *amplification*. (countercycical inequality)
- with $\sigma_H = \sigma_S \Rightarrow \chi = 1 + \varphi$. Indipendent of λ and IES.

- with $\sigma_H \neq \sigma_S$:

$$\chi = \frac{\frac{\sigma_H}{\sigma_S}(\varphi + 1)(\sigma_S \varphi + 1)}{\lambda\left(\frac{\sigma_H}{\sigma_S} - 1\right)(\varphi + 1) + \sigma_H \varphi + 1}.$$

- χ increasing in λ if $\frac{\sigma_H}{\sigma_S} < 1$.

Inequality (λ) and Monetary Policy

Homogeneous IES - $\sigma_H = \sigma_S$

- χ is crucial because it affects the **slope** of the Aggregate Demand:

$$\hat{c}_t = \hat{c}_{t+1|t} - \frac{(1-\lambda)\sigma_S}{1-\chi\lambda}(\hat{R}_t - \hat{\Pi}_{t+1|t}). \tag{1}$$

  - Standard Aggregate Demand Logic (SADL)$\left(\lambda < \frac{1}{\chi}\right)$ = the slope of the aggregate IS curve remains negative.
- What happens when inequality (λ) increases (under SADL)?
  - Aggregate consumption $\hat{c}_t = -\sigma_S \frac{(1-\lambda)}{1-\chi\lambda}\, \epsilon_t^m$.
    We have that $\lambda \uparrow \rightarrow |c| \uparrow$. **Monetary policy *amplification***

Inequality (λ) and Monetary Policy

Heterogeneous IES - $\sigma_S \neq \sigma_H$

- Aggregate Euler equation:

$$\hat{c}_t = \hat{c}_{t+1|t} - \underbrace{\frac{(1-\lambda)\sigma_S}{1-(1+\varphi))\lambda}}_{(+)\text{ when }\lambda\uparrow} \times \underbrace{\frac{\lambda\left(\frac{\sigma_H}{\sigma_S}-1\right)(\varphi+1)+\sigma_H\varphi+1}{\sigma_H\varphi+1}}_{(-)\text{ when }\lambda\uparrow\text{ if }\frac{\sigma_H}{\sigma_S}<1} \times (\hat{R}_t - \hat{\Pi}_{t+1|t}) \tag{2}$$

Heterogeneity in Marginal Rate of Substitution (MRS)

- The dampening effect is a consequence of the **heterogeneity in the MRS** between hours and consumption.
- With **homogenous preferences** individual and aggregate MRS move in the same proportion $\varphi \hat{H}_t + \frac{\hat{c}_t}{\sigma_S} = \hat{w}_t$.
- With heterogeneous preference this is no longer true:

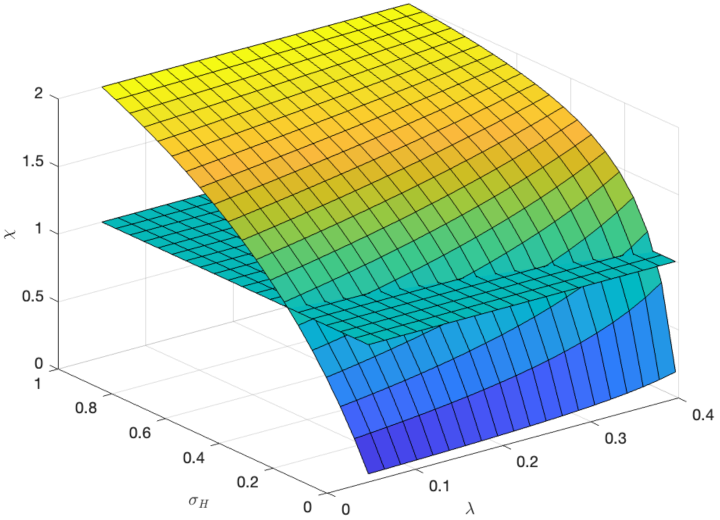
$$\left(\varphi \hat{H}_t + \frac{\hat{c}_t}{\sigma_S}\right) \underbrace{+\lambda \left(1 - \frac{\sigma_H}{\sigma_S}\right) \frac{\hat{c}_t^H}{\sigma_H}}_{\Downarrow \text{ when } \lambda \uparrow \& \frac{\sigma_H}{\sigma_S} < 1} = \hat{w}_t$$

- IES heterogeneity makes the sign of the slope of the Euler equation depend on λ even if we restrict our attention to the SADL region.

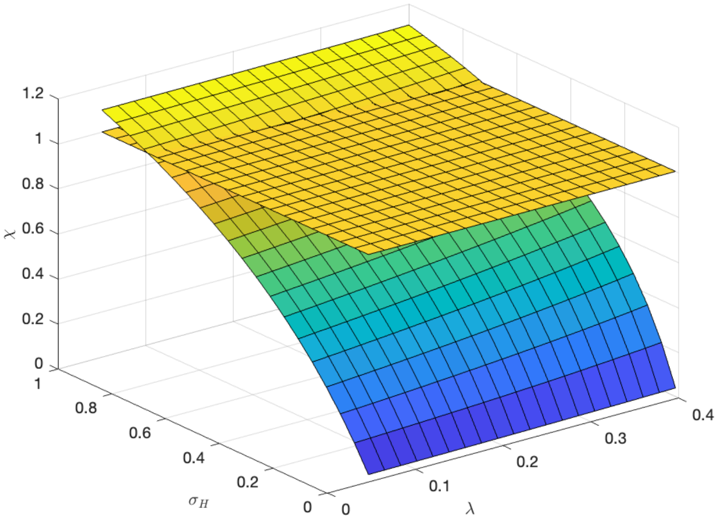
details

surface simul

χ



χ - Sticky Wages



Medium Scale TANK

F. Bilbiie, 2008 meets Christiano, Eichenbaum, and Evans, 2005

- Consumption & hours inequality in steady state.
- Capital + Investment adjustment costs.
- Sticky wages.
- Taylor rule with contemporaneous inflation + smoothing.
- ▸ Calibration : $\sigma_H = 0.1$ and $\sigma_S = 0.80$ (Vissing-Jørgensen, 2002) $\Rightarrow \chi = 0.5$.

Inequality and Monetary Policy

Dampening

- Changes in the effect of monetary policy tightening when λ increases from 10 to 11%:

	Output	Consumption	Agg. Hours	Inflation
Impact	-0.54%	-0.56%	-0.54%	0.16%
1 year	-3.17%	-4.22%	-3.25%	0.99%
2 year	-45.95%	-6.23%	-17.86%	2.95%

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Conclusions

- We study the effect of monetary policy on labor supply.
- Using **survey data** and a **FAVAR** we find that in US and in the UK this response is **heterogeneous**.
- While aggregate hours decline, **labor supply of poor household increases** (conditionally on keeping the job).
- We rationalize this result allowing for **IES heterogeneity** in a two-agents New-Keynesian model set up and revisit the implications of inequality on the effectiveness of monetary policy.
- When IES are heterogeneous **higher inequality dampens the aggregate effects of monetary policy**.

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Roadmap

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Appendix

Cross sectional variance

return

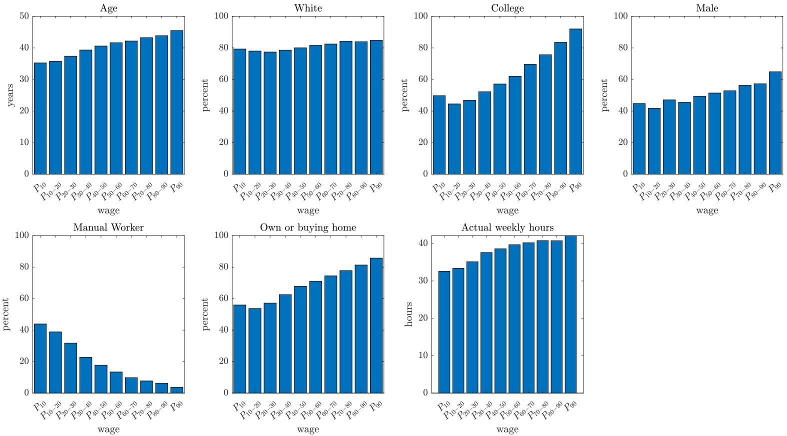
- $$\underbrace{\Gamma}_{Total\ variance} = \underbrace{\Gamma^G}_{Between\ Groups} + \underbrace{\Gamma^1}_{Group1} + ... + \underbrace{\Gamma^T}_{GroupT}$$
- We are interested in $\frac{\Gamma^1}{\Gamma}$.
  - $\Gamma = \sum_{i=1}^{N} \left(h(i) - \bar{h}\right)^2$
  - $\Gamma^1 = \sum_{i=1}^{N^1} \left(h^1(i) - \bar{h}^1\right)^2$
  - $\bar{h}$ is the mean across all individuals,
  - $\bar{h}^1$ is the mean across individuals that belongs to group 1,
  - $h^1(i)$ from $i = 1, ...N^1$ people in group 1.

Hours and Wage data

US CPS

- We use actual hours worked in the main job (AHRSWORK1) as our main measure of weekly hours.
- Our measure of hourly earnings is constructed by using the variable HOURWAGE, the amount earned per hour in current job reported by respondents who are paid hourly.
  - For respondents that are paid weekly, we construct earnings by dividing the variable EARNWEEK (usual weekly earnings) by UHRSWORK1 (usual weekly hours in main job).
- We drop respondents that lie in the top and bottom percentile of the earnings distribution or are aged less than 18 or more than 66.

return

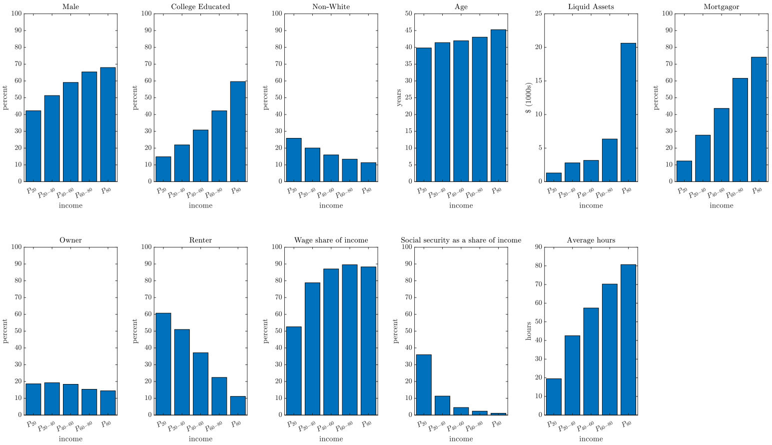

Age
years
wage
White
percent
wage
College
percent
wage
Male
percent
wage
Manual Worker
percent
wage
Own or buying home
percent
wage
Actual weekly hours
hours
wage
P_{10} P_{10-20} P_{20-30} P_{30-40} P_{40-50} P_{50-60} P_{60-70} P_{70-80} P_{80-90} P_{90}

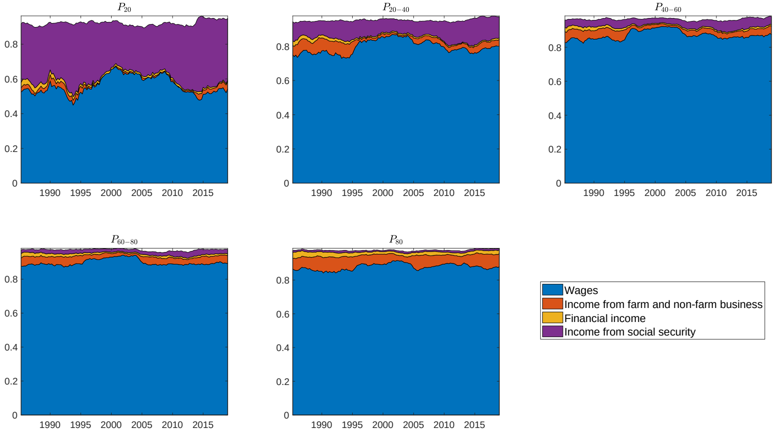
Hours and earnings data

return

US CEX

- We decompose income into the following categories:
    1. **Labor Income**.
    2. **Ambiguous Income**: Amount of income or loss from non-farm business + Amount of income or loss from farm business.
    3. **Social Security**: Amount of Social Security and Railroad Retirement income + Unemployment Compensations + Workers Compensation and veterans' payments + public assistance or welfare including job grants plus food stamps.
    4. **Financial Income**: Interest on saving or bonds + Amount of regular income from dividends royalties, estates, or trusts +Amount of income from pensions or annuities from private companies + Amount of net income or loss from roomers or boarders +Amount of net income or loss from other rental units.


Male
College Educated
Non-White
Age
Liquid Assets
Mortgagor
Owner
Renter
Wage share of income
Social security as a share of income
Average hours
percent
years
$ (1000s)
hours
income
P_{20}
P_{20-40}
P_{40-60}
P_{60-80}
P_{80}

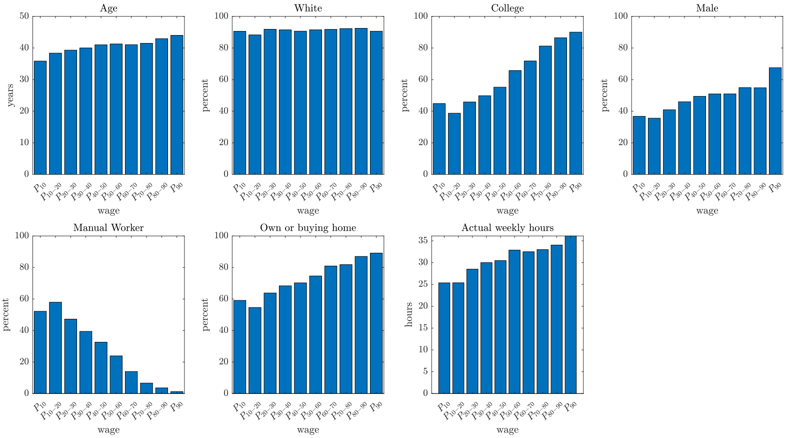

P_{20}
P_{20-40}
P_{40-60}
P_{60-80}
P_{80}
0
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
Wages
Income from farm and non-farm business
Financial income
Income from social security

Hours and Wage data

UK LFS

- We use actual hours worked for each individual (TTACHR).
- Our measure of hourly earnings is the variable HOURPAY.
- We drop respondents that lie in the top and bottom percentile of the earnings distribution or are aged less than 18 or more than 66.

return



Age
years
White
percent
College
percent
Male
percent
Manual Worker
percent
Own or buying home
percent
Actual weekly hours
hours
P_{10} P_{10-20} P_{20-30} P_{30-40} P_{40-50} P_{50-60} P_{60-70} P_{70-80} P_{80-90} P_{90}
wage

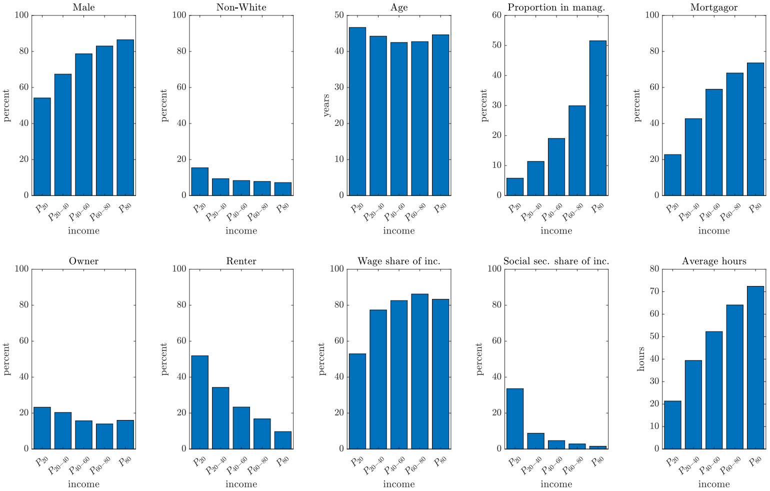
Hours and earnings data

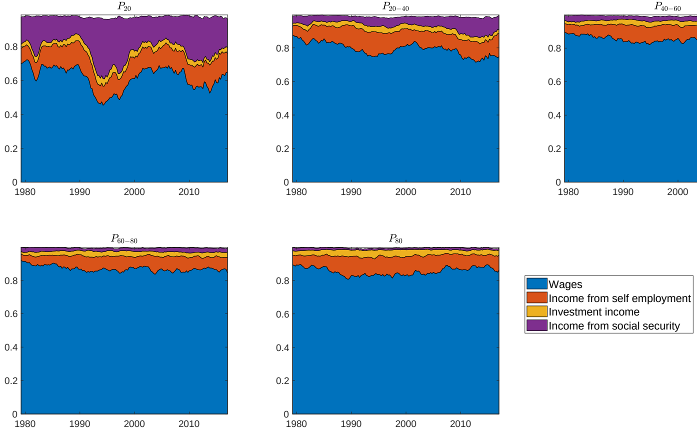
return

UK FES

- We decompose income into the following categories:

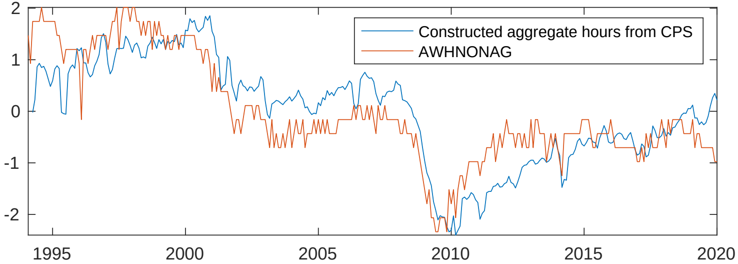
    1. **Labor Income**.
    2. **Ambiguous Income**: wage from subsidiary employment plus income subsidiary self-employment plus income from self-employment.
    3. **Social Security**.
    4. **Financial Income**: income from investment and income from pensions annuities.

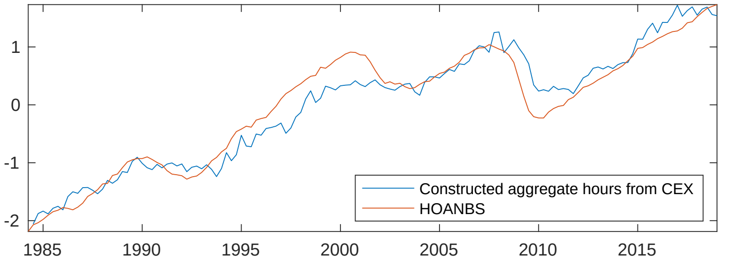

Male
Non-White
Age
Proportion in manag.
Mortgagor
Owner
Renter
Wage share of inc.
Social sec. share of inc.
Average hours
percent
years
hours
income
P_{20}
P_{20-40}
P_{40-60}
P_{60-80}
P_{80}


P_{20}
P_{20-40}
P_{40-60}
P_{60-80}
P_{80}
0
0.2
0.4
0.6
0.8
1980
1990
2000
2010
Wages
Income from self employment
Investment income
Income from social security

Comparison with aggregate data US

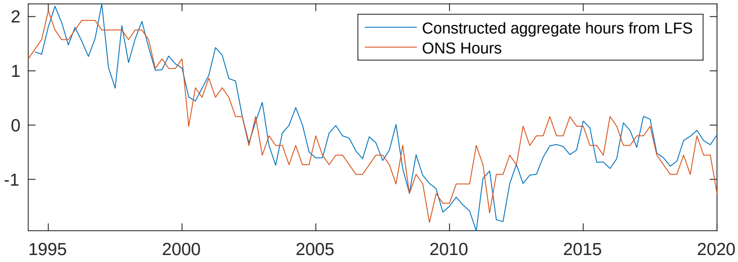
return

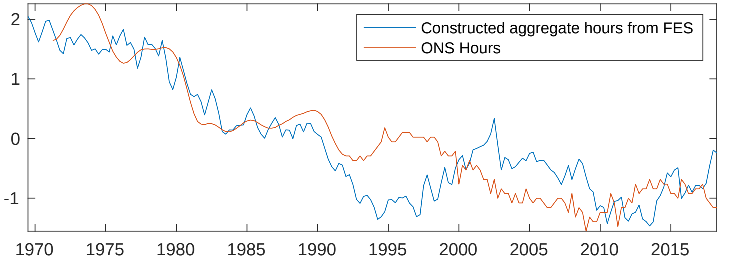




Comparison with aggregate data UK

return





Empirical Model

▸ return

- We estimate a Factor Augmented VAR (FAVAR) in the US and in the UK in **levels**

$$Y_t = \begin{pmatrix} R_t \\ F_t \end{pmatrix} = c + \sum_{j=1}^{P} B_j Y_{t-j} + u_t \tag{3}$$

$$X_t = \beta_0 + \beta_1 \tau + \Lambda F_t + \xi_t \tag{4}$$

  R_t denotes the interest rate, X_t contains **many** times series including surveys and $\hat{F}_t$ represent factors that summarize this information.

- Reduced form u_t are related to structural macro shocks ε_t via

$$u_t = A_0 \varepsilon_t$$

- Why a FAVAR?

Empirical Model

return

- m_t observed proxy of monetary policy *surprise*. [Stock and Watson, 2008 and Mertens and Ravn, 2013]
- Relevance and exogeneity conditions

$$E(m_t \varepsilon_t') = [\alpha \;\; 0]$$
$$E(m_t u_t') = [\alpha \;\; 0] A_0' = b$$

- The latter parametrized and stacked with the FAVAR equations

$$m_t = b u_t + v_t \tag{5}$$

- the correlation is not spurious if u_t and m_t are unpredictable based on $t-1$ info set. With small scale VARs, u_t might be predictable

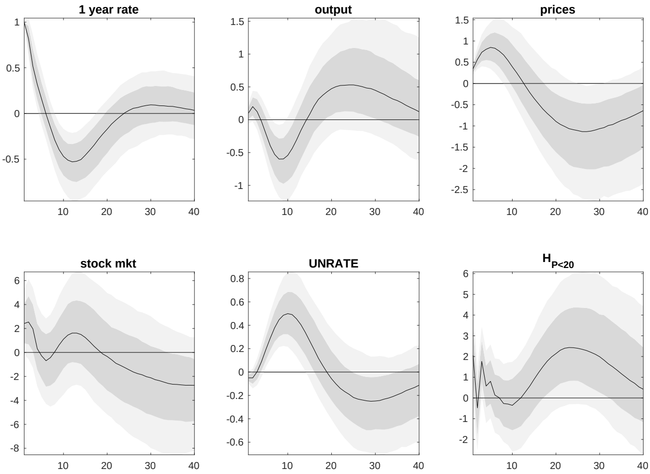
Empirical Model

return

- The number of factors in the FAVAR model for the US are chosen via the information criteria of Bai and Ng, 2002.
- The PC_P criteria suggest the presence of 11 factors for the US.
- The number of factors for the UK FAVAR are also set to 11. (PC_P suggests 10 but IRFs not consistent with theory: large price puzzle)
- The lag length is set to 2.
- The parameters of the VAR model and the instrument equation are estimated using the Gibbs sampling algorithm introduced by Bahaj, 2020.

UK: FES

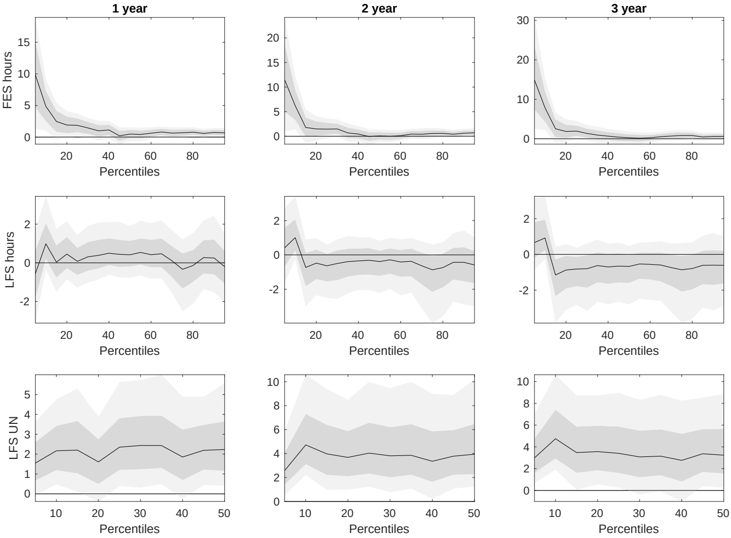
return



UK: Hours and Unemployment

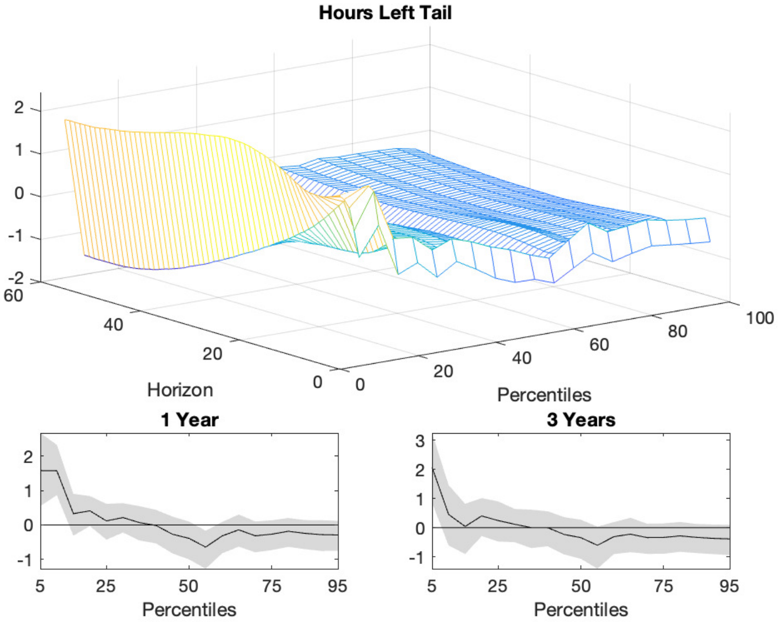
FES LFS Unempl return

across the income/earnings distribution



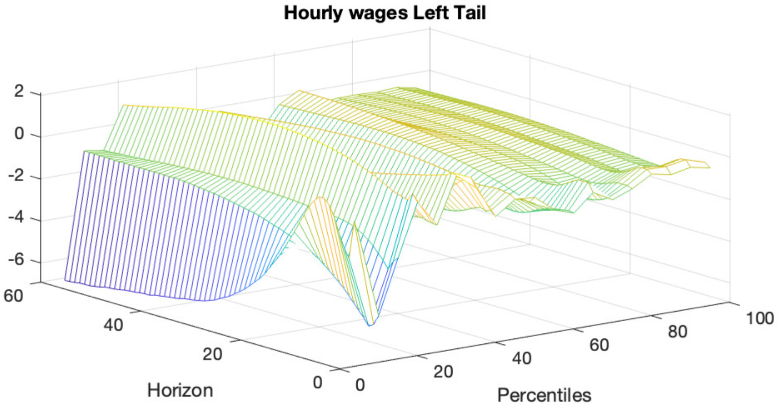
US: 3D Hours of the left tail - CPS

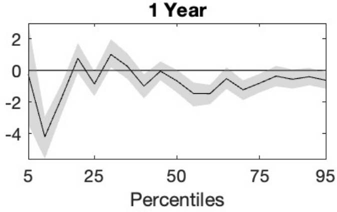
return

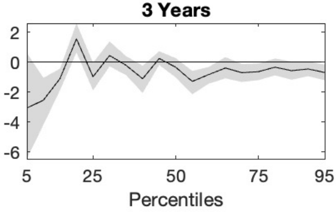


US: 3D Wages of the left tail - CPS

▸ return

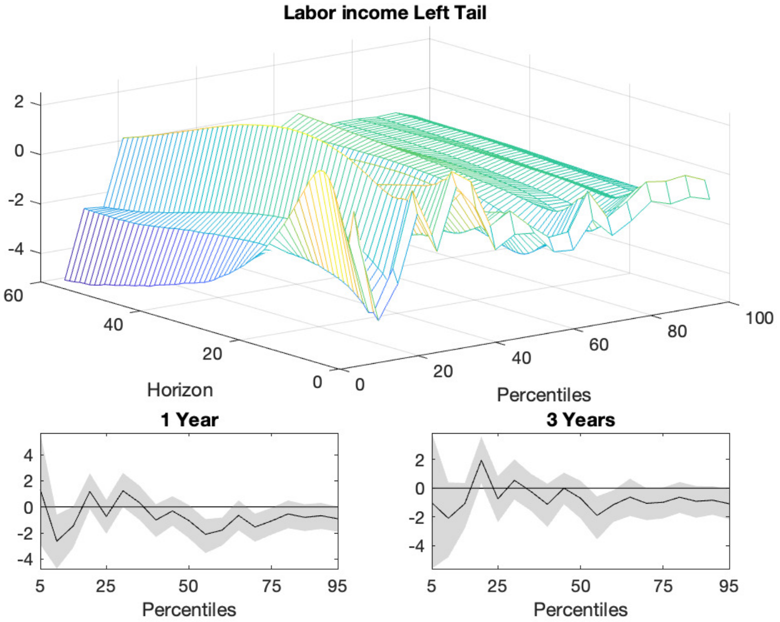






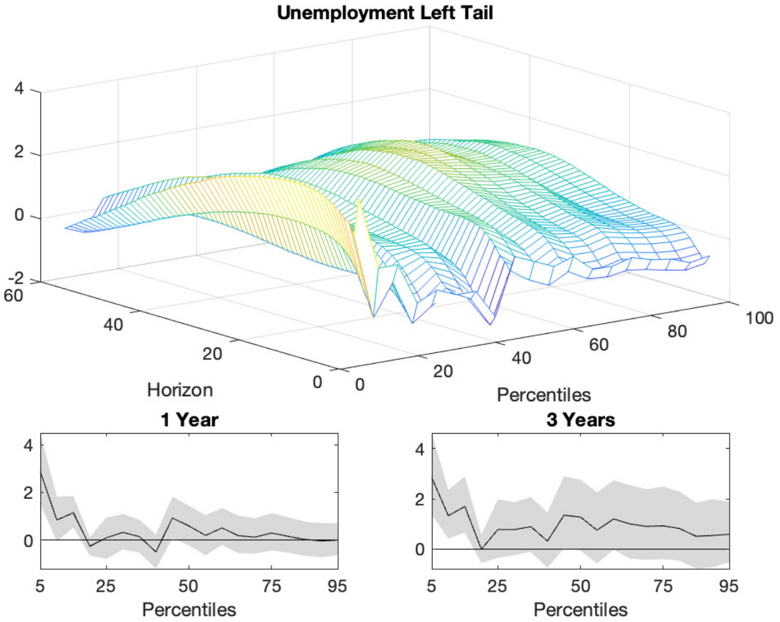
US: 3D Labor income of the left tail - CPS

▸ return



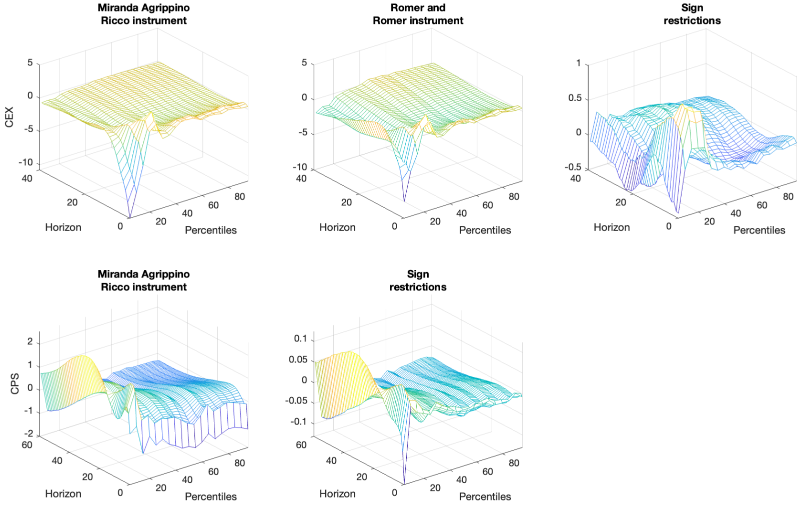
US: 3D Unemployment of the left tail - CPS

return



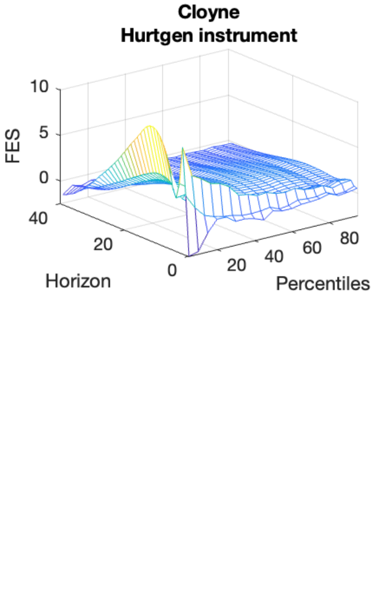
US: Robustness

return



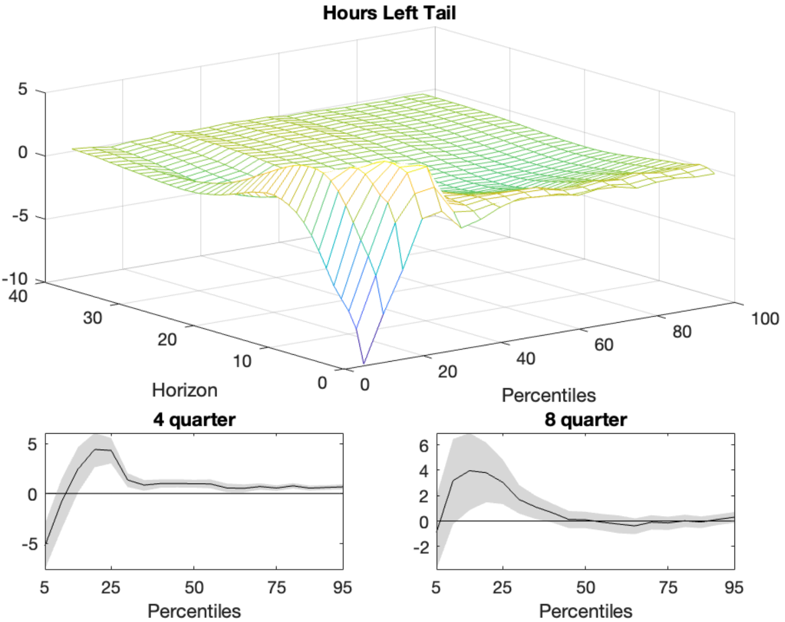
UK: Robustness

return



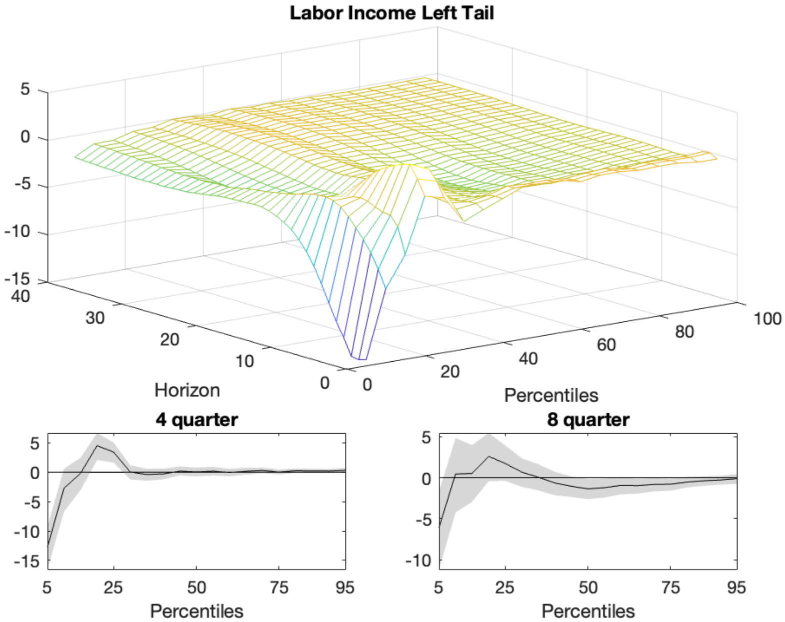
US: 3D Hours of the left tail - CEX

▸ return



US: 3D Labor income of the left tail - CEX

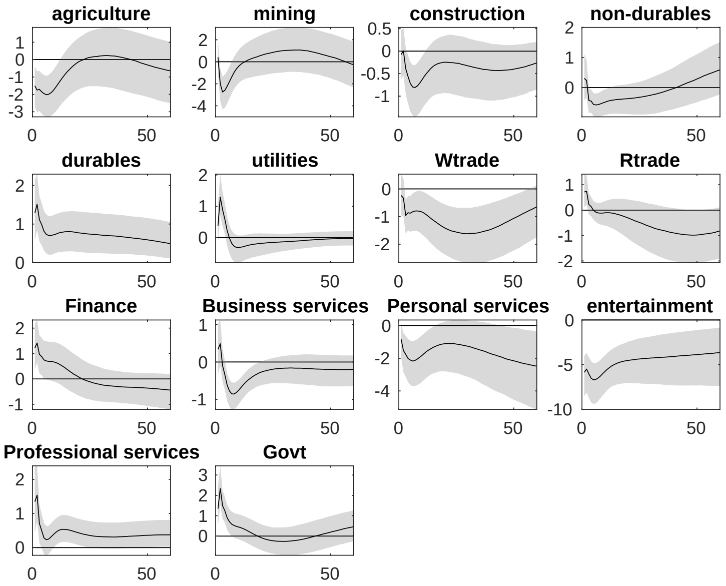
return



US: 3D Hourly wage of the left tail - CEX

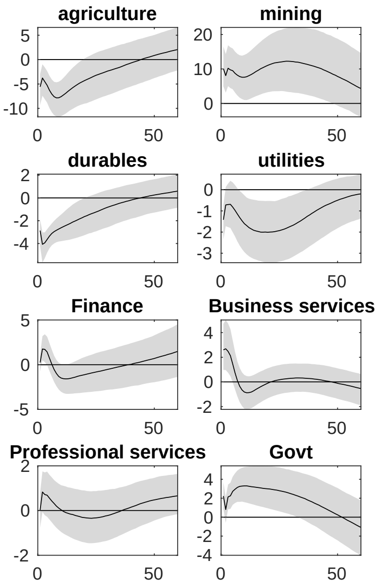
US: (CPS) Results by industry (Hours)

return



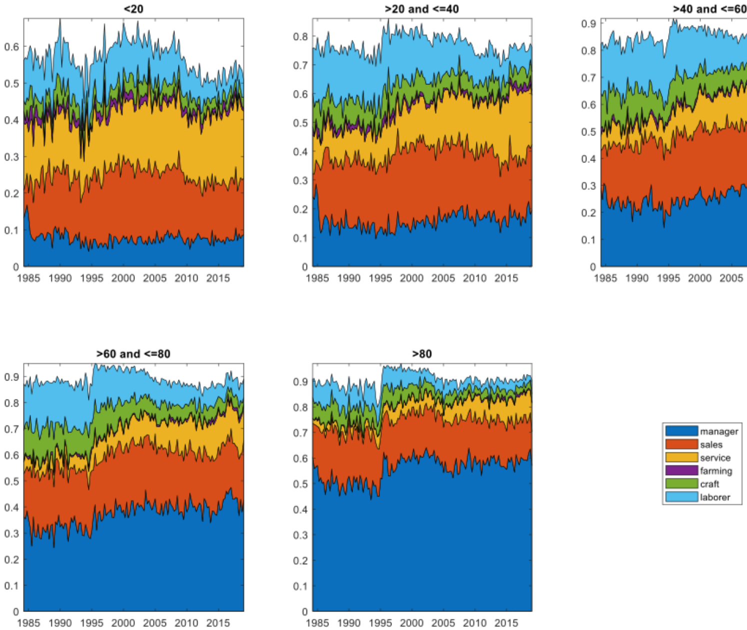
US: (CPS) Results by industry (Wages)

return



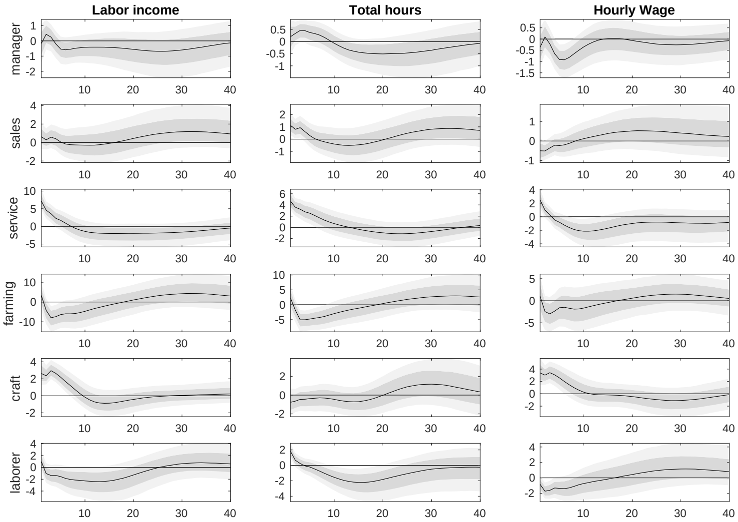
US: (CEX) Results by occupation

return



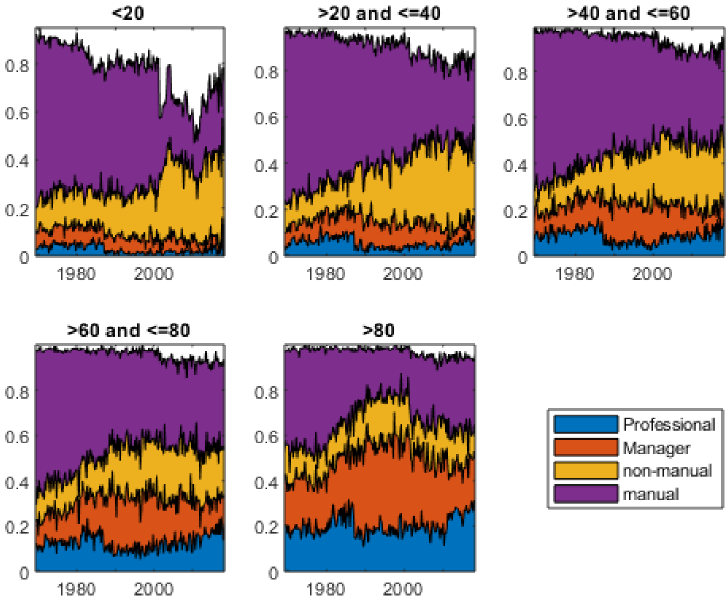
US: (CEX) Results by occupation

return



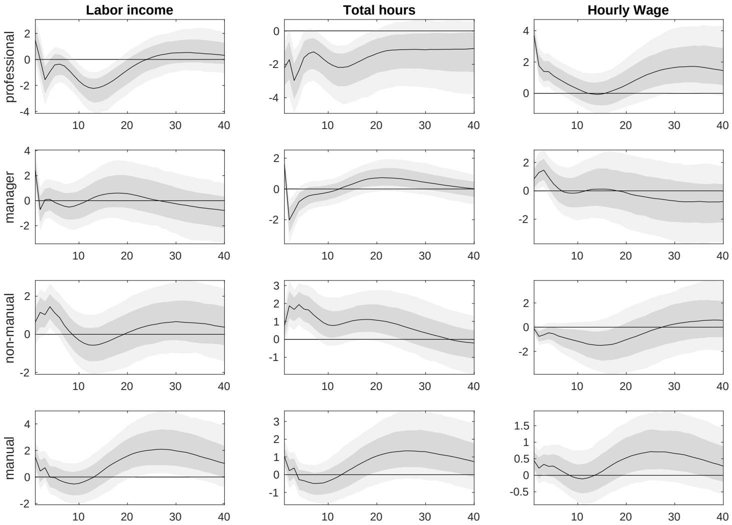
UK: (FES) Results by occupation

return



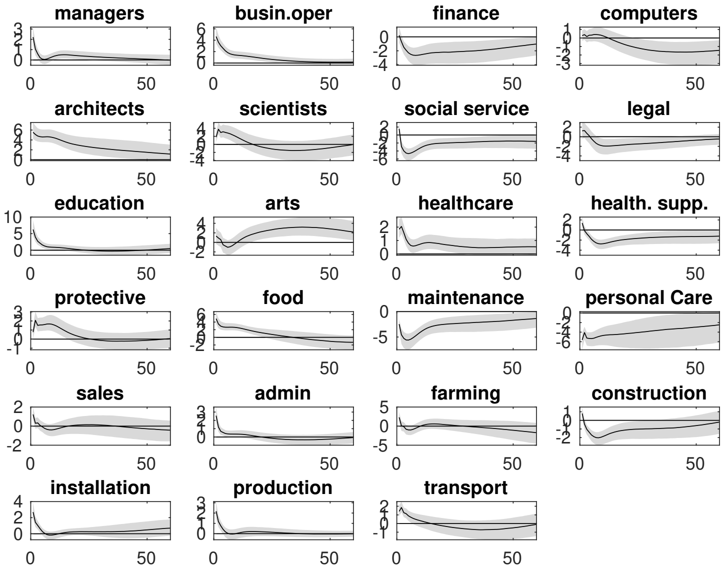
UK: (FES) Results by occupation

return



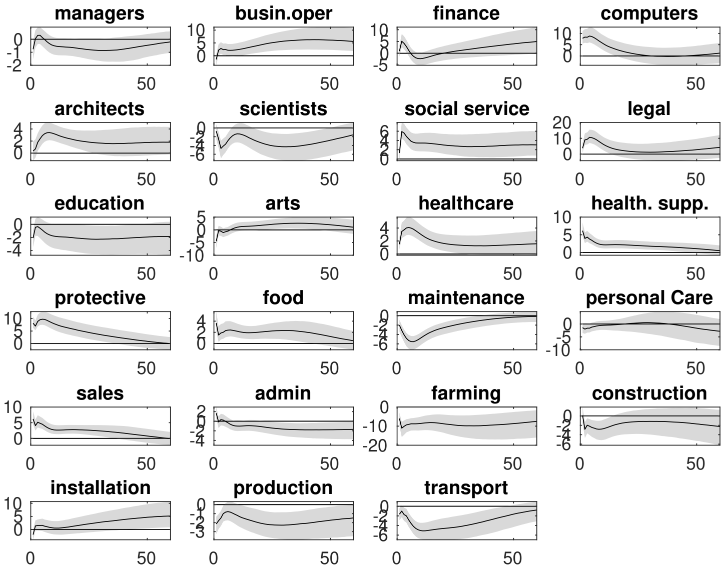
US: (CPS) Hours by occupation

▸ return



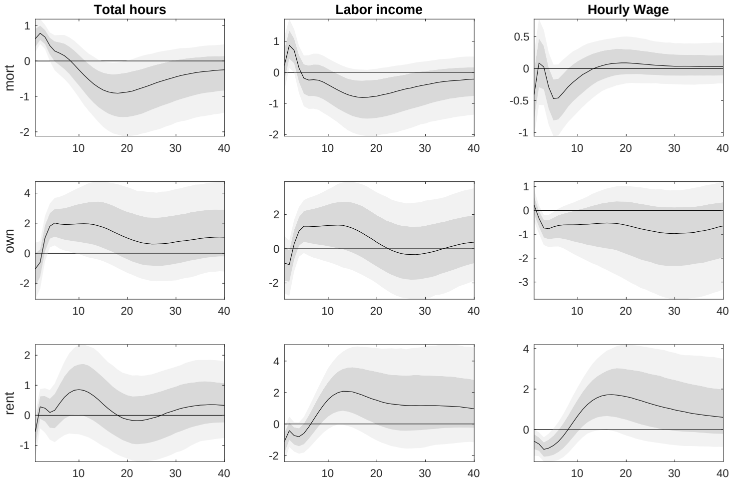
US: (CPS) Hourly wages by occupation

return



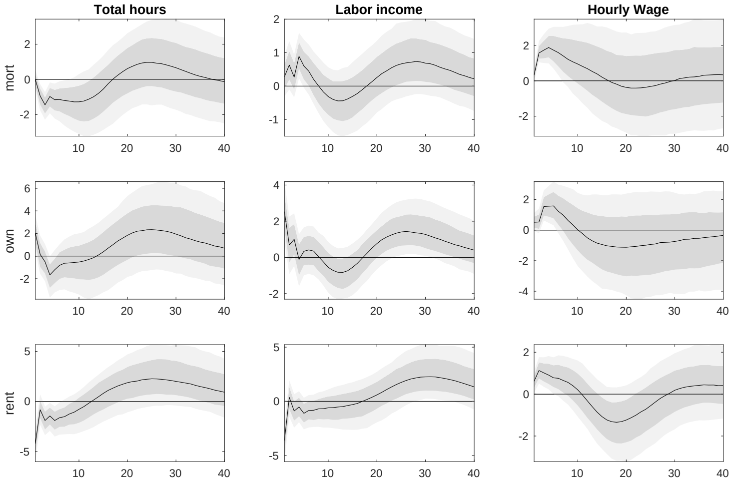
US: (CEX) Results by housing tenure

return



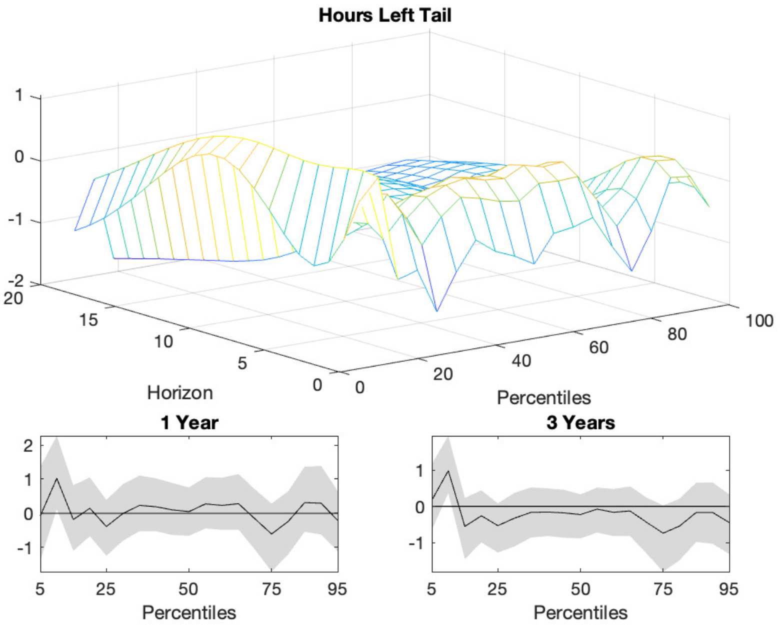
UK: (FES) Results by housing tenure

return



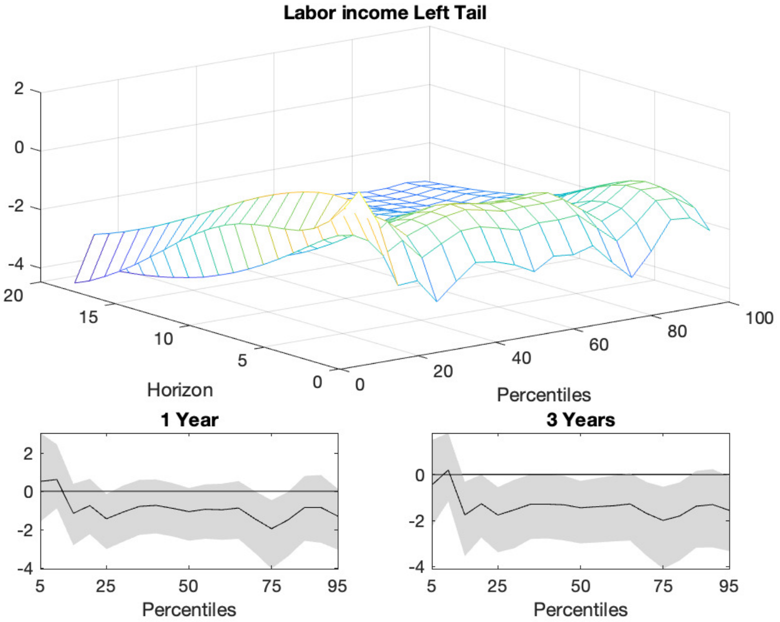
UK: 3D Hours of the left tail - LFS

return



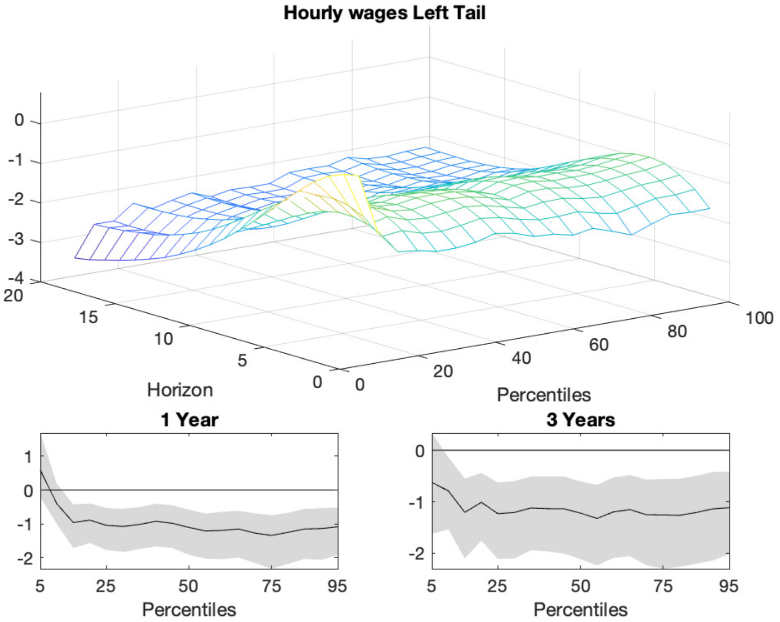
UK: 3D Labor income of the left tail - LFS

return



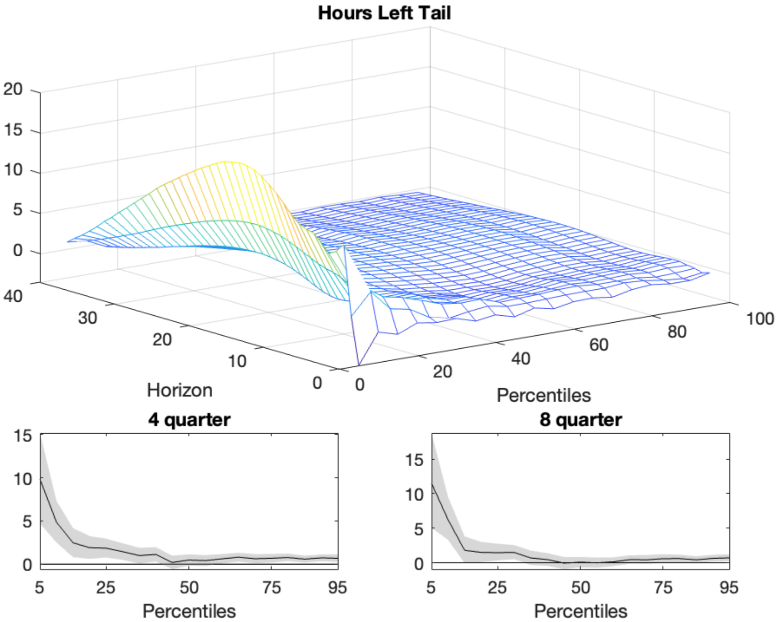
UK: 3D hourly wages of the left tail - LFS

▸ return



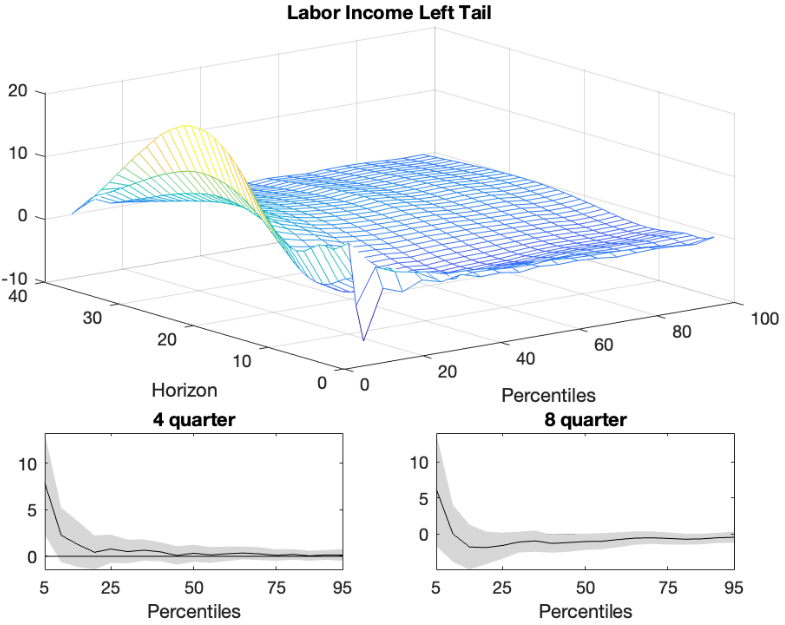
UK: 3D Hours of the left tail - FES

return



UK: 3D Labor income of the left tail - FES

return

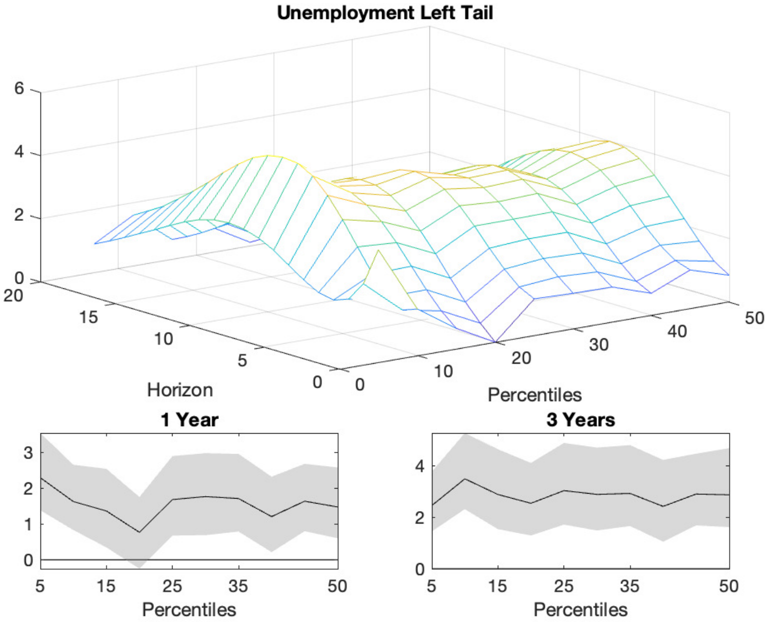


UK: 3D Wages of the left tail - FES

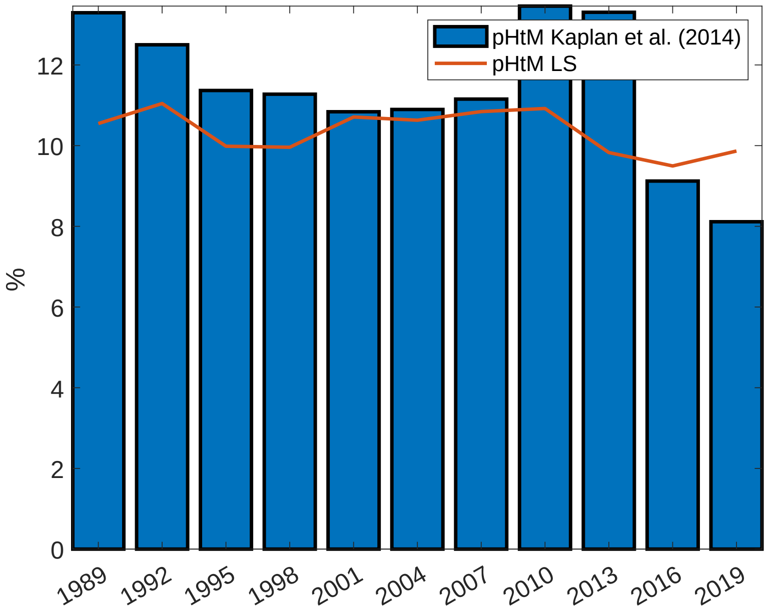
return

UK: 3D Unemployment of the left tail

return



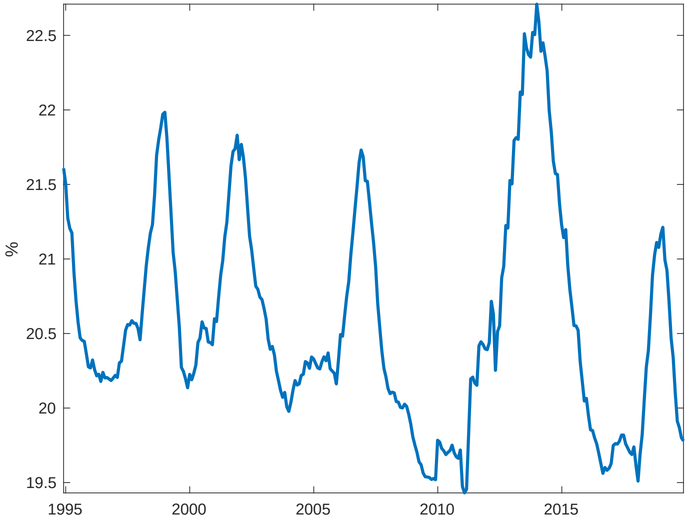
return



pHtM Kaplan et al. (2014)
pHtM LS
%
0
2
4
6
8
10
12
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019

US: Hours proportion of the bottom 20% CPS

return



Savers

return

- Savers maximize their lifetime utility subject to their budget constraint, taking prices and wages as given:

$$\max_{c_t^S, b_t^S, H_t^S} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left(\frac{\left(c_t^S\right)^{1-\frac{1}{\sigma_S}}}{1-\frac{1}{\sigma_S}} - \nu^S \frac{(H_t^S)^2}{2} \right) \quad \text{subject to}$$

$$c_t^S + b_t^S = \frac{1}{1-\lambda} d_t + H_t^S w_t + \frac{R_{t-1}}{\Pi_t} b_{t-1}^S,$$

- Π_t is inflation, w_t are real wages, R is the gross nominal interest rate on bonds and d_t are firm profits. σ_S is the inter-temporal elasticity of substitution and ν^S indicates how leisure is valued relative to consumption.

Hand to Mouth

return

- HtM have no assets and thus consume their labor income as well as the transfer they get from the government:

$$\max_{c_t^H, H_t^H} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t^H)^{1-\frac{1}{\sigma_H}}}{1-\frac{1}{\sigma_H}} - \nu^H \frac{(H_t^H)^2}{2} \right) \quad \text{subject to}$$

$$c_t^H \leq H_t^H w_t.$$

Inequality and Monetary Policy

return

- **Proposition** Under SADL ($\lambda < \frac{1}{1+\varphi}$), if $\sigma_H < \sigma_H^\star$ an increase in λ reduces (increases) the aggregate impact of monetary policy shocks if $\lambda < \lambda^\star$ ($\lambda > \lambda^\star$). Where

$$\lambda^\star = -\frac{\sigma_S - \sigma_H + \sqrt{-\sigma_H \varphi \left(\sigma_H - \sigma_S\right) \left(\sigma_S \varphi + 1\right)}}{(\sigma_H - \sigma_S)(1+\varphi)}$$

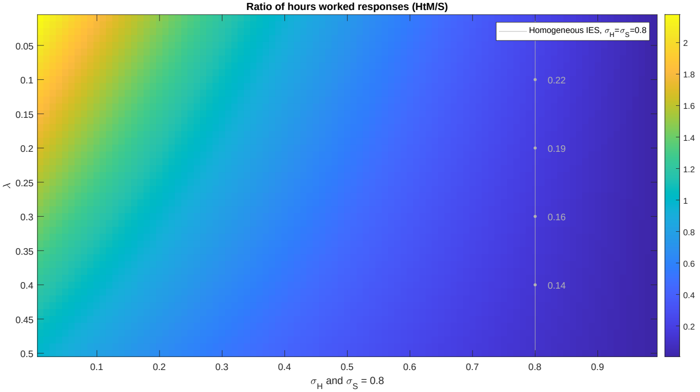
$$\sigma_H^\star = \frac{\sigma_S}{\sigma_S \varphi^2 + \varphi + 1}.$$

- **inequality** $\Uparrow \Rightarrow \Downarrow$ **effectiveness of monetary policy**.

- With $\sigma_S = 1 \Rightarrow \sigma_H^\star = 0.33$:
  - $\sigma_H^\star = 0.33 \Rightarrow \lambda^\star = 0$
  - $\sigma_H^\star = 0.1 \Rightarrow \lambda^\star = 0.2643$
  - $\sigma_H^\star = 0.05 \Rightarrow \lambda^\star = 0.3378$

IES and difference in labor supply

return



Relative (absolute) magnitude of the response of HtM and savers hours worked to a monetary policy shock for different values of σ_H and λ. Values larger than one indicate a larger volatility of HtM labor supply relative to Savers. The gray vertical line indicates the relative ratio when the IES equals 0.8 for both agents.

return

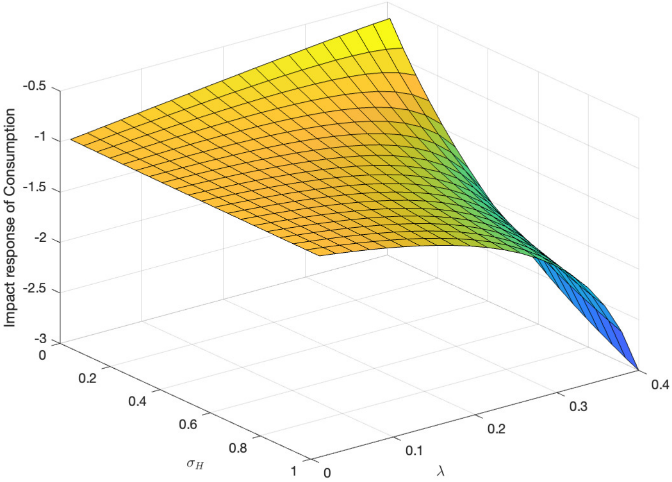
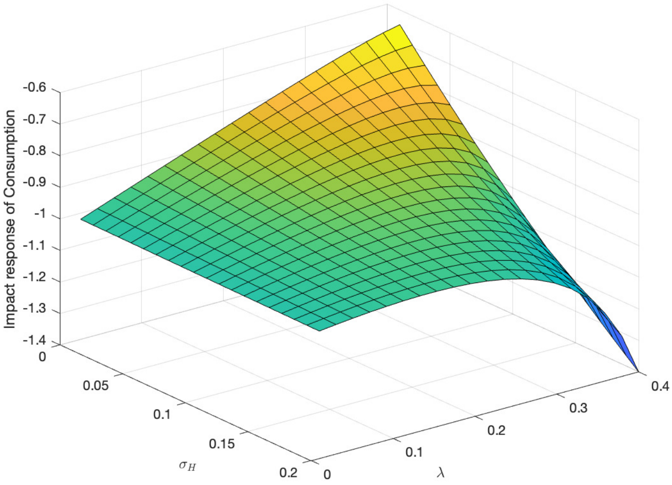


Figure: Impact response of Hours/Consumption to a 1% tightening with $\sigma_S = 1$.

▸ return



Impact response of Consumption
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
0
0.05
0.1
0.15
0.2
σ_H
0
0.1
0.2
0.3
0.4
λ

▸ return

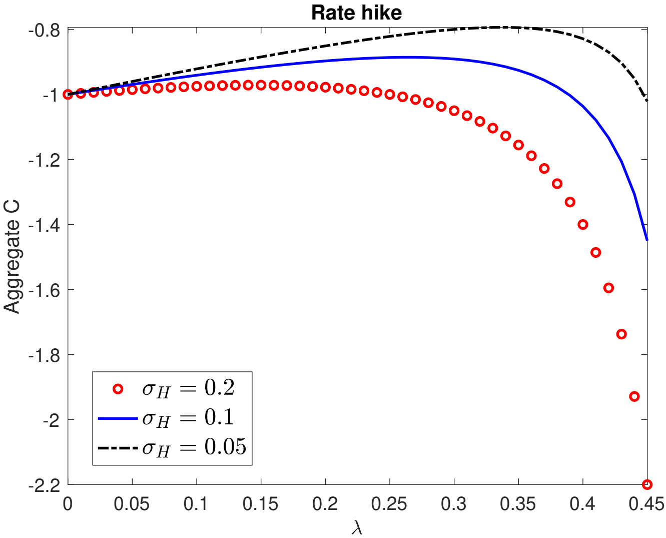
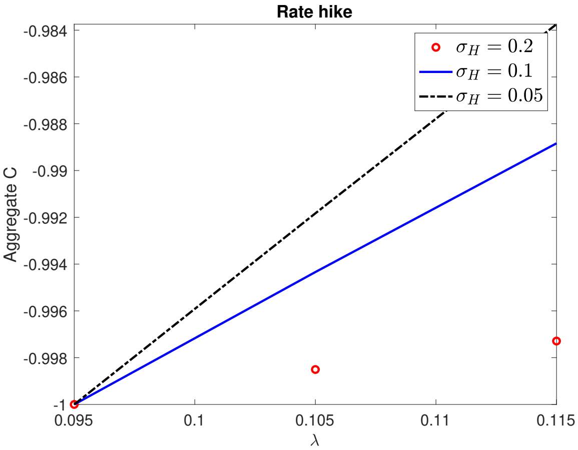


Figure: Impact response of Hours/Consumption to a 1% tightening with $\sigma_S = 1$.

▸ return



Rate hike
Aggregate C
λ
-0.984
-0.986
-0.988
-0.99
-0.992
-0.994
-0.996
-0.998
-1
0.095
0.1
0.105
0.11
0.115
$\sigma_H = 0.2$
$\sigma_H = 0.1$
$\sigma_H = 0.05$

TANK with non-homothetic preferences

▸ return

$$U(c_t^j, H_t^j) = \frac{(c_t^j - \bar{c})^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \nu^j \frac{(H_t^j)^{1+\varphi}}{1+\varphi}$$

- for $c^j \geq \bar{c}$ **IES increasing in consumption**:

$$-c^j \frac{U''_{c^j}}{U'_{c^j}} = \frac{c^j}{\sigma(c^j - \bar{c})}$$

- Log-linear Labor supply: $\varphi \hat{H}_t^j = \hat{w}_t - \frac{c^j}{\sigma(c^j - \bar{c})} \hat{c}_t^j$
- If $\sigma < \frac{c^H}{(c^H - \bar{c})} \Leftrightarrow \frac{\partial \hat{H}_t^j}{\partial \hat{w}_t} < 0$

Log-linearized Conditions of TANK with Non-homotetic preferences		
1:	Aggregate Hours	$(1-\lambda)\hat{H}_t^S \frac{H^S}{H} + \lambda \frac{H^H}{H} \hat{H}_t^H = \hat{H}_t$
2:	Aggregate Consumption	$\hat{c}_t = (1-\lambda)\frac{c^S}{c}\hat{c}_t^S + \lambda \frac{c^h}{c}\hat{c}_t^H$
3:	Euler	$\hat{c}_t^S = \hat{c}_{t+1\|t}^S - \frac{\sigma(c^S - \bar{c})}{c^S}\left(\hat{R}_t - \hat{\Pi}_{t+1\|t}\right)$
4-5:	Labor Supply $j = S, H$	$\hat{H}_t^j = \hat{w}_t - \frac{c^j}{(c^j - \bar{c})\sigma}\hat{c}_t^j$
6:	Budget constraint H	$\hat{c}_t^H = (\hat{H}_t^H + \hat{w}_t)\frac{wH^H}{c^H}$
7:	Phillips Curve	$\hat{\Pi}_t = \beta\hat{\Pi}_{t+1\|t} + \kappa\hat{w}_t$
8:	Taylor Rule	$\hat{R}_t = \hat{\Pi}_{t+1\|t} + \epsilon_t^m$

Table: TANKs: S PIH *Savers*; H poor HtM.

Calibration

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Parameter	Value	Description	Source
β	0.99	Discount Factor	Quarterly
σ^H	0.10	Intertemporal elasticity of substitution, H	Vissing-Jørgensen, 2002
σ^S	0.80	Intertemporal elasticity of substitution, S	Vissing-Jørgensen, 2002
φ	2	Inverse of Frish elasticity of Labor Supply	Chetty et al., 2011
δ	0.0175	Capital depreciation	NIPA
ι	5.5	Investment adjustment costs	Smets and Wouters, 2017
η	11	Elasticity of substitution goods	Price markup 10%
η^w	11	Elasticity of substitution labor	Wage markup 10%
ϕ^r	0.78	Interest rate smoothing	Bayer, Born, and Luetticke, 2020
ϕ^π	2.45	Taylor rule coeff of inflation	Bayer, Born, and Luetticke, 2020
ϕ^y	0.11	Taylor rule coeff of output	Bayer, Born, and Luetticke, 2020
λ	0.10	Share of HtM Agents	hours of bottom 25% in CEX
κ	0.097	Slope of Phillips Curve	Bayer, Born, and Luetticke, 2020
κ^w	0.110	Slope of Wage Phillips Curve	Bayer, Born, and Luetticke, 2020
$\bar{H}^H$	0.20	Steady State Hours, HtM	CPS
$\bar{H}^S$	0.25	Steady State Hours, Savers	CPS
$\bar{\Pi}$	1	Steady State Inflation	Convention

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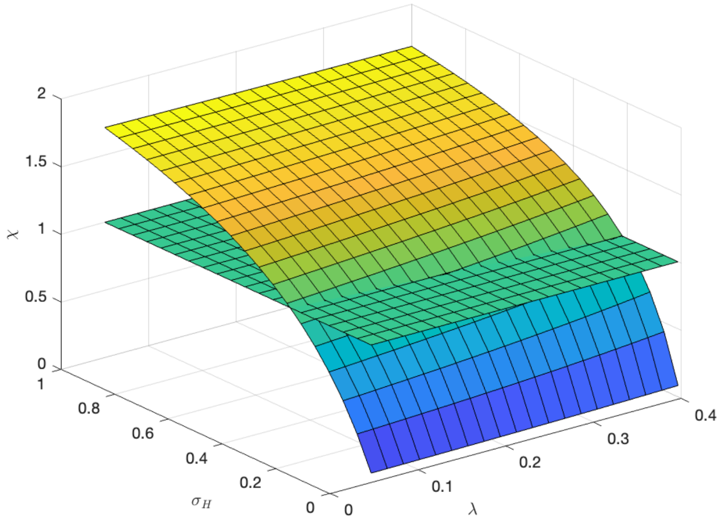

χ Sticky Wages

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