Monetary Policy during a Cost-of-Living Crisis

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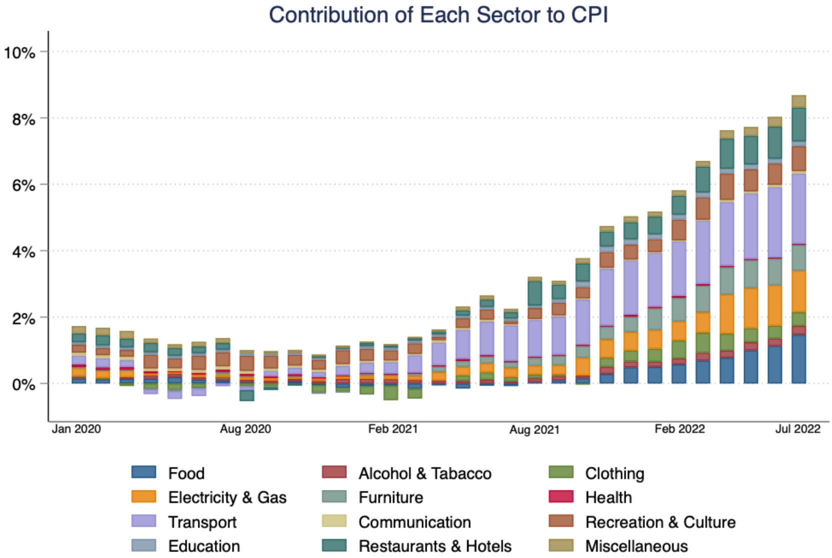
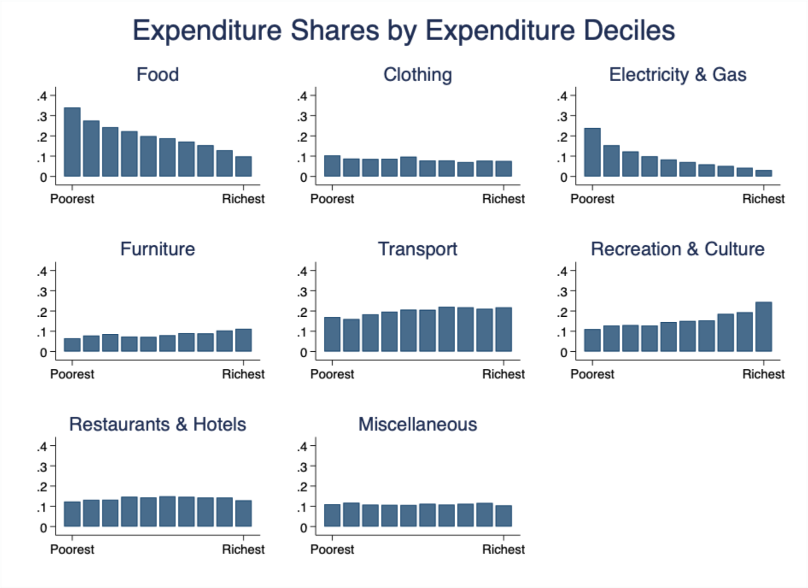
Cost-of-Living Crisis



Data for the UK. Source: ONS.

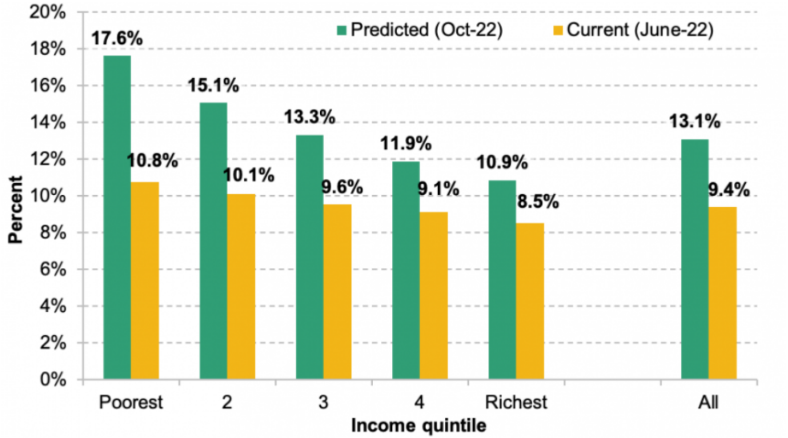
Cost-of-Living Crisis



Data for the UK. Source: Living Cost and Food Survey (LCF).

Cost-of-Living Crisis

Figure 1. Expected inflation by income quintile in October 2022



Data for the UK. Source: Institute for Fiscal Studies (August '22).

Motivating questions

- How do sectoral supply shocks transmit to macroeconomic and distributional outcomes when inflation rates vary across households?
- How does monetary policy affect these outcomes?
- What are the policy trade-offs? *Is a cost-of-living crisis different?*
  - Output gap vs inflation
  - Distribution

This paper

Develop quantitative New-Keynesian model with:

- Multiple, heterogeneous sectors

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- Heterogeneous households

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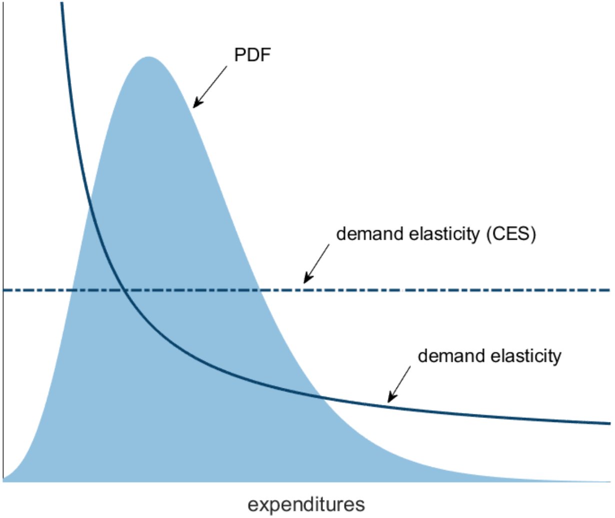
Develop quantitative New-Keynesian model with:

- Multiple, heterogeneous sectors
- Heterogeneous households
- Generalized, non-homothetic preferences
  - Heterogeneous consumption baskets, inflation rates, real interest rates
  - Heterogeneous demand elasticities

Non-CES preferences + household heterogeneity

Inequality matters for markups



Literature

New Keynesian +

- **Multiple Sectors:** Pasten, R. and Weber (2020); Rubbo (2019); LaO and Tahbaz-Salehi (2019); Baqaee, Farhi and Sangani (2021); Guerrieri, Lorenzoni, Straub and Werning (2022), etc.

- **Heterogeneous households:** McKay, Nakamura and Steinsson (2016); Ravn and Sterk (2017); Auclert (2019); Werning (2015); Kaplan, Moll and Violante (2017); Debortoli and Galí (2017), etc.

- **Non-homothetic preferences:** Portillo, Zanna, O'Connel and Peck (2016); Melcangi and Sterk (2019); Blanco and Diz (2021), etc.

Literature

Non-homothetic preferences +

- **Growth:** Herrendorf, Rogerson and Valentinyi (2014); Boppart (2014); Comin, D. and Mestieri (2021), etc.
- **Inequality:** Engel (1857); Houthakker (1957); Hamilton (2001); Almås (2012); Argente and Lee (2021), etc.
- **Taxation:** Jaravel and Olivi (2021); Xhani (2021), etc.

Households

Unit mass of households, indexed by j. Die with probability δ.
Consume goods from different sectors, indexed by $k = 1, 2, ..K$.
Continuum of symmetric varieties within each sector, indexed by i.

Utility:

$$\mathbb{E}_t \sum_{s=0}^{\infty} (\beta(1-\delta))^{t+s} \left(U(\mathbf{c}_{t+s}) - \chi(n_{t+s}) \right)$$

where

$$U(\mathbf{c}) = U(\mathcal{U}_1(\mathbf{c^1}), ..., \mathcal{U}_K(\mathbf{c^K}))$$

- U: weakly separable in sectors.
  - *Controls relation between expenditures and composition basket*
- $\mathcal{U}_k$: concave and twice differentiable.
  - *Controls relation between expenditures and demand elasticity*

Households

- Households have an idiosyncratic productivity level $\theta(j)$.
- Firm ownership is proportional to steady-state labor income.
- Budget constraint household j:

$$e_t(j) + b_t(j) = R_{t-1} b_{t-1}(j) + \theta(j) n_t(j) W_t + \sum_k \varsigma(j) div_{k,t},$$

where $e_t(j) = \sum_k e_{k,t}(j) = \sum_k \int_0^1 p_{k,t}(i) c_{k,t}(i,j) di$.

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- Extensions in progress include:
  - hand-to-mouth households,
  - richer heterogeneity in firm ownership,
  - sectoral wage heterogeneity,
  - fiscal transfers.

Households

Key objects (at steady state)

Demand elasticity:	$\epsilon_k(j) = \frac{\partial c_k(i,j)}{\partial p_k(i)} \frac{p_k(i)}{c_k(i,j)}$
Super-elasticity:	$\epsilon^s_k(j) = \frac{\partial \epsilon_k(j)}{\partial p_k(i)} \frac{p_k(i)}{\epsilon_k(j)}$
Cross-price elasticity:	$\rho_{k,l}(j) = \frac{P_l}{c_k(j)} \frac{\partial c_k(j)}{\partial P_l}$
Budget share:	$s_k(j) = \frac{e_k(j)}{e(j)}$
Marginal budget share:	$\xi_k(j) = \frac{\partial e_k(j)}{\partial e(j)}$

Firms

- Firms produce varieties end Production function:

$$y_{k,t}(i) = A_{k,t} l_{k,t}(i).$$

- They are monopolistically competitive; respect household demand function.
- They can adjust their price only with probability $1 - \theta_k$ (Calvo).

Government

- Fiscal authority eliminates steady-state markups using subsidies, financed by lump-sum taxes on firms.

- Central bank interest rate rule:

$$\hat{R}_t = \phi \pi_t^{CPI} + u_t^R.$$

where the baseline value is $\phi = 1.5$.

- We also consider alternative inflation indices, including the "Divine Coincidence" index, cf Rubbo (2019).

Market Clearing

New Keynesian Phillips Curve

s.s. with zero inflation

NKPC for sector k:

$$\pi_{k,t} = \beta(1-\delta)\mathbb{E}_t\pi_{k,t+1} +$$

$$\lambda_k\left((\bar{\sigma}^{-1}+\psi^{-1})(\hat{\mathcal{Y}}_t - \hat{\mathcal{Y}}_t^*) - \sum_l \bar{\xi}_l(\hat{P}_{k,t} - \hat{P}_{l,t}) - \sum_l \bar{\xi}_l(\hat{A}_{k,t} - \hat{A}_{l,t}) + \mathcal{M}_{k,t}\right)$$

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where:

$\hat{\mathcal{Y}}_t - \hat{\mathcal{Y}}_t^*$: output gap
$\sum_l \bar{\xi}_l (\hat{P}_{k,t} - \hat{P}_{l,t})$: relative price wedge
$\sum_l \bar{\xi}_l (\hat{A}_{k,t} - \hat{A}_{l,t})$: relative productivity wedge
$\mathcal{M}_{k,t}$: endogenous markup wedge

Endogenous markup wedge

$$\mathcal{M}_{k,t} = \mathcal{M}^E_{k,t} + \mathcal{M}^P_{k,t}.$$

- Total expenditure component:
  - $\mathcal{M}^E_{k,t} = \int \gamma_{e,k}(j)\xi_k(j)e(j)\left(\frac{\hat{e}_t(j)-\sum_l s_l(j)\hat{P}_{l,t}}{E_k}\right)dj,$
  - $\gamma_{e,k}(j) = \left(1 - \frac{\epsilon_k(j)+\epsilon^s_k(j)}{\bar{\epsilon}_k}\right)\frac{1}{\bar{\epsilon}_k - 1}.$

Endogenous markup wedge

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- Total expenditure component:
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  - $\gamma_{e,k}(j) = \left(1 - \frac{\epsilon_k(j)+\epsilon^s_k(j)}{\bar{\epsilon}_k}\right)\frac{1}{\bar{\epsilon}_k - 1}.$
- Expenditure switching component:
  - $\mathcal{M}^P_{k,t} = \sum_l \mathcal{S}_{k,l} \cdot \left(\hat{P}_{l,t} - \hat{P}_{k,t}\right)$
  - $\mathcal{S}_{k,l} = \int_j \frac{e_k(j)}{E_k}\gamma_{e,k}(j)\rho_{k,l}(j) dj$

Under CES preferences we obtain $\gamma_{e,k}(j) = 0 \Rightarrow \mathcal{M}_{k,t} = 0$.

Model solution

$\mathcal{M}^E_{k,t}$ is forward looking but also depends on dynamics of the wealth distribution. Can be characterised with 2 equations per sector.

The full model has a block-recursive structure:

- Core block of $4K + 3$ linear equations to solve for $\{\pi_{k,t}, \hat{P}_{k,t}, \hat{\mathcal{M}}^E_{k,t}, \hat{\mathcal{M}}^0_{k,t}\}_{k=1}^K, \hat{\mathcal{Y}}_t, \hat{\mathcal{Y}}^*_t$ and $\hat{R}_t$. Solve with standard methods.
- Solve for expenditure distribution and other aggregates in second step (straightforward in sequence space).

Amplification

1-sector model

- Homogeneous EIS, no restributive effects of interest rates ($\Gamma^R = 0$).
- Define $\tilde{\lambda} = \frac{(1-\theta)(1-\beta\theta)}{\theta}$. NKPC simplifies to:

$$\pi_t = \tilde{\lambda} \underbrace{\frac{\bar{\epsilon}-1}{\bar{\epsilon}-1+\bar{\eta}}}_{\textit{passthrough}} \Big((\sigma^{-1} + \psi^{-1})(\hat{\mathcal{Y}}_t - \hat{\mathcal{Y}^*}_t) + \underbrace{\frac{\bar{\epsilon}}{\bar{\epsilon}-1} \bar{\gamma_e}}_{\textit{markup wedge}} \hat{\mathcal{Y}}_t \Big) + \beta(1-\delta))\pi_{t+1}$$

- Slopes shaped by household heterogeneity! Coefficients
  - Flattening NKPC via limited micro pass-through ($\bar{\eta} > 0$)
  - Steepening via endogenous markup wedge ($\bar{\gamma_e} > 0$)

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- Slopes shaped by household heterogeneity! Coefficients
  - Flattening NKPC via limited micro pass-through ($\bar{\eta} > 0$)
  - Steepening via endogenous markup wedge ($\bar{\gamma}_e > 0$)
- Breakdown "divide coincidence"

Quantitative implementation

- The model period is one quarter. Calibrate to the UK.
- Calibrate sectoral Calvo parameters based on UK evidence (Dixon and Tian, 2017).
- Directly feed in data on the (steady-state) distribution of expenditures, income and wealth.

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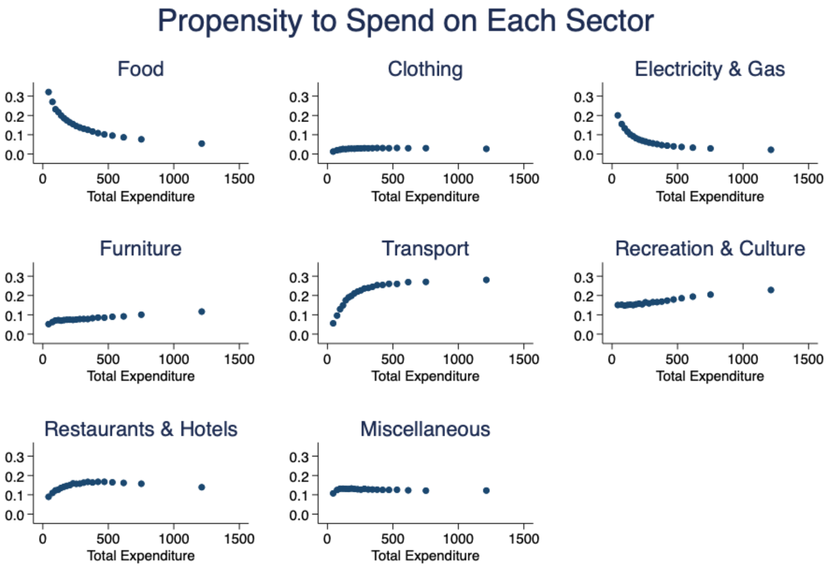
Preferences:

- U (outer utility): non-homothetic CES, following Comin et al. (2021)
  - estimate on LCF micro data (2001-2019).
- $\mathcal{U}$ (inner utility): HARA, target:
  - An average net markup of 50 percent in each sector (De Loecker and Eeckhout, 2020).
  - Average pass-through of 60 percent (Amiti et al., 2019).
- Set $\sigma = \psi = 1$ and $\beta = 0.99$ for all households.

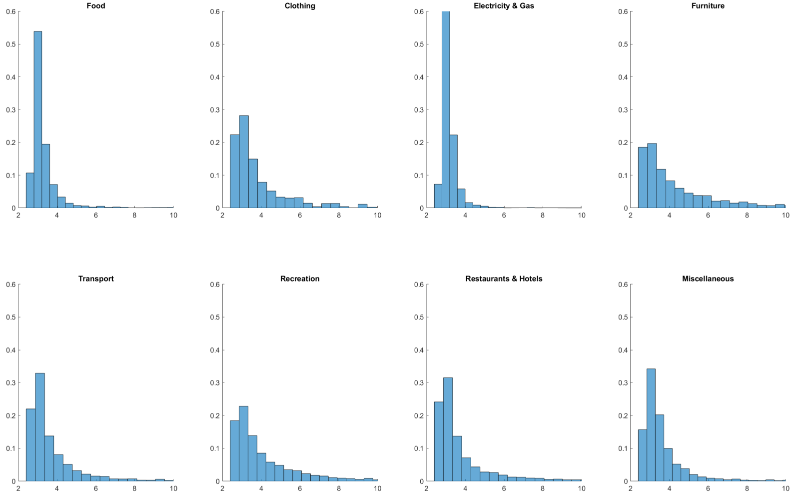
Outer utility



Each point represents the average expenditure change on a given sector when the household's total expenditure goes up by 1.
The data has been binned into 20 equally sized groups.

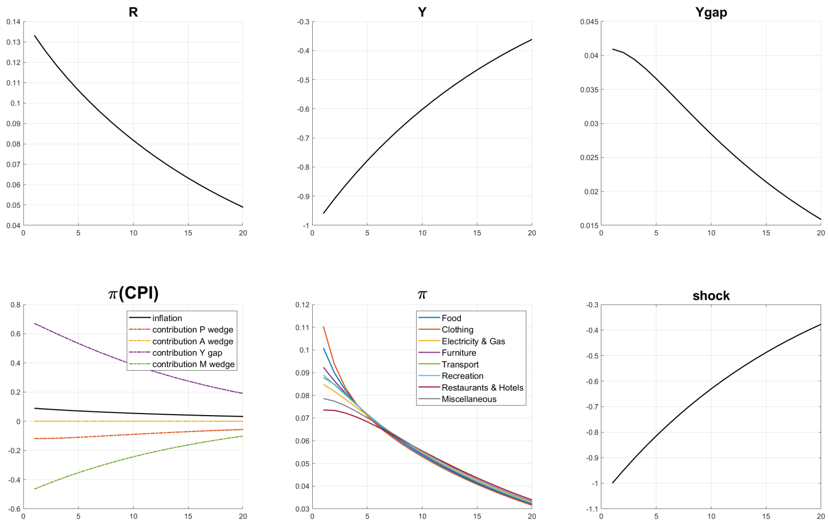
Inner utility

Distribution of demand elasticities



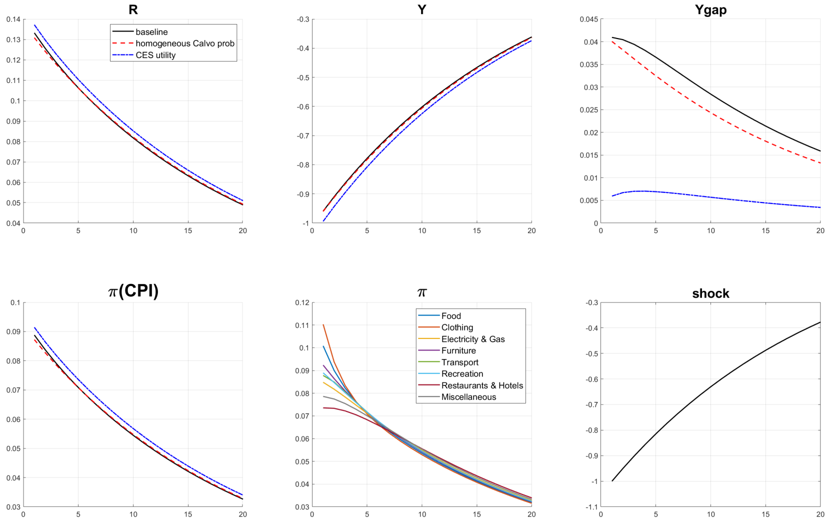
Aggregate productivity shock

Markup wedge quantitatively important



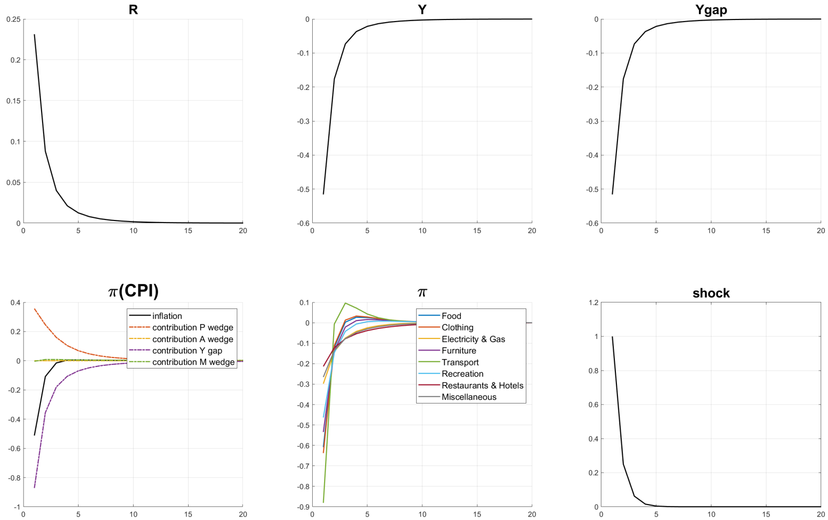
Aggregate productivity shock

Dampening inflation, amplification output gap



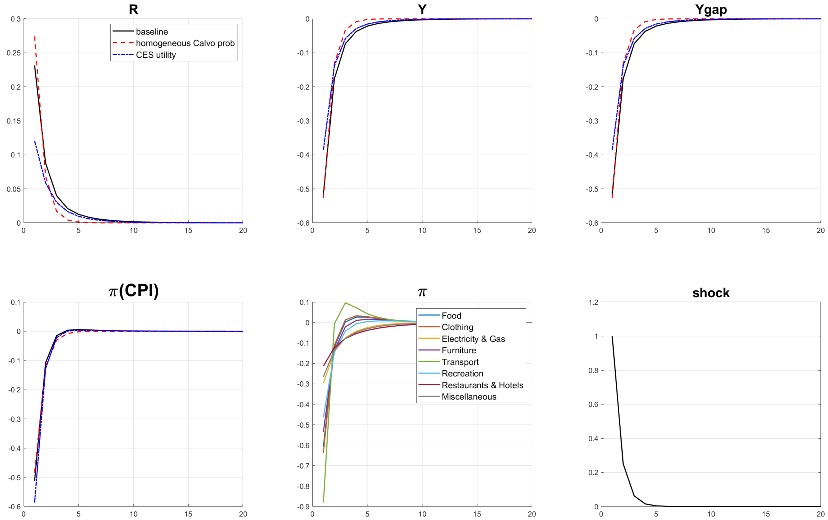
Monetary policy shock

Limited control over markup wedge?



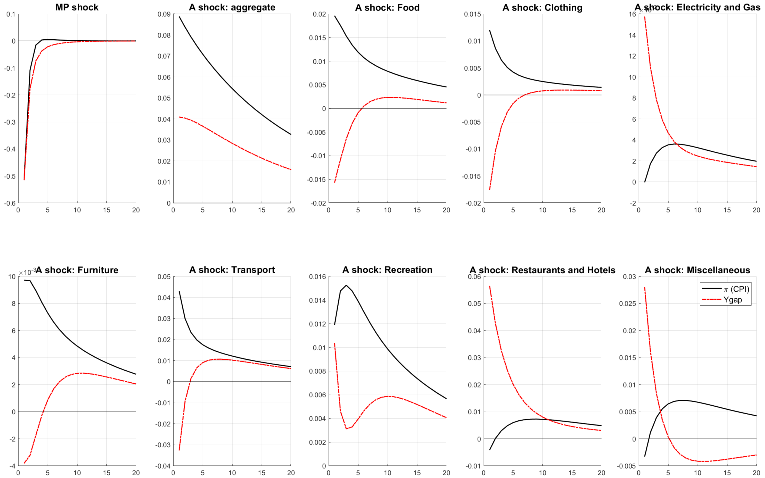
Monetary policy shock

Flattened NKPC



Trade-offs: sectoral shocks are different

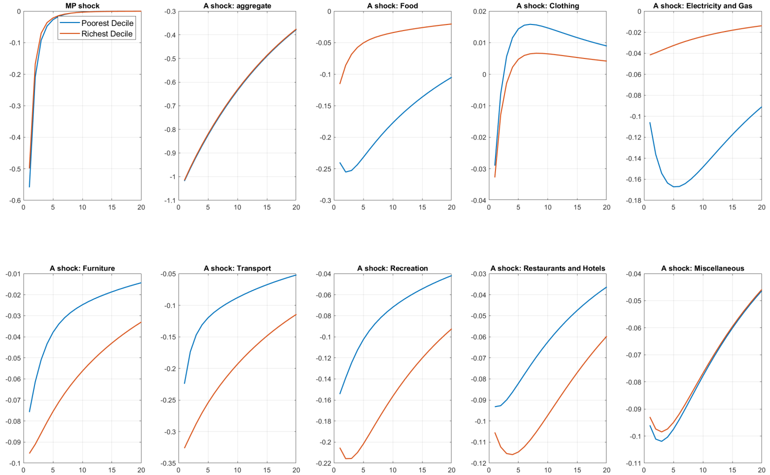
Output gap vs CPI inflation



DC inflation

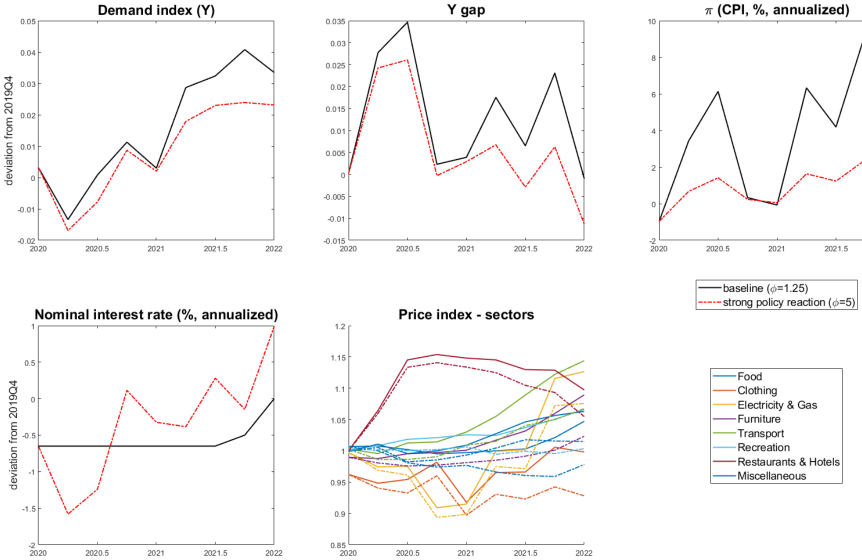
Trade-offs: sectoral shocks are different

Dynamics of the consumption distribution



Cost of Living Crisis UK: 2020-2021

Policy counterfactual



Conclusion

- Developed multi-sector HANK model with generalized, non-homothetic preferences
  - time-varying distribution but computationally tractable
- Household heterogeneity alters macro dynamics via NKPC
  - modified slope + endogenous markup wage
- **Sectoral shocks are different**. Stronger trade-offs
  - output vs CPI inflation
  - distributional dynamics
- Quantitative application to the UK in '20-'22 (preliminary):
  - '20-'21: tightening could have closed inflation & output gap
  - '22: trade-off, output gap vs inflation
  - distributional trade-offs? (in progress)
- Optimal policy? (in progress)

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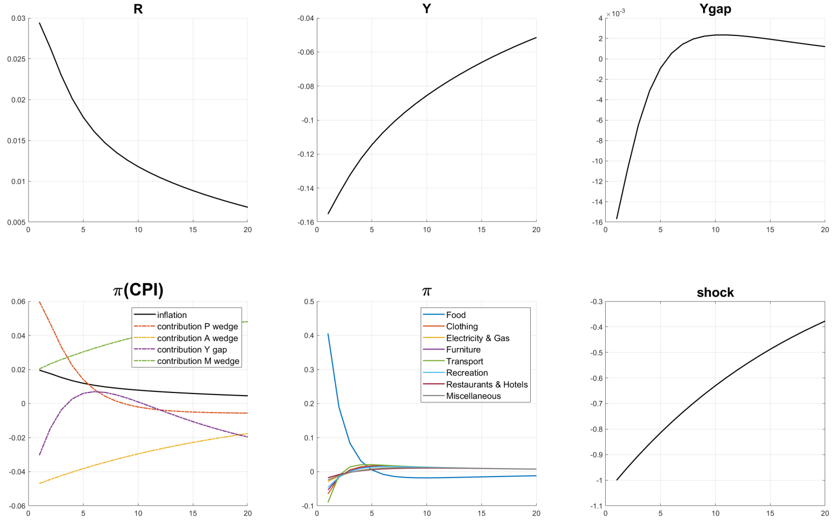
Productivity shock: Food



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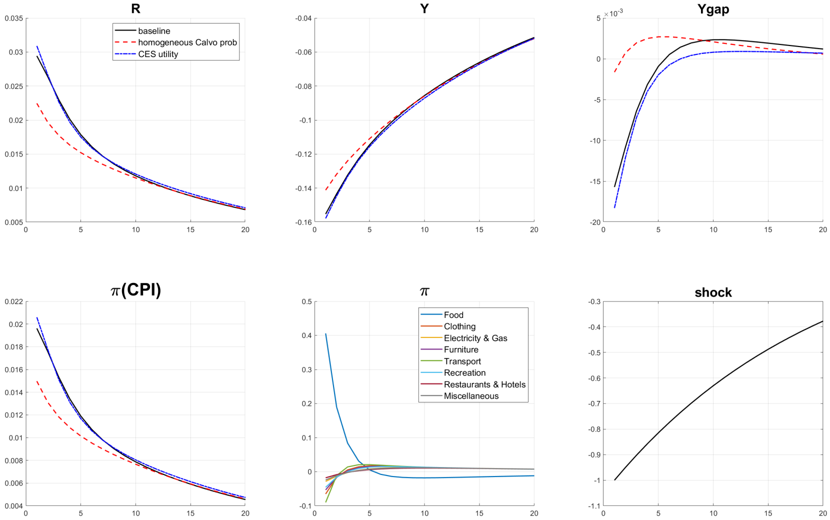

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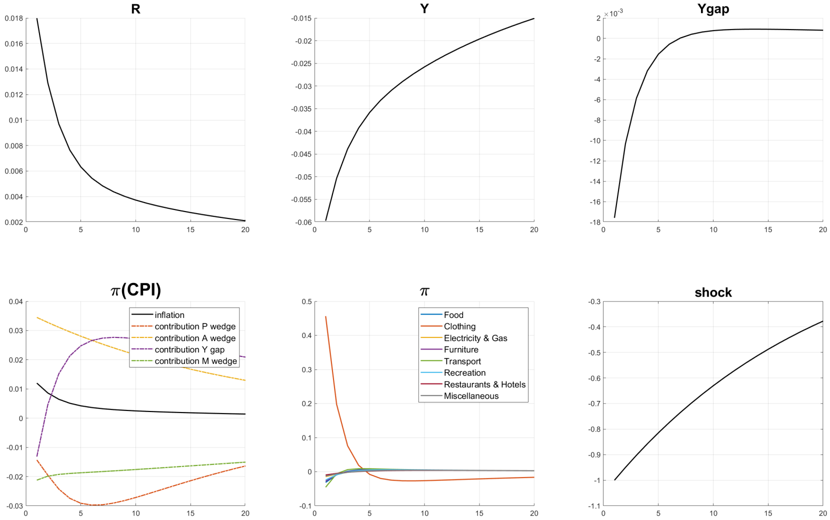
Productivity shock: Clothing



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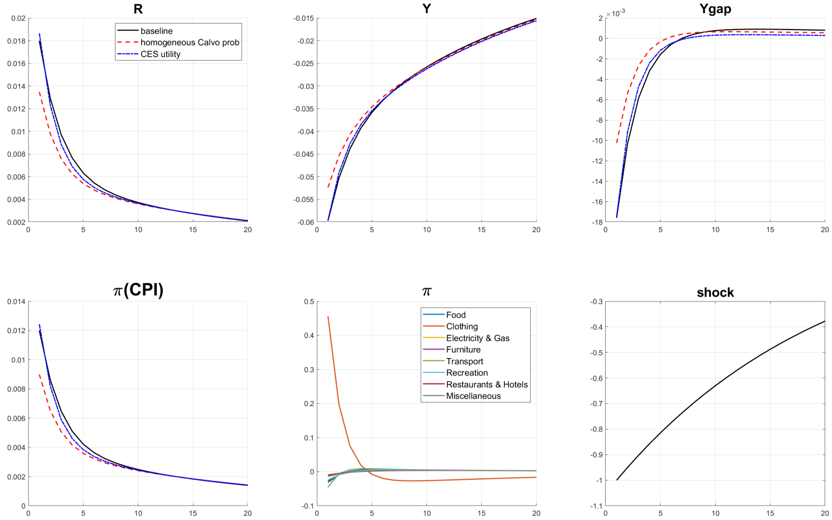
Productivity shock: Clothing



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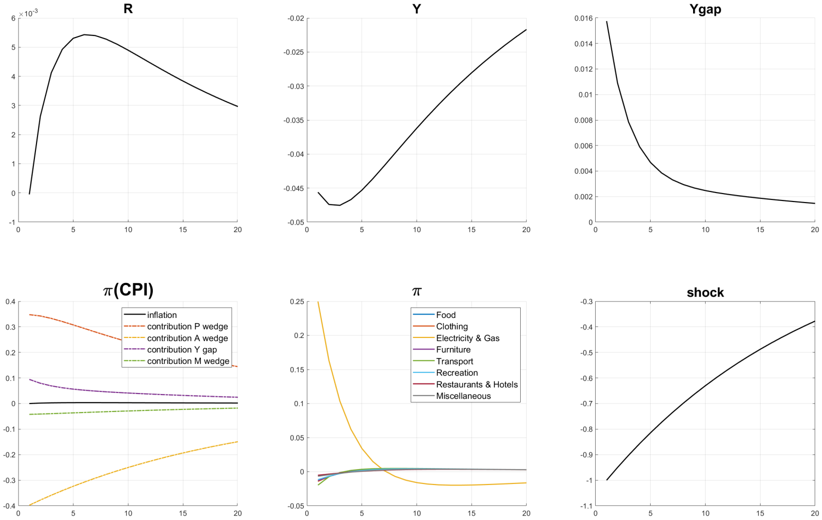
Productivity shock: Electricity and Gas



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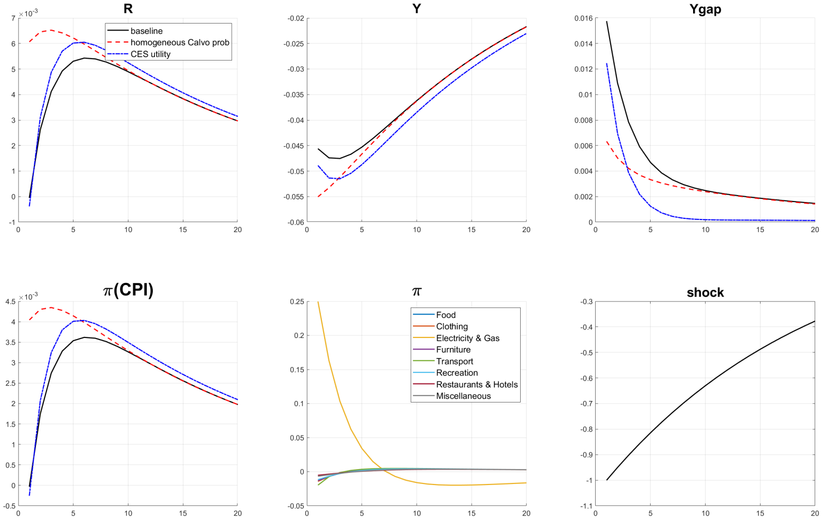

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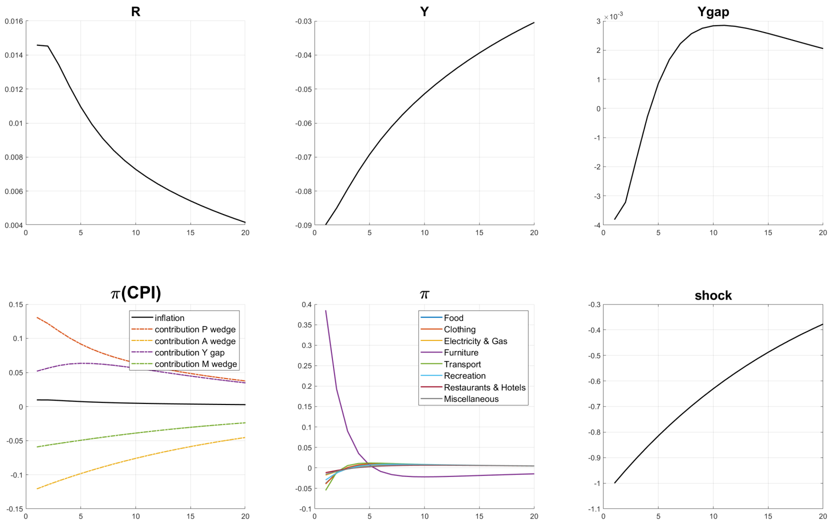
Productivity shock: Furniture



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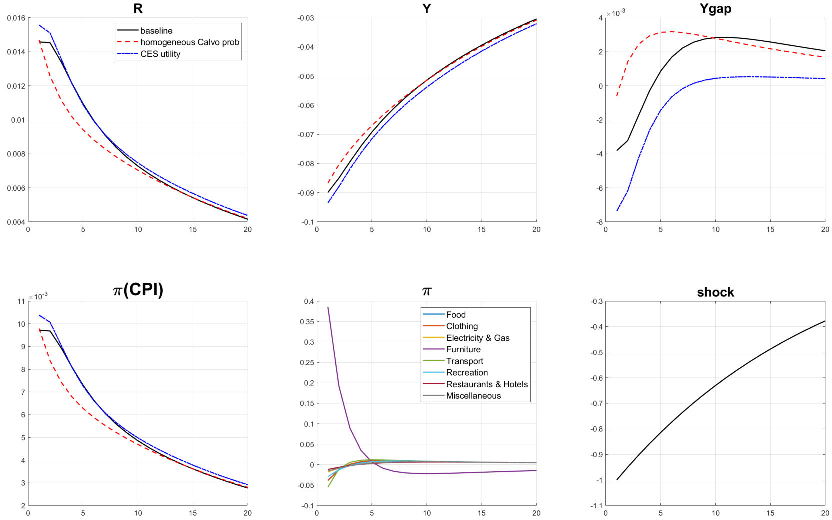
Productivity shock: Furniture



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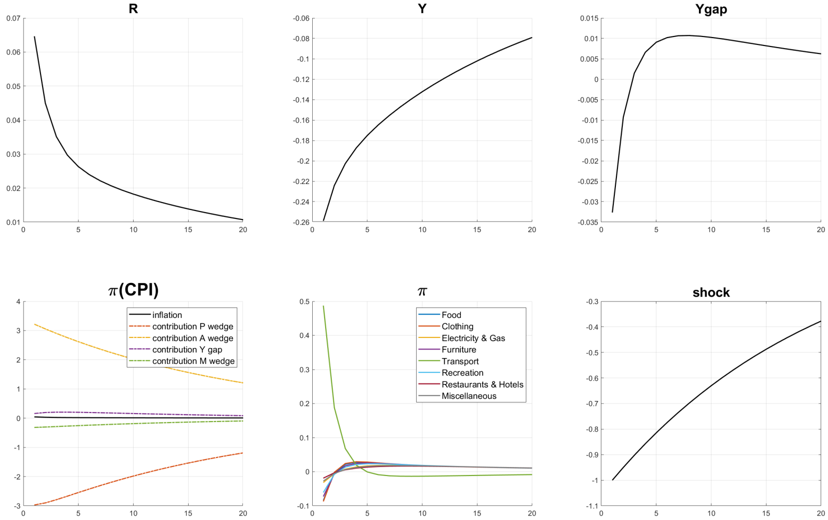
Productivity shock: Transport



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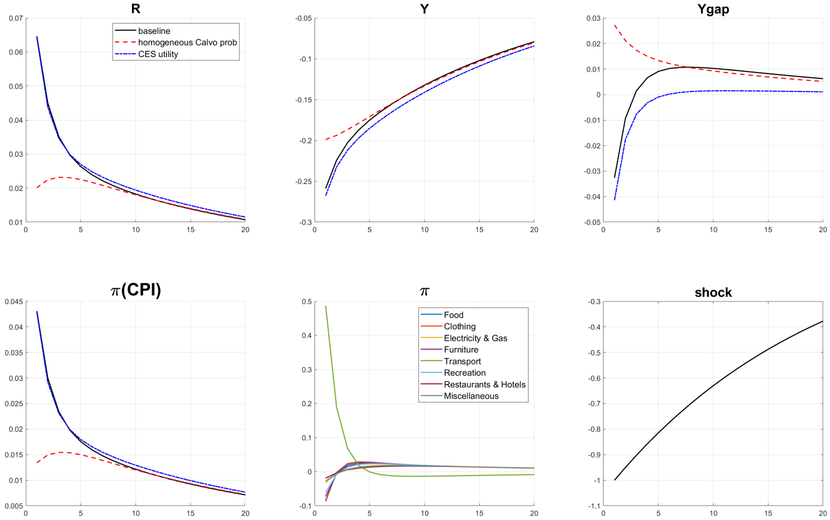
Productivity shock: Transport



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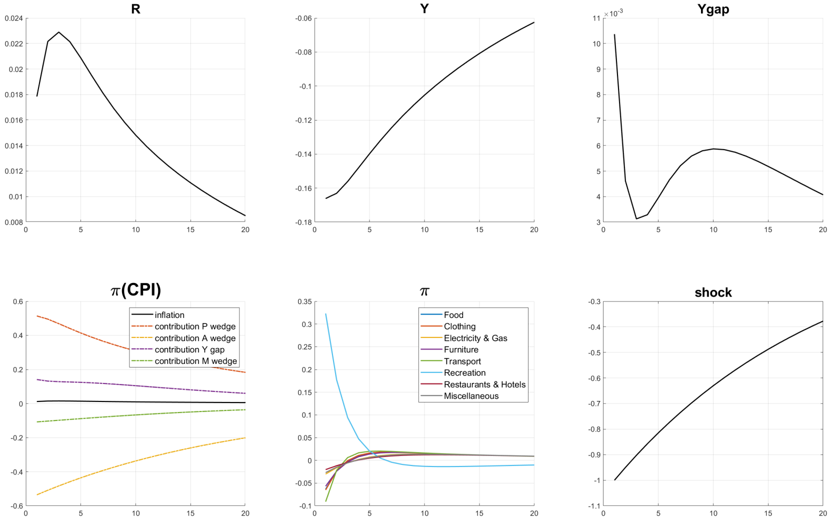
Productivity shock: Recreation



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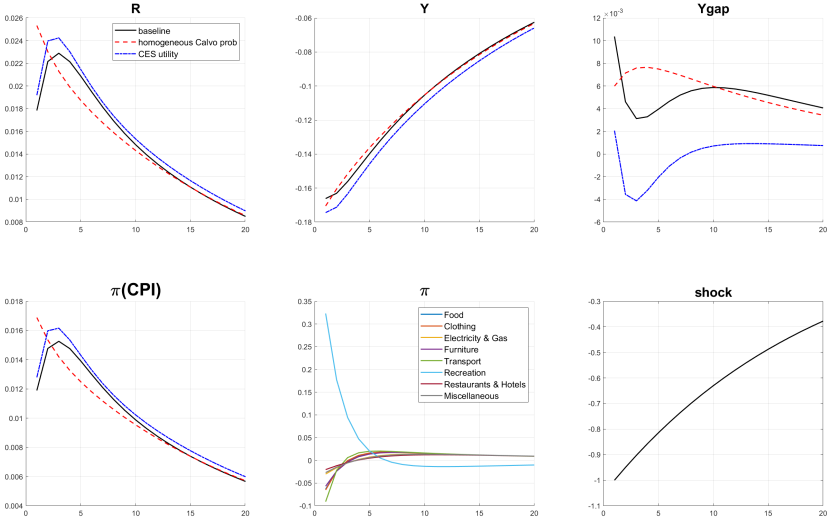
Productivity shock: Recreation



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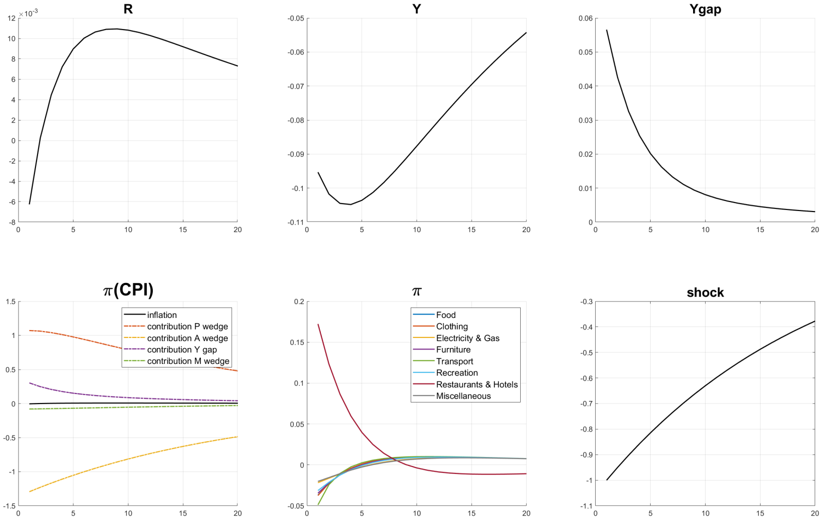
Productivity shock: Restaurants and Hotels



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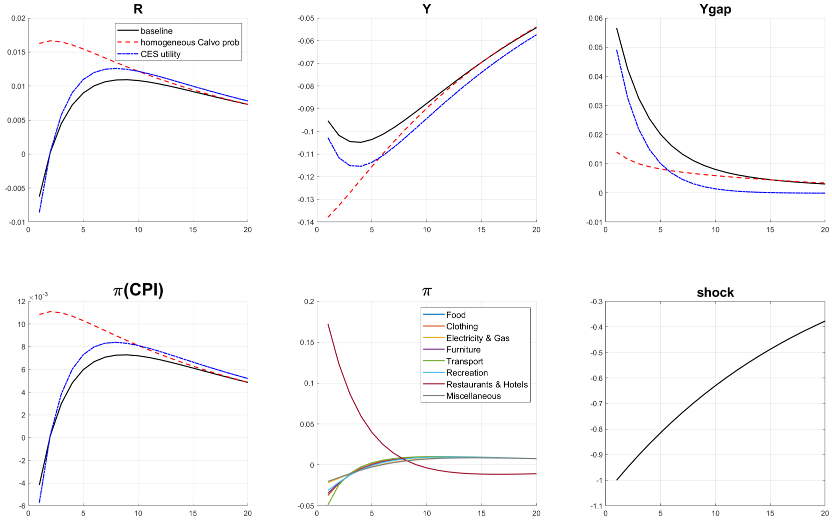

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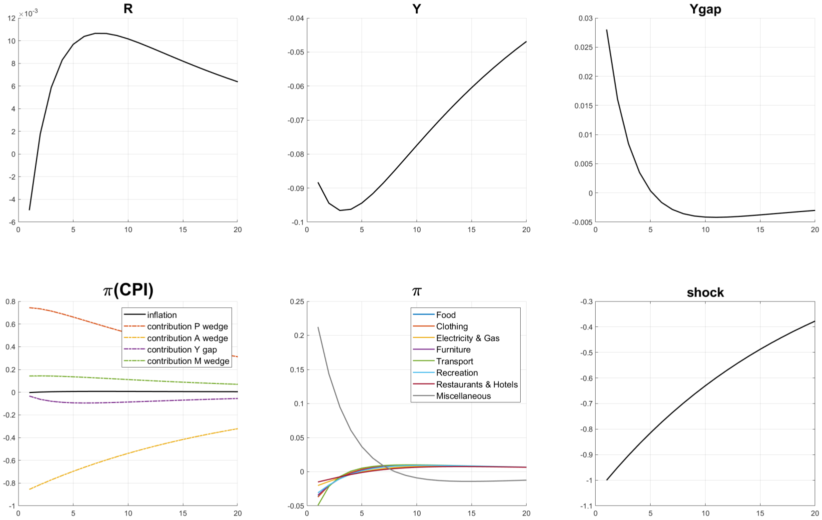
Productivity shock: Miscellaneous



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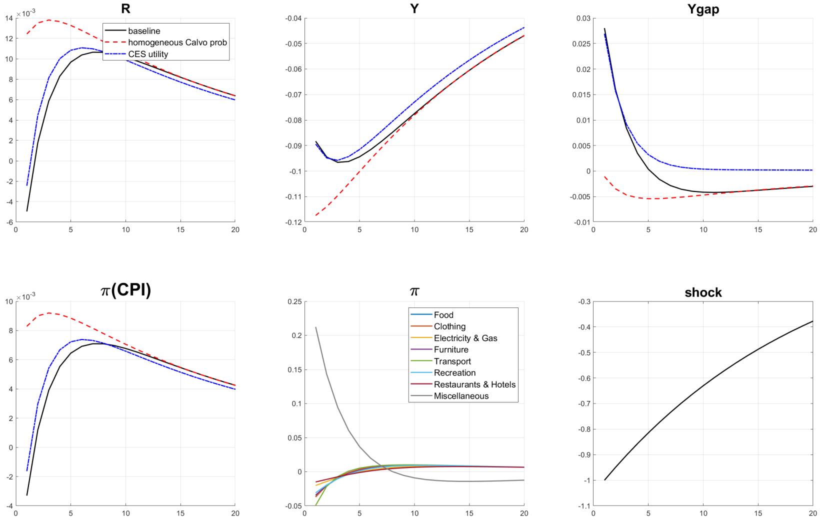

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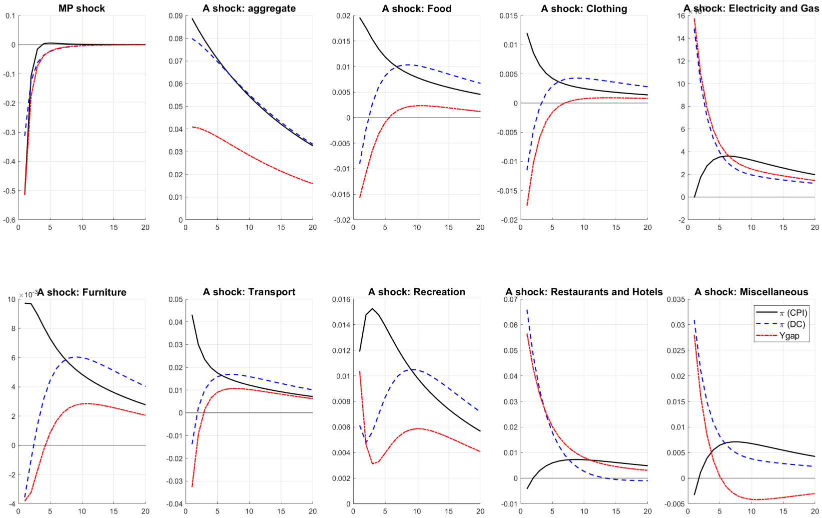
Policy trade-off: output gap vs inflation



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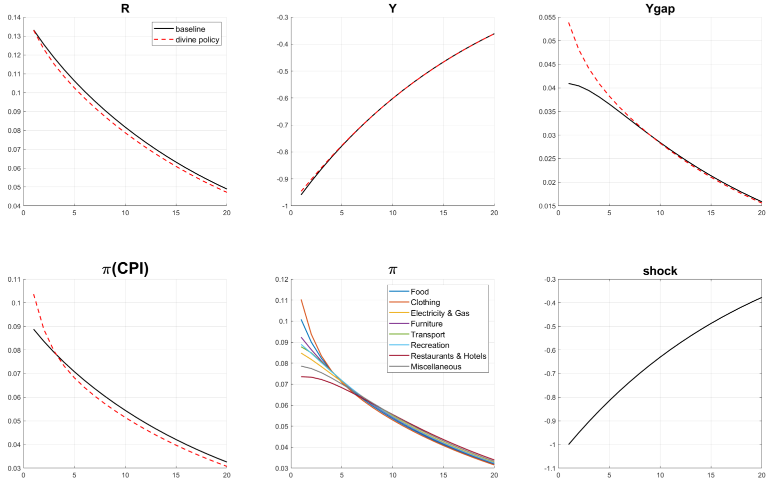
Aggregate productivity shock

π^{DC} in policy rule



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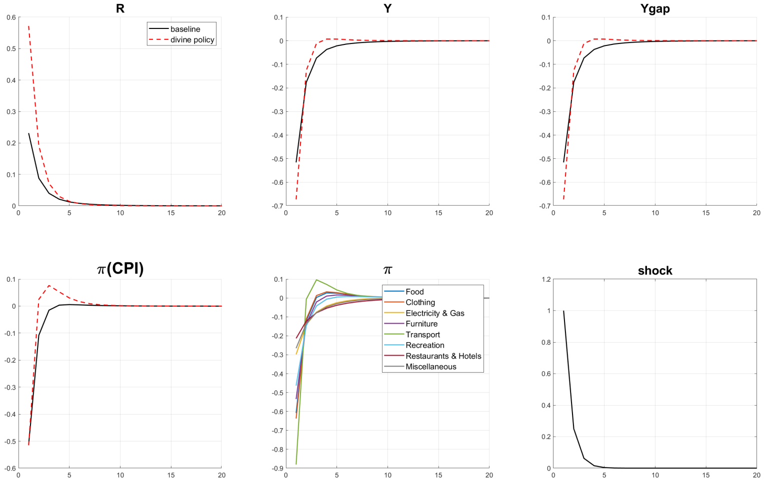
Monetary policy shock

π^{DC} in policy rule



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Market clearing

Clearing in, respectively, the labour market, the bond market, and the goods market, implies:

$$\int_0^1 \theta(j) n_t(j) dj = \sum_k \int_0^1 l_{k,t}(i) di,$$

$$\int_0^1 b_t(j) dj = 0,$$

$$\int_0^1 c_{k,t}(i,j) dj = y_{k,t}(i).$$

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New Keynesian Phillips Curve

Coefficients shaped by household heterogeneity

NKPC for sector k:

$$\pi_{k,t} = \beta \mathbb{E}_t \pi_{k,t+1} +$$
$$\lambda_k \left((\bar{\sigma}^{-1} + \psi^{-1})(\hat{\mathcal{Y}}_t - \hat{\mathcal{Y}}_t^*) - \sum_l \bar{\bar{\xi}}_l (\hat{P}_{k,t} - \hat{P}_{l,t}) - \sum_l \bar{\bar{\xi}}_l (\hat{A}_{k,t} - \hat{A}_{l,t}) + \mathcal{M}_{k,t} \right)$$

where:

$$\lambda_k = \frac{(1-\theta_k)(1-\beta\theta_k)}{\theta_k} \frac{\bar{\epsilon}_k - 1}{\bar{\epsilon}_k - 1 + \bar{\eta}_k} \qquad \text{(slope NKPC)}$$
$$\bar{\epsilon}_k = \int \frac{e_k(j)}{E_k} \epsilon_k(j) dj \qquad \text{(avg. demand elasticity)}$$
$$\bar{\eta}_k = \frac{P_k}{\bar{\epsilon}_k} \frac{\partial \bar{\epsilon}_k}{\partial P_k} \qquad \text{(price super-elasticity agg. demand)}$$
$$\bar{\bar{\xi}}_l = \int_j \frac{\theta(j) Wn(j)}{\int_j \theta(j) Wn(j)} \partial_e e_l(j) dj, \qquad \text{(avg. marginal budget share)}$$

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Endogenous markup wedge

Total expenditure component

Evolution:

$$\mathcal{M}^E_{k,t} = \mathbb{E}_t \mathcal{M}^E_{k,t+1} - \bar{\gamma}_{e,k} \bar{\sigma}^{\mathcal{M}}_k \hat{R}_t + \sum_l \bar{\gamma}_{e,k} \bar{\sigma}^{\mathcal{M}}_{k,l} \mathbb{E}_t \pi_{l,t+1} - \frac{\delta}{1-\delta} \mathbb{E}_t \mathcal{M}^0_{k,t}$$

where $\hat{\mathcal{M}}^0_{k,t}$ is a state variable which captures dynamics of the wealth distribution, and

Endogenous markup wedge

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where $\hat{\mathcal{M}}^0_{k,t}$ is a state variable which captures dynamics of the wealth distribution, and

- $\bar{\gamma}_{e,k} = \int \frac{e(j)}{E} \gamma_{e,k}(j) dj$
- $\bar{\sigma}^{\mathcal{M}}_k = \int \frac{\gamma_{e,k}(j)}{\bar{\gamma}_{e,k}} \frac{e(j)}{E_k} \xi_k(j) \sigma(j) dj$
- $\bar{\sigma}^{\mathcal{M}}_{k,l} = \int \frac{\gamma_{e,k}(j)}{\bar{\gamma}_{e,k}} \frac{e(j)}{E_k} \xi_k(j) \xi_l(j)\ \sigma(j) dj$

Endogenous markup wedge

Wealth dynamics

Deceased households replaced by identical type, but with steady-state level of wealth. Evolution:

$$\frac{1}{(1-\delta)R}\hat{\mathcal{M}}^0_{k,t} = \hat{\mathcal{M}}^0_{k,t-1} - \Gamma^R \left(\hat{R}_t - \sum_l \bar{s}_l \pi_{l,t+1}\right) -$$
$$\sum_{l\neq 0} \int \gamma_{b,k}(j) \left(\frac{e(j)}{E}\left(\bar{s}_l - s_l(j)\right) + \frac{wn(j)}{WL}\left(\bar{\psi}_l - \psi_l(j)\right)\right) dj \hat{P}_{l,t} -$$
$$\left(1 + \frac{\bar{\psi}}{\bar{\sigma}}\right) \int \gamma_{b,k}(j) \frac{wn(j)}{WL} dj \hat{\mathcal{Y}}_t + \frac{R-1}{R}\hat{\mathcal{M}}^E_{k,t}$$

where $\gamma_{b,k}(j) = \frac{R-1}{R} \frac{\gamma_{e,k}(j)\xi_k(j)}{1+\frac{wn\psi}{e(j)\sigma(j)}} \frac{E}{E_k}$ and $\Gamma^R = \int \gamma_{b,k}(j) \frac{b(j)}{RE} dj$.

Output gap

Evolution aggregate demand index:

$$\hat{\mathcal{Y}}_t = -\bar{\sigma}\left(\hat{R}_t - \mathbb{E}_t \sum_k \frac{\frac{\bar{\sigma}_k}{\psi} + \bar{\bar{\xi}}_k}{\frac{\bar{\sigma}}{\psi} + 1} \pi_{k,t+1}\right) + \mathbb{E}_t \hat{\mathcal{Y}}_{t+1}$$

Flexible-price counterpart ("natural" level of output):

$$\hat{\mathcal{Y}}_t^* = \sum_k \frac{\frac{\bar{s}_k}{\psi} + \bar{\bar{\xi}}_k}{\frac{1}{\psi} + \frac{1}{\bar{\sigma}}} \hat{A}_{k,t}$$

$\bar{\sigma} = \int \frac{e(j)}{E} \sigma(j) dj$
$\bar{\sigma}_k = \int \frac{e(j)}{E} \partial_e e_k(j) \sigma(j) dj$
$\bar{s}_k = \frac{E_k}{\sum_k E_k}$

Sectoral productivity shocks

- Food
- Clothing
- Electricity
- Furniture
- Transport
- Recreation
- Restaurants
- Miscellaneous