Workers, Capitalists, and the Government: Fiscal Policy and Income (Re)Distribution

Cristiano Cantore[†] Lukas B. Freund[‡]

28 October 2020

XXV Meeting of the Central Bank Researchers Network
Banco Central del Uruguay

The views expressed in this paper are those of the authors and are not necessarily reflective of views at the Bank of England.

[†] Bank of England, Centre for Macroeconomics, and University of Surrey

[‡] University of Cambridge

Motivation: bridging the gap between TANK & HANK

- New workhorse model in macro: Heterogeneous-Agent New Keynesian (**HANK**) *[Kaplan-Moll-Violante 2018]*
- Interest in **tractable** ('HANK') models $\Rightarrow$ capture & clarify properties *[Debortoli-Galí 2018, Bilbiie 2019, Acharya-Dogra 2020, Challe 2020, Kopiec 2020, Ravn-Sterk 2020]*
- Our approach: bridge gap between influential Two-Agent (**TANK**) model *[Galí, López-Salido & Vallés 2007, Bilbiie 2008]* and full-blown HANK setup
    - HANK literature $\Rightarrow$ limitations of traditional TANK model

The paper in one slide

- Develop a **C**(apitalist)-**W**(orker) **TANK** model to study the interaction of household heterogeneity & fiscal policy

1. Model **intermediately constrained worker household** type via portfolio adjustment costs (instead of fully hand-to-mouth)

   ⇒ **Intertemporal marginal propensities to consume** consistent with micro data & multi-asset HANK models *[Auclert-Rognlie-Straub 2018]*
   ⇒ **Fiscal multiplier path less sensitive to path of deficits** (than in benchmark with hand-to-mouth)

2. Adopt **capitalist**/worker structure

   ⇒ **Avoid profit income effects on labor supply** *[Broer-Hansen-Krusell-Öberg 2020]*
   ⇒ **Fiscal multipliers smaller** (than implied by traditional two-agent model with flexible wages)

Building Blocks

A tale of two TANK models

VAR evidence

- Point of departure: **TANK-UH** = canonical 2-agent NK model of limited asset market participation *[Galí, López-Salido & Vallés 2007, Bilbiie 2008]*
  1. Hand-to-mouth (H) households
  2. Unconstrained (U) households
- 2 main **issues** highlighted in recent literature
  1. **Consumption dynamics** inconsistent with micro data *[Auclert-Rognlie-Straub 2018, Fagereng-Holm-Natvik 2019, Hagedorn-Manovskii-Mitman 2019]*
  2. Transmission of demand shocks hinges on implausible profit income effects on **labor supply** *[Broer-Hansen-Krusell-Öberg 2020]*
- Introduce 2 modifications $\Rightarrow$ **TANK-CW**
  1. Workers (W) can save subject to portfolio adjustment costs vs. hand-to-mouth (H) fully excluded from asset markets
  2. Capitalists (C) don't supply labor (elastically) vs. Unconstrained (U) do

Consumption dynamics with portfolio adjustment costs

▸ Bond-in-utility interpretation

- **Auclert-Rognlie-Straub (2018)**: iMPCs key to understanding the aggregate effects of macro policy (sufficient statistic result)
  - $\partial c_t / \partial x_s =$ response of consumption at date t to an income shock at date s
- **How do iMPCs look like according to different models?**
- Consider a **partial equilibrium household problem**
  - Given processes for post-tax income and the real interest rate, $\{x_t^i, r_t\}$, choose consumption/savings s.t. budget constraint

$$b_t^i + \frac{\psi^i}{2}\left(b_t^i - b^i\right)^2 = x_t^i + (1 + r_{t-1})b_{t-1}^i + f_t^i - c_t^i$$

  - Trading in bonds potentially s.t. **convex portfolio adjustment costs** indexed by ψ^i: penalized when bond holdings deviate from some long-run level *[Neumeyer & Perri 2003, Schmitt-Grohe & Uribe 2005]*
  - **W**: intermediate degree of adjustment cost, ψ^W
  - H: nested for $\psi^H \to \infty$ (limited vs. *limited* asset market participation) U/C: corresponds to $\psi^{U/C} = 0$ (permanent-income hypothesis)

Consumption dynamics: Euler equation & analytical solution

Analytical results

- **Euler equation** for worker, allowing for portfolio adjustment costs

$$u'(c_t^W) = \beta E_t u'(c_{t+1}^W) \frac{(1+r_t)}{1+\psi^W(b_t^W - b^W)}$$

  - consider log utility w.l.o.g.

- Intuition: target saving, discounted Euler equation

- **Analytical solution** to log-linearized version

$$\tilde{b}_t^W = \mu_1 \tilde{b}_{t-1}^W - \sum_{l=0}^{\infty} \mu_2^{-(1+l)} E_t \left[(\hat{x}_{t+l}^W - \hat{x}_{t+l+1}^W) + \hat{r}_{t+l} \right]$$

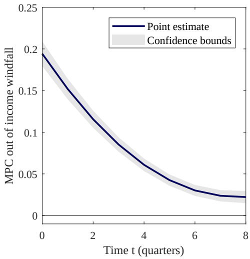
where $\mu_1 = \frac{1}{2}\left(1+\beta^{-1}+\psi^W - \sqrt{(1+\beta^{-1}+\psi^W)^2 - \beta^{-1}}\right)$ is the stable root, satisfying $|\mu_1| < 1$ whenever $\psi^W > 0$, while $\mu_2 = \left(1+\beta^{-1}+\psi^W\right) - \mu_1$, such that $|\mu_2| > 1$

Consumption dynamics: iMPCs

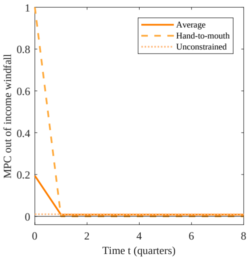
▸ Proposition 1 ▸ Anticipated windfall ▸ Interest rate shock

- Let's compare theoretical iMPCs out of an unanticipated income windfall to micro consumption data *[Auclert et al. 2018, Fagereng et al. 2019]*

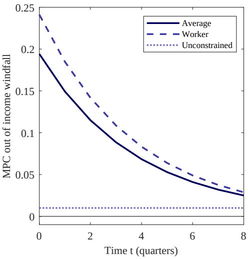
- Average over unconstrained (U or C) & fully (H) vs. partially (W) constrained (more on parameters in a minute)



(a) Data (interpolated from annual)



(b) Hand-to-mouth household (& unconstrained)



(c) Intermediately constrained worker (& unconstrained)

Labor supply and profit income effects

▸ Analytics ▸ Determinacy properties

- **Broer-Hansen-Krusell-Öberg (2020) critique**: RANK transmission mechanism of mon. pol. driven by profit income effects on labor supply due to countercyclical variations in markups – implausible!
- TANK-UH: tight interdependence of labor and financial markets makes mechanism even more forceful *[Bilbiie 2008]*
    - Bonus effect of intermediate PACs: more robust determinacy properties
- **Capitalist/worker setup**: firm ownership concentrated among capitalists who do not supply labor *[Walsh 2017, Broer et al. 2020]*
  $\Rightarrow$ **short-circuits the profit income effect on labor supply**

Household Heterogeneity & Fiscal Policy

What are the implications for fiscal policy?

▸ Equations: UH ▸ Equations: CW ▸ Parameters

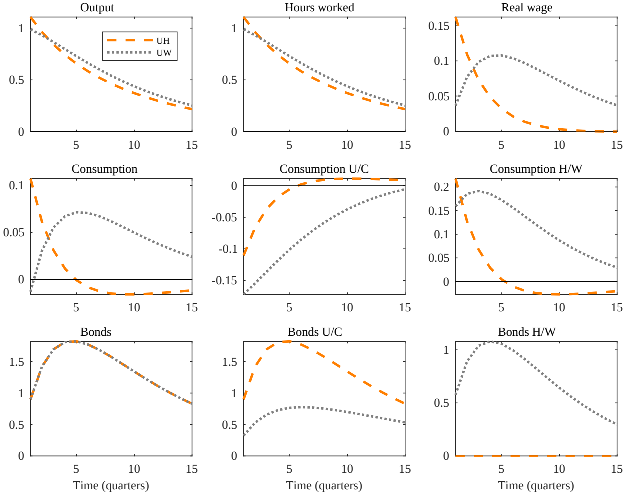
- Embed alternative 2-household blocks into **standard NK environment**
  - Firms: labor only input, sticky prices, flexible wages *[Bilbiie 2008]*
  - Government: Taylor rule + simple fiscal block with tax rule that allows for deficit finance *[Galí, López-Salido & Vallés 2007]*

- Compare **GE effects of $\Uparrow$ in deficit-financed public spending** according to calibrated versions of different TANK models

- **Calibration** of population shares, λ, and portfolio adjustment cost, ψ^W: **target micro consumption data**
  - Model with hand-to-mouth: $\psi^H \rightarrow \infty$ by definition, pick λ to match avg. quarterly impact MPC $\approx$ 0.2
  - Model with workers: pick ψ^W and λ to match avg. quarterly impact MPC $\approx$ 0.2 *and* annual MPC $\approx$ 0.55
    (similar values from IRF matching on macro time-series data)

IRFs with hand-to-mouth vs. worker households

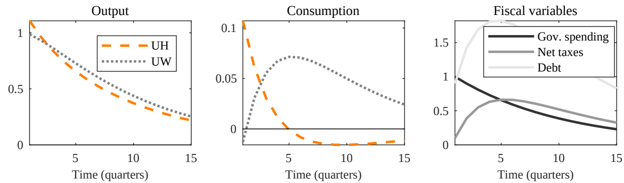
▸ With CW model ▸ Medium-scale variant



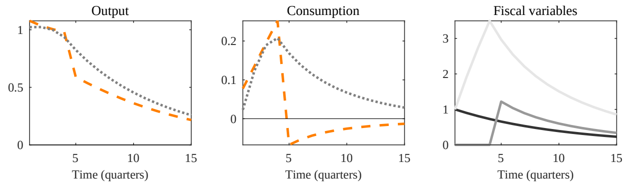
Notes: All series are in percent deviations from their steady state except for the fiscal variables, which are measured in percentage of steady-state output. Consumption components are weighted by population shares. Explanations for the acronyms: UH – unconstrained and hand-to-mouth households; UW – unconstrained and worker households; CW – capitalist and worker households.

Realistic iMPCs ⇒ output path sensitivity to financing mix ↓

▸ Alternative fiscal rule



(a) Baseline

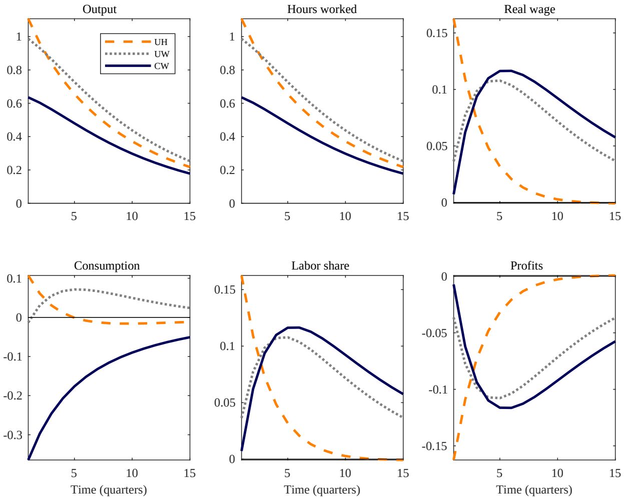


(b) Delayed tax rise

Notes: All series are in percent deviations from their steady state except for the fiscal variables, which are measured in percentage of steady-state output. Explanations for the acronyms: UH – unconstrained and hand-to-mouth households; UW – unconstrained and worker households; CW – capitalist and worker households.

No profit income effects on labor supply ⇒ multipliers ↓

▸ Numbers ▸ Medium scale



Notes: All series are in percent deviations from their steady state except for profits, which are measured in percentage of steady-state output. Explanations for the acronyms: UH – unconstrained and hand-to-mouth households; UW – unconstrained and worker households; CW – capitalist and worker households.

Conclusion

Insights from a capitalist-worker TANK model

▸ Forward guidance

- Introduced a **two-agent New Keynesian** (TANK) **model with capitalists and workers** that matches the implications of richer HANK models in key dimensions, while allowing for tractable analysis

1. **Realistic** pattern of **intertemporal marginal propensities to consume**
   - Policy: the *sensitivity* of output path to public deficits is dampened relative to the predictions of the traditional TANK model with hand-to-mouth households

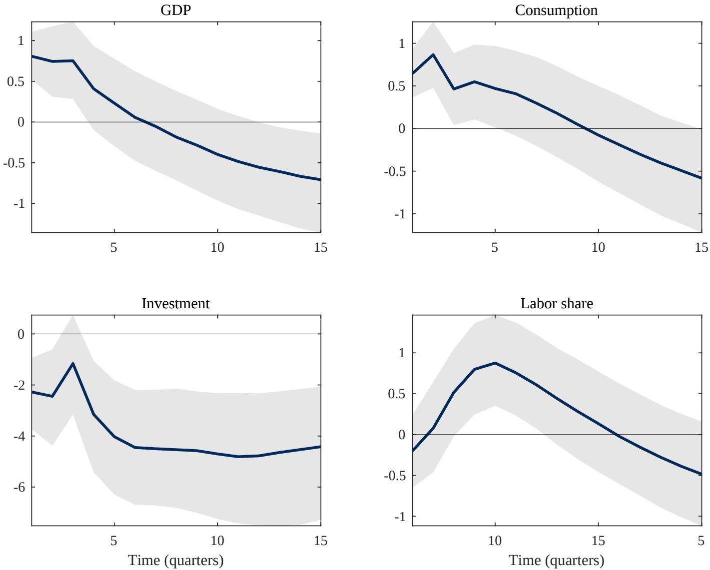
2. **Immune to** critique of transmission mechanism relying on **profit income effects on labor supply**
   - Policy: compared to the traditional TANK model (with flexible wages), fiscal multipliers are smaller in *size*

THANK YOU!

Extra slides

Structural VAR estimated on US macro data (1981:III-2007:IV)

Main



Benchmark TANK-UH model: equilibrium equations

Main

Description	Equation
Euler equation U	$\hat{c}_t^U = E_t \hat{c}_{t+1}^U - \hat{r}_t$
Budget constraint U	$\hat{c}_t^U + \tilde{b}_t^U = \hat{n}_t + \hat{w}_t + \frac{\tilde{d}_t}{1-\lambda} - \tilde{t}_t + R\tilde{b}_{t-1}^U$
Budget constraint H	$\hat{c}_t^H = \hat{n}_t + \hat{w}_t - \tilde{t}_t$
Aggregate consumption	$\hat{c}_t = \lambda \hat{c}_t^H + (1-\lambda)\hat{c}_t^U$
Aggregate labor supply	$\hat{n}_t = \varphi^{-1}(\hat{w}_t - \hat{c}_t)$
Dividends	$\tilde{d}_t = -\hat{w}_t$
Phillips curve	$\hat{\Pi}_t = \beta E_t \hat{\Pi}_{t+1} + \frac{(1-\theta)(1-\beta\theta)}{\theta}\hat{w}_t$
Government budget constraint	$\tilde{b}_t = R\tilde{b}_{t-1} + \tilde{g}_t - \tilde{t}_t$
Government spending	$\tilde{g}_t = \rho^g \tilde{g}_{t-1} + \epsilon_t^g$
Fiscal rule	$\tilde{t}_t = \phi^{\tau t}\tilde{t}_{t-1} + \phi^{\tau B}\tilde{b}_t + \phi^{\tau G}\tilde{g}_t$
Taylor rule	$\hat{R}_t = \phi^\pi \hat{\Pi}_t$
Fisher equation	$\hat{r}_t = \hat{R}_t - E_t \hat{\Pi}_{t+1}$
Bond holdings	$\tilde{b}_t = (1-\lambda)\tilde{b}_t^U$

TANK-CW: equilibrium equations

Main

Description	Equation
Euler equation C	$\hat{c}_t^C = E_t \hat{c}_{t+1}^C - \hat{r}_t$
Budget constraint C	$\tilde{b}_t^C = \frac{\tilde{d}_t}{1-\lambda} - \tilde{t}_t + R\tilde{b}_{t-1}^C - \hat{c}_t^C$
Euler equation W	$\hat{c}_t^W = E_t \hat{c}_{t+1}^W - \hat{r}_t + \psi^W \tilde{b}_t^W$
Budget constraint W	$\tilde{b}_t^W = \left(\hat{n}_t^W + \hat{w}_t\right) n^W + R\tilde{b}_{t-1}^W - \hat{c}_t^W - \tilde{t}_t$
Aggregate consumption	$\hat{c}_t = \lambda \hat{c}_t^W + (1-\lambda)\hat{c}_t^C$
Labor supply	$\hat{n}_t^W = \varphi^{-1}\left(\hat{w}_t - \hat{c}_t^W\right)$
Dividends	$\tilde{d}_t = -\hat{w}_t$
Phillips curve	$\hat{\Pi}_t = \beta E_t \hat{\Pi}_{t+1} + \frac{(1-\theta)(1-\beta\theta)}{\theta}\hat{w}_t$
Government budget constraint	$\tilde{b}_t = R\tilde{b}_{t-1} + \tilde{g}_t - \tilde{t}_t$
Government spending	$\tilde{g}_t = \rho^g \tilde{g}_{t-1} + \epsilon_t^g$
Fiscal rule	$\tilde{t}_t = \phi^{\tau t}\tilde{t}_{t-1} + \phi^{\tau B}\tilde{b}_t + \phi^{\tau G}\tilde{g}_t$
Taylor rule	$\hat{R}_t = \phi^{\pi}\hat{\Pi}_t$
Fisher equation	$\hat{r}_t = \hat{R}_t - E_t \hat{\Pi}_{t+1}$
Bond holdings	$\tilde{b}_t = \lambda \tilde{b}_t^W + (1-\lambda)\tilde{b}_t^C$

Baseline Calibration

Main

Parameter	Interpretation	Value (H | W)	Source
		Shared parameter values	
β	Discount factor	0.99	Annual real interest rate of 4%
ρ^G	AR1 Government spending shock	0.9	Benchmark
ψ^W	Portfolio adjustment cost	∞ | 0.07	Definition | iMPC evidence
λ	% of H/W	0.19 | 0.8	iMPC evidence
b^W	Workers' steady-state bond holdings	0	Comparability of models
ξ	Rotemberg price stickiness	42.68	Average price duration 3.5q
ϕ^π	Interest rate response to inflation	1.5	Galí *et al.* (2007)
$\phi^{\tau,t}$	Tax smoothing	0	Galí *et al.* (2007)
$\phi^{\tau,g}$	Tax response to government spending	0.1	Galí *et al.* (2007)
$\phi^{\tau,b}$	Tax response to debt	0.33	Galí *et al.* (2007)
Π	Steady-state inflation rate	1	Benchmark
φ	Inverse Frisch elasticity	0.05	Determinacy of UH
η	Int. goods elasticity of substitution	6	Steady-state profits excl. subsidy
τ^S	Production subsidy	$(\eta-1)^{-1}$	Marginal cost pricing

Conditions for equivalence to bond-in-utility

▸ Main

- **Portfolio adjustment costs**: adjustment cost in budget constraint

$$u'(c_t) + u'(c_t)\rho'(b_t) = \beta E_t u'(c_{t+1})(1 + r_t)$$

$\downarrow$ $\rho(b_t) = \frac{\psi}{2x}(b_t - b)^2$, log utility, $b = 0$, log-linearized

$$\hat{c}_t - \psi \tilde{b}_t = E_t \hat{c}_{t+1} - \hat{r}_t$$

- **Bond-in-utility**: $E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) + v(b_t)\right]$

  [Hagedorn 2018, Michaillat & Saez 2019]

$$u'(c_t) - v'(b_t) = \beta E_t u'(c_{t+1})(1 + r_t).$$

- In general, equivalence between the two approaches requires that $v'(b_t) = -u'(c_t)\rho'(b_t)$

- First-order equivalent when $v(b_t) = -\frac{\psi}{2x}(b_t - b)^2$

Analytical solution for the partial eqm. model with PACs

▸ Main

- Log-linearize around steady state with income normalized to unity, $b^W = 0$ and $(1+r) = \beta^{-1}$
- Substitute worker's budget constraint into Euler equation
- Then for $\psi^W > 0$, the stationary solution is

$$\tilde{b}_t^W = \mu_1 \tilde{b}_{t-1}^W + \sum_{l=0}^{\infty} \mu_2^{-(l+1)} E_t \left[(\hat{x}_{t+l}^W - \hat{x}_{t+l+1}^W) + \hat{r}_{t+l} \right]$$

where $\mu_1 = \frac{1}{2}\left(1 + \beta^{-1} + \psi^W - \sqrt{(1+\beta^{-1}+\psi^W)^2 - \beta^{-1}}\right)$ is the stable root, satisfying $|\mu_1| < 1$ whenever $\psi^W > 0$, while $\mu_2 = \left(1 + \beta^{-1} + \psi^W\right) - \mu_1$, such that $|\mu_2| > 1$

- Consumption can be backed out from the (log-linearized) budget constraint, after cancelling out adjustment costs and rebate

$$\hat{c}_t^W = \hat{x}_t + \beta^{-1} \tilde{b}_{t-1}^W - \tilde{b}_t^W$$

Analytics: unanticipated income shocks

Main

Proposition (iMPCs for an unanticipated income shock)

Following an unanticipated one-off income windfall the response of a worker household's consumption on impact is

$$\frac{d\hat{c}_0^W}{d\hat{x}_0^W} = 1 - \mu_2^{-1}.$$

The subsequent expected path of consumption, for $t \geq 1$ *obeys*

$$\frac{E_0\left[d\hat{c}_t^W\right]}{d\hat{x}_0^W} = \mu_1^{t-1}\left(\beta^{-1} - \mu_1\right)\mu_2^{-1}.$$

For $\psi^W \to \infty$*, the roots* $\mu_1 = 0$ *and* $\mu_2 \to \infty$*, so that the worker's consumption response reduces to that of a hand-to-mouth household.*

Analytics: anticipated income shocks

▸ Main

Proposition (iMPCs for an anticipated income shock)

The response of consumption when news arrives at $t = 0$ of a one-off income windfall that materializes $s \geq 0$ periods later is

$$\frac{d\hat{c}_0^W}{E_0\left[d\hat{x}_s^W\right]} = \mu_2^{-s}\left(1-\mu_2^{-1}\right).$$

The subsequent expected path of consumption, for $t \geq 1$ obeys

$$\frac{E_0\left[d\hat{c}_t^W\right]}{E_0\left[d\hat{x}_s^W\right]} = \begin{cases} \mu_2^{-s}\left(1-\mu_2^{-1}\right) \times \left(\mu_2^t - (\beta^{-1}-\mu_1)\mu_1^{t-1}\sum_{l=1}^{t}\left(\frac{\mu_1}{\mu_2}\right)^{1-l}\right), & \text{for } t \leq s \\ \mu_1^{t-(s+1)}(\beta^{-1}-\mu_1)\left(\mu_2^{-1} - \left(1-\mu_2^{-1}\right)\sum_{l=1}^{s}\left(\frac{\mu_1}{\mu_2}\right)^{l}\right), & \text{for } t > s, \end{cases}$$

where if $s = 0$ the empty sum is treated as equal to zero, as is convention.

Analytics: interest rate effects

Main

Proposition (Interest rate effects)

The response of consumption when news arrives at $t = 0$ of a one-off change in the real interest rate $s \geq 0$ periods later is

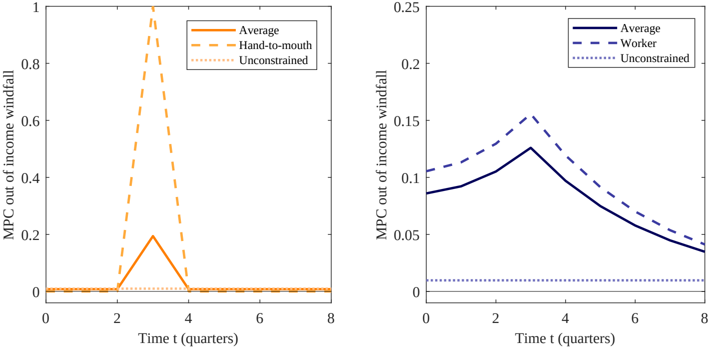
$$\frac{d\hat{c}_0^W}{E_0\left[d\hat{r}_s\right]} = -\mu_2^{-(s+1)}$$

The subsequent expected path of consumption, for $t \geq 1$ obeys

$$\frac{E_0\left[d\hat{c}_t^W\right]}{E_0\left[d\hat{r}_s\right]} = \begin{cases} -\mu_2^{t-(s+1)} + (\beta^{-1} - \mu_1)\mu_1^{t-1}\mu_2^{-s}\sum_{l=1}^{t}\left(\frac{\mu_1}{\mu_2}\right)^{1-l}, & \text{for } t \leq s \\ \mu_1^{t-(s+1)}(\beta^{-1} - \mu_1)\mu_2^{-1}\sum_{l=1}^{s}\left(\frac{\mu_1}{\mu_2}\right)^{l}, & \text{for } t > s. \end{cases}$$

iMPCs for anticipated income shock

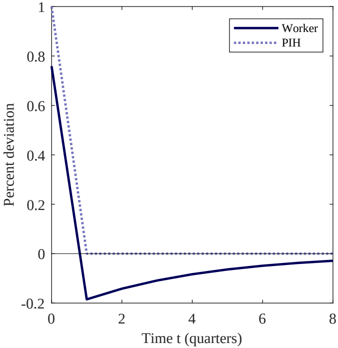
Main



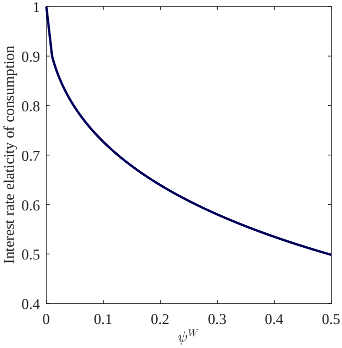
(a) Model with hand-to-mouth households **(b)** Model with portfolio adjustment costs

Interest rate effects in the model with PACs

Main



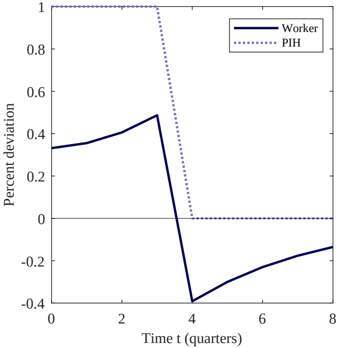
(a) Effect on consumption of an interest rate cut in the current period



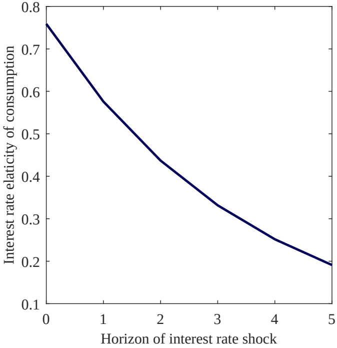
(b) Interest rate elasticity of consumption for different values of ψ^W

Interest rate effects in the model with PACs: forward guidance

Main



(c) Effect on consumption of news about an interest rate cut three quarters ahead



(d) Effect on consumption of news about an interest rate cut at different shock horizons

Profit income effects on labor supply in TANK-UH

Main

- Similar point made by Broer et al. (2020) for monetary policy
- Assume $\tilde{b}_t = 0$ for simplicity

$$\begin{aligned} \varphi\hat{n}_t + \hat{c}_t &= \hat{w}_t, \\ \hat{c}_t^U &= \hat{w}_t + \hat{n}_t - \tilde{t} + \frac{\tilde{d}_t}{1-\lambda}, \\ \hat{c}_t^H &= \hat{w}_t + \hat{n}_t - \tilde{t}_t, \\ \hat{c}_t &= \lambda\hat{c}_t^H + (1-\lambda)\hat{c}_t^U, \\ \tilde{t}_t &= \tilde{g}_t \end{aligned} \qquad \Rightarrow \hat{n}_t = \frac{(\tilde{g}_t - \tilde{d}_t)}{1+\varphi}$$

Profit income effects on labor supply with capitalists

Main

- Now let's break the link between profits and labor supply
- U(nconstrained) become C(apitalist)

$$\begin{aligned}
\hat{n}_t^C &= 0, \\
\hat{c}_t^C &= \frac{\tilde{d}_t}{1-\lambda} - \tilde{t}_t, \\
\hat{n}_t &= \lambda \hat{n}_t^H, \\
\varphi \hat{n}_t^H + \hat{c}_t^H &= \hat{w}_t, \\
\hat{c}_t^H &= (\hat{w}_t + \hat{n}_t^H) n^H - \tilde{t}_t, \\
\hat{c}_t &= \lambda \hat{c}_t^H + (1-\lambda)\hat{c}_t^C,
\end{aligned}
\qquad \Rightarrow \hat{n}_t = \frac{\tilde{g}_t}{1+\varphi}$$

Fiscal multipliers: simple and medium-scale models

Main

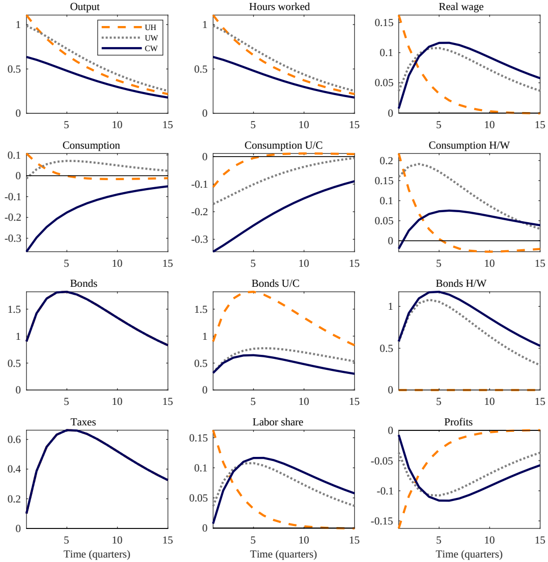
	Simple models				Medium-scale models			
	RA	UH	UW	CW	RA	UH	UW	CW
Impact multiplier	0.96	1.11	0.99	0.64	0.81	0.95	1.21	1.32
Cumulative multiplier	0.96	1.00	1.08	0.73	0.42	0.45	0.58	0.79

Table 3: Fiscal multipliers according to simple and medium-scale models

Notes: This table summarizes the output effects of a government spending shock according to different TANK models: the first main column refers to the simple models described in Tables 1 and 2, the second refers to medium-scale variants (set out in detail in Appendix B.3). Explanations for the acronyms: RA – representative agent; UH – unconstrained and hand-to-mouth households; UW – unconstrained and worker households; CW – capitalist and worker households. In the simple models, where the steady-state of government spending is zero, the impact multiplier is computed as dy_0/dg_0 and the cumulative multiplier as $\sum_{l=0}^{\infty} \beta^l dy_l/dg_l$. In models with positive government spending in steady state, these objects are normalized accordingly.

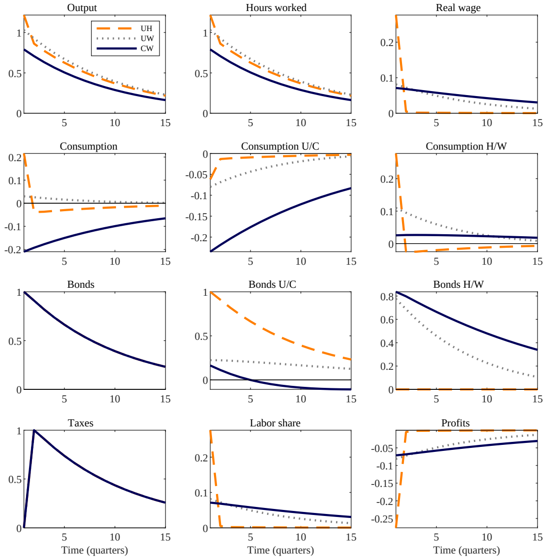
Full IRFs from all three simple models

Main



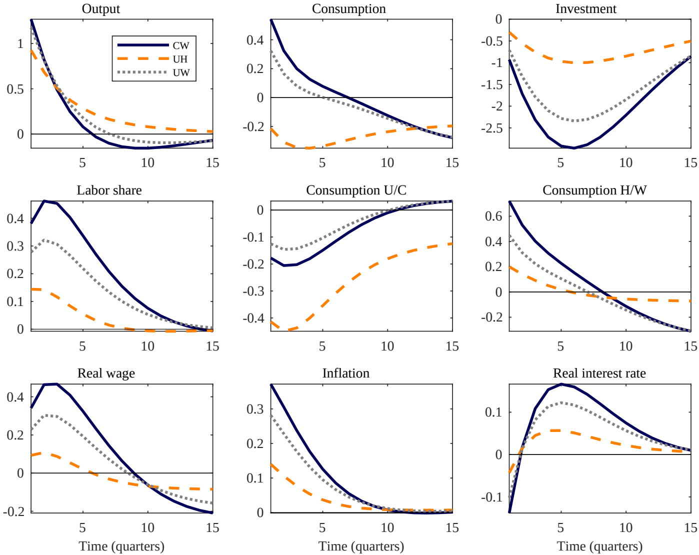
Fiscal rule such that bonds beak at impact

Main



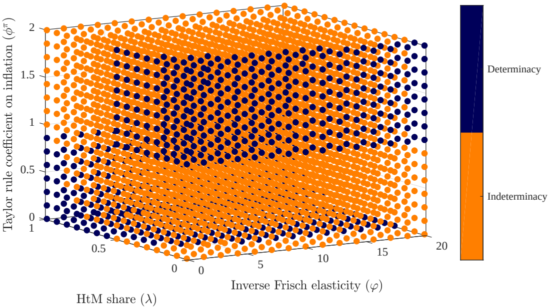
IRFs for medium-scale models

Main



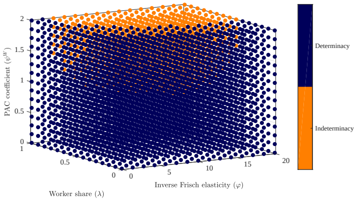
Stability regions in the benchmark TANK-UH model

Main

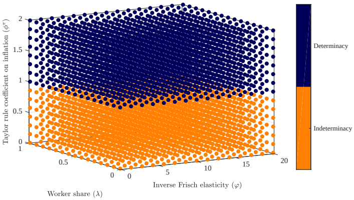


Notes: This figure shows regions in parameter space that are associated with the presence of uniqueness and multiplicity of the rational expectations equilibrium in a neighborhood of the steady-state, respectively.

Stability regions in the model with portfolio adjustment costs



(a) Stability in $(\varphi, \lambda, \psi^W)$ space



(b) Stability in $(\varphi, \lambda, \phi^\pi)$ space

Notes: This figure shows regions in parameter space that are associated with the presence of uniqueness and multiplicity of the rational expectations equilibrium in a neighborhood of the steady-state. The right-hand panel assumes $\psi^W = 0.074$.