Limited Asset Market Participation and Monetary Policy in a Small Open Economy

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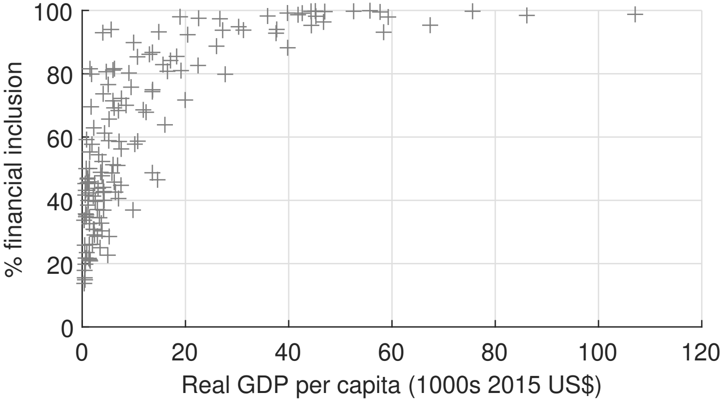
Some background

Households that live hand-to-mouth make a large share of modern economies

- E.g., Aguiar, Bils & Boar (2019) find 40% US households are H2M (half poor)
- Financial inclusion against GDP (World Bank, Global Financial Inclusion Database):



Financial incl. is % of (aged 15+) pop with account at financial institution or a mobile-money-service provider

LAMP and monetary policy

Common to model two household types since Mankiw (2000, AERp&p).

- TANK shortcut to full heterogeneity (Debortoli & Gali, 2018; Bilbiie, 2020)

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The presence of H2M (or limited asset market participation, LAMP) has policy implications

- Gali *et al*, (2004, JMCB) show usual Taylor principle no longer guarantees determinacy
- Gali *et al*, (2007, JEEA) LAMP can $\Longrightarrow$ positive G multiplier on C
- Bilbiie (2008, JET) shows LAMP can lead to an **inverted aggregate demand logic** (IADL)

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- This can occur when the profit channel outweighs the wage effect of monetary policy

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- Ricardian (SADL): $r \downarrow \implies c \uparrow$ (intertemp subs), labour demand $\uparrow$ and $w \uparrow$

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- BUT $w \uparrow$ lowers profits $\implies \uparrow$ pressure on Ricardian labour supply but $\downarrow$ pressure on demand
- Degree of LAMP can be large enough so profit channel outweighs wage effect.

Inertial policy

There is a lot of recent interest in “make-up” policy rules like price-level targeting

- The US Fed revised strategy to target inflation that ‘averages 2 percent over time’

Central banks tend to follow inertial monetary policy

- There are various reasons (uncertainty, long/variable pass through, credibility)
- In the NK model, this gets the Taylor rule closer to fully optimal policy

Despite this, there are limited papers studying monetary policy with **policy inertia** (including, price-level targeting) in a **small open economy** with **LAMP**

Paper Overview

Framework: linearized TANK-SOE following Gali & Monacelli (2005) and Bilbiie (2008)

In this paper, we are working on:

1. studying the determinacy properties of a TANK-SOE model, thinking about:
    - impact of policy inertia
    - impact of trade openness
    - impact of an effective lower bound on interest rates (ZLB)
2. studying optimal policy
    - Under discretion and commitment
    - Around three types of equilibrium (flexi-price/efficient/equitable)

Model summary

The baseline model is a small open economy New Keynesian model with

- Complete international financial markets
- No capital
- Zero trend inflation
- Producer (domestic) currency pricing
- Standard ‘Ricardian’ households and hand-to-mouth households

Model summary

The baseline model is a small open economy New Keynesian model with

- ~~Complete~~ Incomplete international financial markets
- ~~No~~ capital in production
- ~~Zero~~ positive trend inflation
- ~~Producer (domestic)~~ Dominant/local (foreign) currency pricing
- Standard 'Ricardian' households and hand-to-mouth households

Model 1/2

Supply

$$\pi_{H,t} = \beta \pi_{H,t+1} + \Psi mc_t, \tag{1}$$
$$mc_t = w_t + (1 - w_C)\, s_t \tag{2}$$
$$y_t = \lambda n_t^R + (1 - \lambda)\, n_t^C \tag{3}$$
$$\pi_t = \pi_{H,t} + (1 - w_C)\,(s_t - s_{t-1}) \tag{4}$$

- w_C = home bias, $\Psi = (1-\xi)(1-\beta\xi)/\xi$, ξ = calvo, λ = proportion of Ricardian households
  n_t = labour, s_t = terms of trade $(p_{F,t} - p_{H,t})$

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Ricardian household

$$w_t = \varphi n_t^R + \sigma c_t^R, \tag{5}$$
$$c_t^R = c_{t+1}^R - \frac{1}{\sigma}\,(r_t - \pi_{t+1}) \tag{6}$$
$$s_t = \frac{\sigma}{w_C} c_t^R \tag{7}$$

Model 2/2

Rule-of-thumb households

$$w_t = \varphi n_t^C + \sigma c_t^C, \tag{8}$$

$$c_t^C = w_t + n_t^C \tag{9}$$

Model 2/2

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Rearranged to 3-equation model

$$\pi_{H,t} = \beta \pi_{H,t+1} + \Psi \Lambda_1 c_t^R, \tag{10}$$
$$c_t^R = c_{t+1}^R - \frac{w_C}{\sigma}\left(r_t - \pi_{H,t+1}\right) \tag{11}$$

plus policy rule:

$$r_t = \rho r_{t-1} + \theta_\pi \pi_{t+1} \tag{12}$$

- w_C = home bias, σ = CRRA, $\Psi = (1-\xi)(1-\beta\xi)/\xi$, ξ = calvo, $\Lambda_1(\lambda, w_C)$ is composite parameter

IADL threshold

1. Inverted-aggregate demand (IADL) threshold when Λ_1 changes sign:
   - $\Lambda_1 > 0$: SADL - interest rate has usual impact on AD
   - $\Lambda_1 < 0$: IADL - interest rate rise $\Longrightarrow$ AD increases

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Λ_1 depends on trade openness $(1 - w_C)$ and degree of LAMP $(1 - \lambda)$

- Implies threshold $\lambda = \lambda^* (w_C)$ where $\Lambda_1 = 0$ below which IADL occurs

$$\lambda^* = \frac{\varphi \left[w_C(1+\varphi) + \sigma - 1 \right]}{\varphi \left[w_C(1+\varphi) + \sigma - 1 \right] + \varphi + \sigma}. \tag{13}$$

(φ = Frisch, σ = CRRA, w_C = trade openness)

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(φ = Frisch, σ = CRRA, w_C = trade openness)

- $\lambda^{*\prime}(w_C) > 0$, i.e.: trade openness lowers threshold λ^*

Increasing trade openness lowers likelihood of IADL

Role of policy inertia

2. Role of interest rate inertia

$$r_t = \rho r_{t-1} + \theta_\pi \pi_{t+1} \tag{14}$$

- Under SADL when $\lambda > \lambda^*$ inertia *increases* the determinate policy space
- Under IADL when $\lambda < \lambda^*$ inertia *decreases* the determinate policy space
- There is region of λ where no unique equilibrium exists for $\theta_\pi > 0$ under PLT

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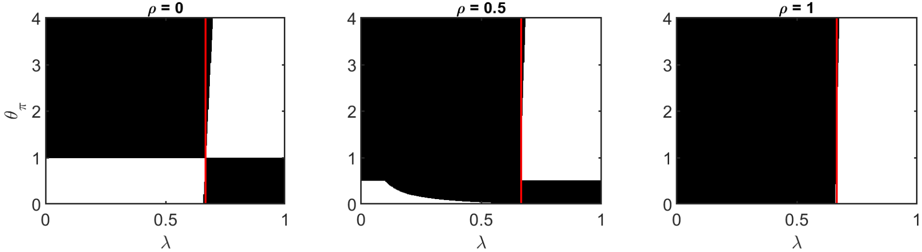

White = unique and stable equilibrium; $\varphi = 2$, $w_C = 1$, $\xi = 0.75$, $\mu_C = 0.62$, $\beta = 0.99$

Role of openness

3. Role of openness
   - Under SADL when $\lambda > \lambda^*$ openness *decreases* the determinate policy space
   - Under IADL when $\lambda < \lambda^*$ openness *increases* the determinate policy space for low λ and *decreases* it for high λ

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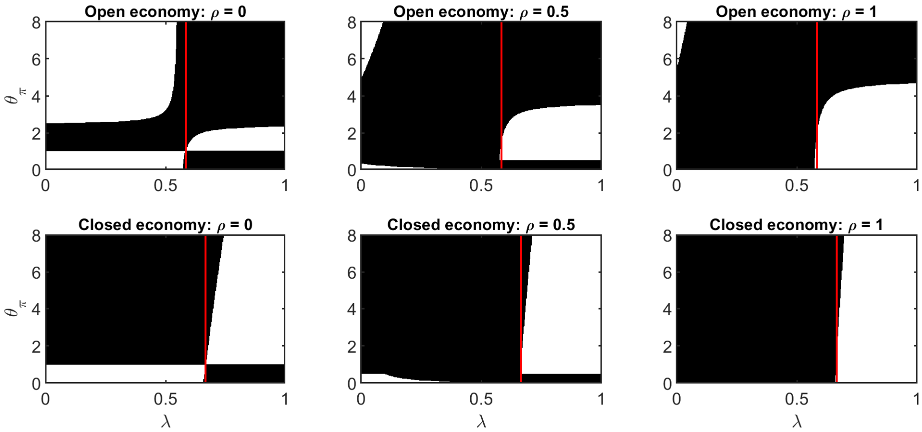

Output gap 1/2

- Consider the policy rule:

$$r_t = \rho r_{t-1} + \theta_\pi \pi_{t+1} + \theta_y y_t \tag{15}$$

Note: $y_t = \Xi c_t^R$

- **Under SADL** generalised Taylor principle:

$$\theta_\pi + \frac{(1-\beta)\Xi}{\Psi \Lambda_1} \theta_y > 1 - \rho_r. \tag{16}$$

Because (usually) $\Xi < 0$ when $\Lambda_1 < 0$, output target can restore Taylor principle under **IADL**.

- This is what Bilbiie (2008) shows

Output gap 2/2

To ensure determinacy under **IADL**, θ_y must satisfy:

$$\theta_y > \left(\frac{\theta_\pi - 1 - \rho}{1+\beta}\right)\frac{\Psi\Lambda_1}{\Xi} - \frac{2\sigma(1+\rho)}{\Xi} \tag{17}$$

- $\Xi > 0$ when $\Lambda_1 < 0$ for low λ, so still inverted Taylor principle in this region

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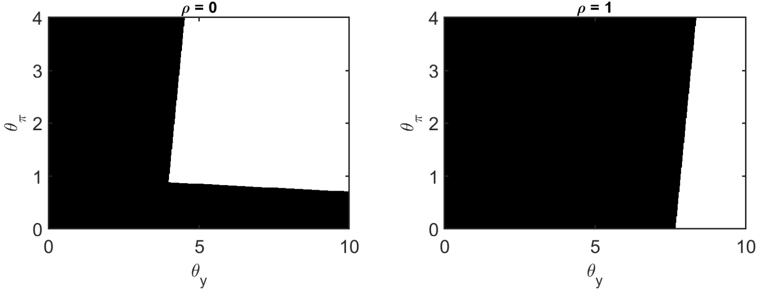
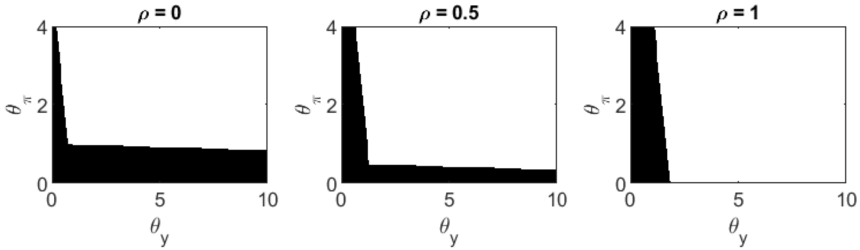
- $\Xi > 0$ when $\Lambda_1 < 0$ for low λ, so still inverted Taylor principle in this region
- Policy inertia undermines benefits of output target (plot shows $\lambda = 0.5 < \lambda^*$, i.e., IADL)

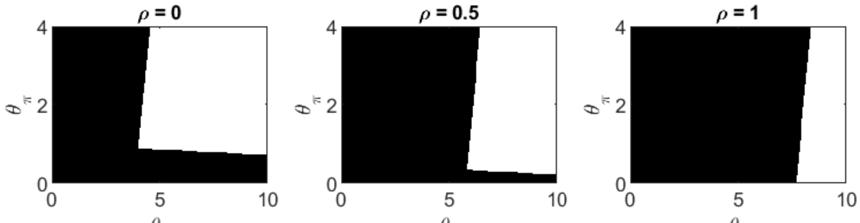


Output gap: open vs closed

(a) Open economy



(b) Closed economy



Effective lower bound considerations

Suppose

$$\bar{r} + r_t = \begin{cases} \bar{r} + \rho_r r_{t-1} + \theta_\pi \pi_{t+1} & \text{if } > 0 \\ 0 & \text{otherwise.} \end{cases} \tag{18}$$

- NK-ZLB model can have long-run and short-run indeterminacy
- E.g., there are two deterministic steady states
- We only consider short-run indeterminacy here by assuming the inflationary SS always holds in long-run

We can write:

$$r_t = \max\left\{-\bar{r}, \rho_r r_{t-1} + \theta_\pi \pi_{t+1}\right\} \tag{19}$$

News shock representation

- Define

$$\eta_t \equiv \max\{-\bar{r}, \rho_r r_{t-1} + \theta_\pi \pi_{t+1}\} + \rho_r r_{t-1} + \theta_\pi \pi_{t+1}. \tag{20}$$

  then:

$$r_t = \rho_r r_{t-1} + \theta_\pi \pi_{t+1} + \eta_t \tag{21}$$

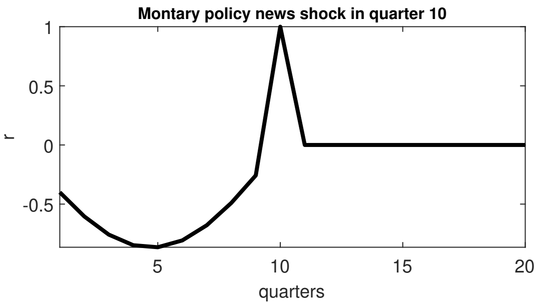
  η_t is a partially anticipated endogenous news-shock

- We can check determinacy properties relating to ZLB by studying properties of IRFs to monetary policy news shocks (see Holden, 2019)

Intuition for multiple equilibria

Consider standard 3-equation closed NK model (no LAMP), no policy inertia

- Plot shows news shock observed at $t = 1$, hitting at $t = 10$



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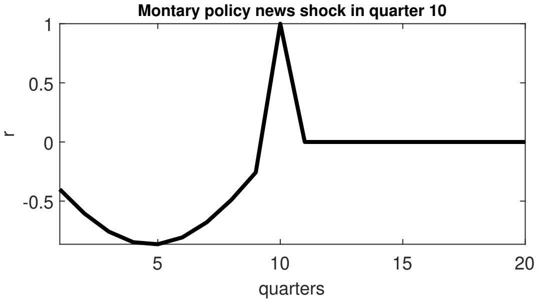
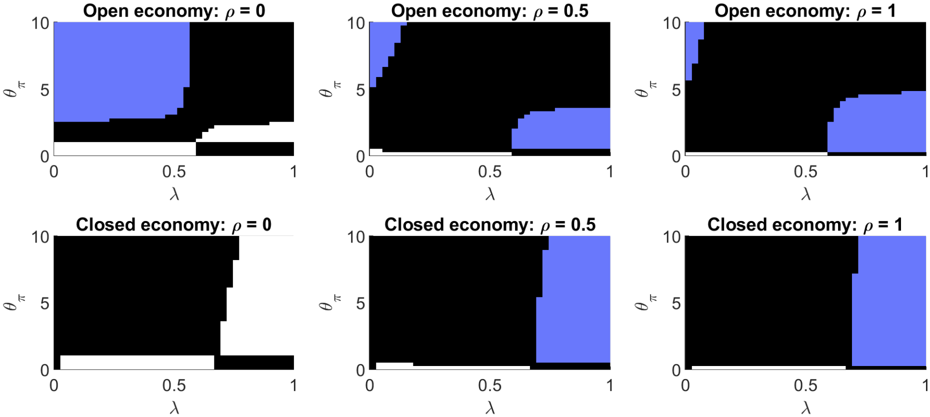


- A future ZLB episode is equivalent to a future monetary policy news shock
- If this is sufficiently contractionary, this could be self-fulfilling

Testing for multiple equilibria

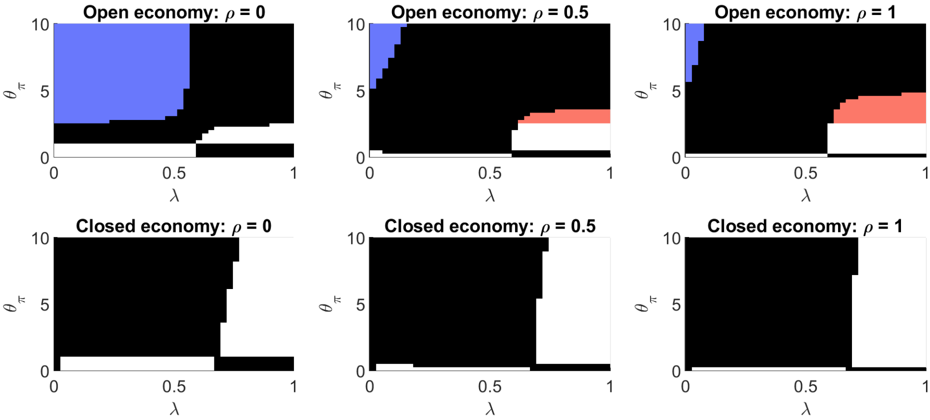
- Holden (2019) outlines necessary and sufficient conditions for uniqueness
- Depends on notion of positivity in news shock IRFs.
  - Let $m_k = [m_{1,k}, \cdots, m_{T,k}]'$ be impulse response of r_t up to $t = T$ to a news shock in period k
  - Let matrix M stack m_k for $k = 1, 2, \cdots, T$
  - We can test matrix M to determine determinacy properties relating to ZLB.
- We have to choose a horizon of future news shocks, T
  - Beyond this horizon its *as if* there is no further ZLB risk
  - It can be computationally expensive to perform full checks for large horizons
  - we can perform weaker checks

Test one: sufficient statistics for uniqueness up to $t + 200$



- White = uniqueness guaranteed, blue = cannot guarantee uniqueness
- **SADL**: Uniqueness gauranteed with no policy inertia
- **IADL**: Uniqueness guaranteed under inverted Taylor principle

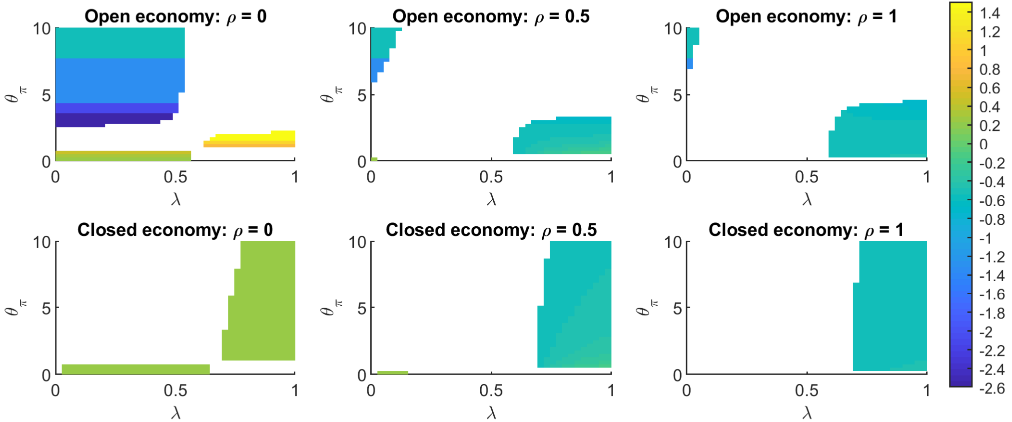
Test two: necessary and sufficient statistics for uniqueness up to $t + 20$



- White = uniqueness guaranteed, blue = multiple equilibria **always** possible, red = multiple equilibria nearly always possible
- **SADL**: Self-fulfilling ZLB possible under active inertial rule
- **IADL**: Self-fulfilling ZLB episodes under Taylor principle

Test three: continuous sufficient statistic

Minimum determinant of a principal sub-matrix of M. Uniqueness if positive



- **SADL**: Increasing $\theta\pi$ worsens determinacy properties
- **IADL**: Increasing $\theta_p i$ appears to improve determinacy properties

Very briefly on optimal policy

Solve optimal policy (LQ welfare) under discretion and commitment, around:

i decentralized flex-price equilibrium,

ii the optimal social-planner allocation and

iii the efficient and equitable social-planner allocation

Results:

1. In closed economy $w = 1$, efficient allocation also equitable (as in Bilbiie ,2008)
   - openness can introduce a wedge away from equitable allocation which *increases* in degree of LAMP
2. Quadratic welfare function:
   - **Openness** increases ($w \downarrow$) $\Longrightarrow$ higher weight on mean output gap in *i* and *ii*
   - **LAMP** increases ($\lambda \downarrow$) $\Longrightarrow$ higher weight on mean output gap in *i* and *ii*, higher weight on output deviations
3. Under discretion:
   - More **openness** or less **LAMP** increases $\Longrightarrow$ more aggressive targeting rule
   - Inflationary bias: *increases* in **openness** or degree of **LAMP**

Review of results

Linear model:

- In contrast to usual results, under IADL, **openness can improve determinacy** properties and policy **inertia worsens determinacy** properties
- In the open economy under IADL, there is a region with low λ where determinacy is possible under the Taylor principle.
- As Bilbiie (2008) shows, an output gap target can restore Taylor principle – this is undermined with policy inertia.

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ZLB

- The ZLB can introduce multiplicity and self-fulfilling ZLB traps
- The region under IADL that satisfies Taylor principle is **indeterminate** with the ZLB
- Under IADL the region that satisfies the inverted Taylor principle is always **determinate**
- Policy inertia appears to worsen determinacy properties – overturned with shadow rate
- Under SADL: policy aggressiveness **worsens determinacy** properties
- Under IADL: policy aggressiveness **improves determinacy** properties

Optimal policy

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Welfare function

Solve optimal policy (LQ welfare) under discretion and commitment, around:

i decentralized flex-price equilibrium,

ii the optimal social-planner allocation and

iii the efficient and equitable social-planner allocation

2. Quadratic welfare loss function:

$$\Omega = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{2} \left(\pi_{H,t}^2 + \varpi x_{j,t}^2 \right) - \Upsilon_j x_{j,t} \right], \quad j = i, ii, iii \tag{22}$$

where $\varpi = \frac{\Psi(1+\varphi)}{\zeta\lambda}$, $\Upsilon_i = \frac{(1-w)(1-\lambda)\varphi}{\lambda}$, $\Upsilon_{ii} = \Upsilon_i + \frac{\Psi}{\zeta}$ and $\Upsilon_{iii} = 0$ ($\varphi =$ Frisch, $\zeta =$ CES)

- **Openness** increases ($w \downarrow$) $\Longrightarrow \Upsilon_i, \Upsilon_{ii} \uparrow$
- **LAMP** increases ($\lambda \downarrow$) $\Longrightarrow \varpi, \Upsilon_i, \Upsilon_{ii} \uparrow$

Results so far: optimal policy

3. Optimal policy under discretion:

$$\pi_{H,t} = \frac{\kappa \Upsilon_j}{\kappa^2 + (1-\beta)\varpi} + \frac{\varpi}{\kappa^2 + (1-\beta\rho_u)\varpi} u_t \tag{23}$$

where $\kappa = \Psi \left(1 + \left[1 - (1-\lambda)\, w\right] \frac{\varphi}{\lambda}\right)$

- More **openness** or less **LAMP** increases $\Longrightarrow$ more aggressive targeting rule

  Because: the *more* open the economy, the *steeper* the NKPC
  Because: the *higher* the degree of LAMP, the *flatter* the NKPC

  - RoT consume all income regardless of inflation

  Same result under commitment

- Inflationary bias: *increases* in **openness** or degree of **LAMP**