Does Household Heterogeneity across Countries Matter for Optimal Monetary Policy within a Monetary Union?

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Motivation

Monetary policy and inequality

⇒ **what we already know:** hand-to-mouth or (financially) constrained households (λ) important for transmission of MP (e.g., Kaplan et al. 2018)

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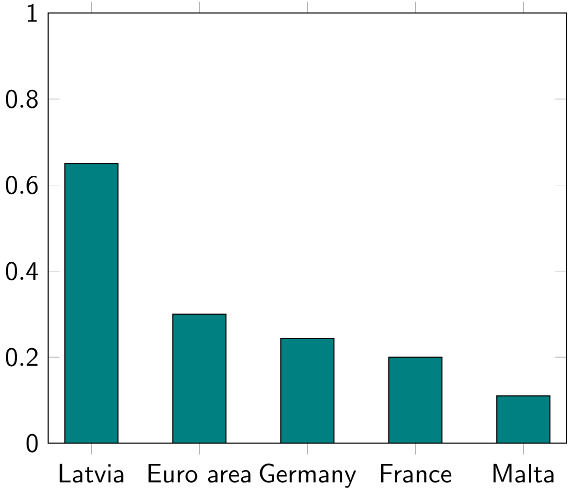
Share of hand-to-mouth households across EA countries



Kaplan et al. (2014): Germany around 0.3, France around 0.2

Source: Own illustration. Data taken from Almgren et al. (2022), approx. values.

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⇒ **what we want to know:** implications of this asymmetry ($\lambda \neq \lambda^*$) for optimal monetary policy?

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- ⇒ what we already know: hand-to-mouth or (financially) constrained households (λ) important for transmission of MP (e.g., Kaplan et al. 2018)
- ⇒ what we also know: heterogeneity across countries forming a monetary union regarding λ (Almgren et al. 2022, Kaplan et al. 2014)
- ⇒ **what we want to know:** implications of this asymmetry ($\lambda \neq \lambda^*$) for optimal monetary policy?
- ⇒ **furthermore:** role of imperfect insurance (consumption inequality, $q > 1$)?

The paper in a nutshell I

Methodology

Two-country monetary union model with heterogeneous households

$\Rightarrow$ based on the tractable Heterogeneous Agents New Keynesian (HANK) model with liquidity from Bilbiie & Ragot 2021

$\Rightarrow$ + currency union with two countries

$\Rightarrow$ + heterogeneous shares of financially-constrained households across countries

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- ⇒ + heterogeneous shares of financially-constrained households across countries
- ⇒ CB can insure consumption through money (CBDC)
- ⇒ CBDC is introduced as an additional **country-specific instrument**

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$\Rightarrow$ CB can insure consumption through money (CBDC)

$\Rightarrow$ CBDC is introduced as an additional **country-specific instrument**

$\Rightarrow$ optimal monetary policy

$\Rightarrow$ two inequality metrics: share of constrained households λ and steady state inequality q

$\Rightarrow$ two distortions: price adjustment costs and imperfect insurance

The paper in a nutshell II

Main results

Household heterogeneity and asymmetry change the design of optimal monetary policy in a monetary union

- ⇒ trade-off between output, price and inequality changes (different welfare weights)
- ⇒ new objectives arise: balance out asymmetry within the union + provide consumption-insurance

The paper in a nutshell II

Main results

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- $\Rightarrow$ trade-off between output, price and inequality changes (different welfare weights)
- $\Rightarrow$ new objectives arise: balance out asymmetry within the union + provide consumption-insurance
- $\Rightarrow$ heterogeneity (within and across countries) $\uparrow$: consumption-insurance motive $\uparrow$, price stabilization $\downarrow$
- $\Rightarrow$ distribution of CBDC between countries depends on their asymmetry

Literature

Country dimension →

Household hetero-geneity dimension ↓

	One country	Two countries
RANK	Standard NK model	Brissimis and Skotida 2008
TANK, (T)HANK	Areosa and Areosa 2016, Bilbiie 2021, Bilbiie and Ragot 2021, Hansen et al. 2023	**Currency union with asymmetry:** Bayer et al. 2023, Ida 2023 **Open economy:** Auclert et al. 2021 or Levine et al. 2023

Our paper:
Optimal MP in THANK within an asymmetric currency union

Figure 1: Other Contributions (non-exhaustive, see paper for more details)

Model framework

Model framework I

Two-country monetary union tractable HANK model (based on one-country THANK model of Bilbiie and Ragot 2021)

- ⇒ two countries: **Home** and **Foreign** $(*)$
- ⇒ **currency union**

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⇒ **monopolistically competitive firms** facing Rotemberg (1982) price adjustment costs

⇒ **national governments** redistributing firm profits and setting optimal subsidy

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- ⇒ **currency union**
- ⇒ **monopolistically competitive firms** facing Rotemberg (1982) price adjustment costs
- ⇒ **national governments** redistributing firm profits and setting optimal subsidy
- ⇒ **two household types**: financially-constrained households **(N)** and saver households **(S)**

Model framework II

Households:

S	**N**
intertemporal consumption-smoothing (bonds (i_t), money)	hand-to-mouth consumption
labor and profit income	labor income
precautionary savings in money (idiosyncratic risk)	non-participating in financial markets
firm shares, bonds, money	money
$(1-\lambda), (1-\lambda^*)$	λ, λ^*

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⇒ **idiosyncratic risk** through switching process between states: $(1-\alpha)$ (switch to N), ρ (stay N)

⇒ share of constrained households:

$$\lambda = \frac{1-\alpha}{2-\alpha-\rho} \tag{1}$$

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⇒ **imperfect insurance** between N and S: $q = C^S/C^N > 1$

Model framework III

Central bank: two instruments

union-wide: nominal interest rate (i_t)

country-specific: money holdings (m_t, m_t^*, stock variable) distributed through CBDC at beginning of a period ($x_t, x_t^\star$, flow variable)

Money eq

Model framework III

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⇒ money as a tool for self-insurance purposes

⇒ money as a tool to reach even non-participating households

Money eq

Results

Welfare function - Some intuition I

CB minimizes the loss function (2nd order approximation around zero-inflation steady state):

$$-\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t\Bigg[\underbrace{(\sigma+\varphi)(\tilde{C}_t^U)^2+\gamma\nu(\pi_{H,t})^2+(1-\gamma)\nu(\pi_{F,t})^2+\gamma(1-\gamma)(1+\varphi)(\tilde{ToT}_t)^2}_{\text{standard for 2-country monetary union}}$$

$$\underbrace{+\gamma(1-\gamma)\sigma\frac{CC^*}{(C^U)^2}(\hat{C}_t-\hat{C}_t^*)^2}_{\text{lack of full insurance across countries}}+...$$

Variable without a time index: steady-state value
Variable with "$\sim$": gap between a variable and its efficient ($q=1,\pi=0$) counterpart
Variable with "$\wedge$": log deviation from a variable and its steady-state value

Welfare function - Some intuition II

$$\ldots + \underbrace{\sigma\left(\gamma\lambda(1-\lambda)\frac{C^S C^N}{C C^U}(\hat{q}_t)^2 + (1-\gamma)\lambda^*(1-\lambda^*)\frac{C^{S*}C^{N*}}{C^* C^U}(\hat{q}_t^*)^2\right)}_{\text{common in TANK models}}$$

$$\underbrace{-2\gamma\lambda(q^\sigma - 1)\left(\frac{C^N}{C^U}(\hat{C}_t^N + \frac{1-\sigma}{2}(\hat{C}_t^N)^2) - \hat{L}_t - \frac{1+\varphi}{2}(\hat{L}_t)^2\right)}_{\text{liquidity-insurance motive due to inequality distortion in steady state in Home } (q>1)}$$

$$\left.\underbrace{-2(1-\gamma)\lambda^*((q^*)^\sigma - 1)\left(\frac{C^{N*}}{C^U}(\hat{C}_t^{N*} + \frac{1-\sigma}{2}(\hat{C}_t^{N*})^2) - \hat{L}_t^* - \frac{1+\varphi}{2}(\hat{L}_t^*)^2\right)}_{\text{liquidity-insurance motive due to inequality distortion in steady state in Foreign } (q^*>1)}\right] \quad (2)$$

Long-run implications I

Importance of λ for optimal MP in a symmetric union $(\lambda = \lambda^*)$

Table 1: Implied steady-state values from optimal Ramsey policy in a symmetric union (and same country size, $\gamma = 0.5$)

Model outcome

	π	m	x	i	q
$\lambda = 0.5$	-0.366%	0.627	-0.002306	0.0167	1.167
$\lambda = 0.3$	-0.297%	0.278	-0.000828	0.0174	1.174
$\lambda = 0.2$	-0.226%	0.148	-0.000335	0.0181	1.181

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$\Rightarrow$ Optimal deflation and providing liquidity through money (m)

$\Rightarrow$ 40% decrease in λ: money demand falls by 63.66% (non-linear relation)

$\Rightarrow$ For $\lambda = 0$: $m = 0$

Long-run implications II

Importance of $\lambda \neq \lambda^*$ for optimal MP in an asymmetric union (λ^U constant at 0.3)

Table 2: Implied steady-state values from Ramsey optimal policy in a currency union, union-wide values

Model outcome	Union-wide			
	π^U	m^U	i	c^U
1) Symmetric union ($\lambda = \lambda^* = 0.3$)	-0.297%	0.278	0.0174	0.999
2) Asymmetric union ($\lambda = 0.35, \lambda^* = 0.25$)	-0.299%	0.278	0.0174	0.999
3) Asymmetric union ($\lambda = 0.4, \lambda^* = 0.2$)	-0.31%	0.280	0.0173	0.999

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$\Rightarrow$ Optimal deflation increasing in $(\lambda - \lambda^*)$

Long-run implications III

Table 3: Implied steady-state values from Ramsey optimal policy in a currency union, country-specific values

Model outcome	Country-specific	c	c^S	c^N	m
1) Symmetric union	Home	0.999	1.046	0.891	0.278
$(\lambda = \lambda^* = 0.3)$	Foreign	0.999	1.046	0.891	0.278
2) Asymmetric union	Home	0.991	1.046	0.891	0.325
$(\lambda = 0.35, \lambda^* = 0.25)$	Foreign	1.007	1.046	0.891	0.232
3) Asymmetric union	Home	0.984	1.045	0.891	0.374
$(\lambda = 0.4, \lambda^* = 0.2)$	Foreign	1.015	1.045	0.891	0.186

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$\Rightarrow$ CB redistributes towards country with higher risk through money

$\Rightarrow$ Optimal MP equalizes consumption across N across countries

Short-run implications - asymmetric union I

Importance of $\lambda \neq \lambda^*$ for optimal MP (λ^U constant) in the short run - positive productivity shock ($\rho_A = 0.95$)

Table 4: Five different scenarios

		Technology shock	
		Symmetric	Idiosyncratic
Union	Symmetric	1	2
	Asymmetric	3	4 and 5

Scenario 4: country with lower λ (country F) is hit

Scenario 5: country with higher λ (country H) is hit

$\Rightarrow$ **Does it matter for optimal MP which country is hit by a shock?**

(Paper for more details)

Short-run implications - asymmetric union II

Yes: more expansionary nominal interest rate and higher inflation volatility Liquidity

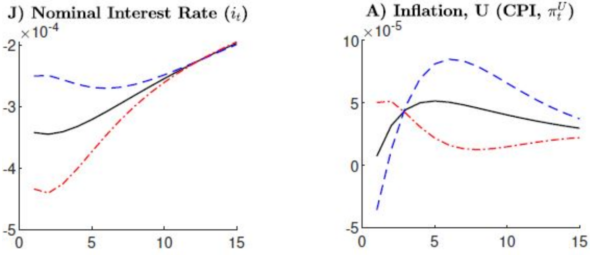

Figure 2: Impulse response function of a positive productivity shock depicting absolute deviations from steady state ($\lambda^U = 0.3$, $\lambda = 0.35$ and $\lambda^* = 0.25$)

Scenario black (3): symmetric shock

Scenario blue (4): idiosyncratic shock, country F (lower λ) is hit

Scenario red (5): idiosyncratic shock, country H (higher λ) is hit

Short-run implications - asymmetric union III

If the more distorted country is hit:

- $\Rightarrow$ CB redistributes through CBDC towards the more distorted country
- $\Rightarrow$ instrument money becomes more important: more liquidity injections
- $\Rightarrow$ CB tolerates more inflation volatility
- $\Rightarrow$ optimal MP is more expansionary

CB sacrifices inflation stabilization in favor of consumption stabilization (i) across countries and (ii) household types

Conclusion

Key take-aways

Heterogeneity across countries ($\lambda \neq \lambda^*$) within a currency union changes the design of optimal MP

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$\Rightarrow$ affecting the trade-off inflation vs. consumption stabilization

$\Rightarrow$ new motives:

providing consumption-insurance in case of imperfect insurance

balancing out asymmetry within a currency union

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- providing consumption-insurance in case of imperfect insurance
- balancing out asymmetry within a currency union

$\Rightarrow$ MP redistributes to the more distorted country (in terms of q and λ) via CBDC as it is welfare-enhancing

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$\Rightarrow$ MP redistributes to the more distorted country (in terms of q and λ) via CBDC as it is welfare-enhancing

$\Rightarrow$ the higher household heterogeneity within a currency union, the more important consumption insurance through money becomes

Conclusion

Key take-aways

Heterogeneity across countries ($\lambda \neq \lambda^*$) within a currency union changes the design of optimal MP

- $\Rightarrow$ affecting the trade-off inflation vs. consumption stabilization
- $\Rightarrow$ new motives:
  - providing consumption-insurance in case of imperfect insurance
  - balancing out asymmetry within a currency union
- $\Rightarrow$ MP redistributes to the more distorted country (in terms of q and λ) via CBDC as it is welfare-enhancing
- $\Rightarrow$ the higher household heterogeneity within a currency union, the more important consumption insurance through money becomes
- $\Rightarrow$ beneficial for a monetary union to have a **country-specific instrument** instrument to target heterogeneity across countries
- $\Rightarrow$ CBDC is part of an optimal MP

Thank you!

In case of questions, comments or suggestions:
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References I

Almgren, M., J.-E. Gallegos, J. Kramer, and R. Lima (2022): "Monetary Policy and Liquidity Constraints: Evidence from the Euro Area," American Economic Journal: Macroeconomics, 14(4), 309–40.

Ampudia, Miguel, Dimitris Georgarakos, Jiri Slacalek, Oreste Tristani, Philip Vermeulen and Giovanni L. Violante (2018): "Monetary policy and household inequality", *ECB Working Paper Series* No. 2170: 1-36.

Areosa, W. D. and M. B. Areosa (2016): "The inequality channel of monetary transmission," Journal of Macroeconomics, 48, 214–230.

Auclert, A., M. Rognlie, M. Souchier, and L. Straub (2021): "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel," Working Paper May 2021.

Bayer, C., A. Kriwoluzky, G. J. Müller, and F. Seyrich (2023): "A HANK2 Model of Monetary Unions," DIW Berlin Disucssion Papers 2044.

Bilbiie, F. O. (2021): "Monetary Policy and Heterogeneity: An Analytical Framework," Mimeo, August 2021.

References II

Bilbiie, F. O. and X. Ragot (2021): "Optimal Monetary Policy and Liquidity with Heterogeneous Households," *Review of Economic Dynamics*, 41, 71–95.

Brissimis, S. N. and I. Skotida (2008): "Optimal monetary policy in the euro area in the presence of heterogeneity," Journal of International Money and Finance, 27, 209–226.

Hansen, N.-J. H., A. Lin, and R. C. Mano (2023): "Should inequality factor into central banks' decisions?" Banca D'Italia Working Papers No. 1410.

Ida, D. (2023): "Liquidity-constrained consumers and optimal monetary policy in a currency union," Journal of International Money and Finance, 131.

Kaplan, G., B. Moll, and G. L. Violante (2018): "Monetary Policy According to HANK," American Economic Review, 108(3), 697–743.

Kaplan, G., G. L. Violante, and J. Weidner (2014): "The Wealthy Hand-to-Mouth," Brookings Papers on Economic Activity, 1, 77–138.

Levine, P., S. McKnight, A. Mihailov, and J. Swarbrick (2023): "Limited Asset Marktet Participation and Monetary Policy in a Small Open Economy," Mimeo August 2023.

Back-up slides

Supplement to the literature classification

Positive
(How does household heterogeneity affect MP?)

vs.

normative
(Should MP care about inequality?) questions

Calibration I

For most of the parameters, we follow Bilbiie and Ragot (2021):

Parameters	Values	Description
φ	0.25	Inverse Frisch elasticity
χ	1	Weight on disutility of labor
σ	1	Intertemporal subsitution elasticity
β	0.98	Discount factor
ϵ	6	Substitution elasticity between goods
ν	100	Rotemberg price adjustment cost
ρ_A	0.95	Persistence of technology shock

Table 5: Baseline calibration

The time interval is a quarter. We assume the countries to be of equal size, thus $\gamma = 0.5$.

Calibration II

Targeting the share of constrained households.

Symmetric union

$\Rightarrow \lambda^U = 0.3 = \lambda = \lambda^*$

Asymmetric union

$\Rightarrow \lambda^U = 0.3$

$\Rightarrow \lambda = 0.35$

$\Rightarrow \lambda^* = 0.25$

Calibration III

Table summarizes the calibration of α, α^*, ρ and ρ^*, implying λ, λ^* and λ^U, used for the analysis of an asymmetric union.

Union	Country H			Country F			Cons. ineq.
λ^U	λ	α	ρ	λ^*	α^*	ρ^*	$q^U = q = q^*$
0.3	0.3	0.9	0.7667	0.3	0.9	0.7667	1.174
0.3	0.35	0.9	0.8143	0.25	0.9	0.7	1.174
0.3	0.4	0.9	0.85	0.2	0.9	0.6	1.173

Table 6: Calibration of λ, λ^* and λ^U with fixed α and α^* and varying ρ and ρ^* in an asymmetric union

Model framework

Share of constrained households

$$\lambda = \frac{1-\alpha}{2-\alpha-\rho} \tag{3}$$

⇒ idiosyncratic risk: $(1-\alpha)$, ρ

⇒ α: probability of staying unconstrained as S

⇒ ρ: probability of staying constrained as N

Steady state inequality

steady-state consumption inequality:

$$q = \left(\frac{1 + i - \alpha}{1 - \alpha}\right)^{1/\sigma}. \tag{4}$$

$i > 0$: return on bonds $>$ return on money (0)

Optimal inflation rate

Optimal inflation lies between **Friedman rule** ($i = 0$, thus $1 + \pi = \beta$ and $q = 1$) and **zero-inflation** ($i = (1 - \beta)/\beta$):

$$\beta - 1 \leq \pi^{optimal} \leq 0 \tag{5}$$

At Friedman rule:

- ⇒ difference between the household types vanishes, i.e. $q = 1$, as the returns on bonds and money are the same
- ⇒ money as a "perfect" means for insurance
- ⇒ however: this will not be an efficient steady state due to price adjustment costs

At zero-inflation steady state:

- ⇒ eliminates the steady-state distortion of price adjustment costs
- ⇒ lack of insurance as the return on money relative to the one on bonds shrinks ($q > 1$)

Money creation

Money eq

CB provides money via CBDC, with x_t denoting newly created or destroyed money in period t. (Real) Money in circulation at the end of each period evolves according to

$$m_{t+1} = \frac{1}{1+\pi_t} m_t + x_t \quad (6)$$

Labor supply and wages

Assumptions:

- $\Rightarrow$ labor is determined by firms' demand
- $\Rightarrow$ union pools hours worked

$\rightarrow$ all households work the same amount: $L_t^S = L_t^N = L_t$, independent of the state. The aggregate amount is determined by

$$\chi(L_t)^{\varphi}((1-\lambda)(C_t^S)^{-\sigma} + \lambda(C_t^N)^{-\sigma})^{-1} = w_t ToT_t^{\gamma-1}. \tag{7}$$

Optimal MP

CB maximizes the weighted aggregate of households' utility functions:

$$\gamma U(C_t^S, C_t^N, L_t) + (1-\gamma) U(C_t^{S*}, C_t^{N*}, L_t^*) \tag{8}$$

or

$$\begin{aligned} &\gamma \left[(1-\lambda) \frac{(C_t^S)^{1-\sigma}}{1-\sigma} + \lambda \frac{(C_t^N)^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{1+\varphi}}{1+\varphi} \right] \\ &+ (1-\gamma) \left[(1-\lambda^*) \frac{(C_t^{S*})^{1-\sigma}}{1-\sigma} + \lambda^* \frac{(C_t^{N*})^{1-\sigma}}{1-\sigma} - \chi \frac{L_t^{*1+\varphi}}{1+\varphi} \right] \end{aligned} \tag{9}$$

Short-run implications - asymmetric union I

Suppose a positive productivity shock:

symmetric shock (both countries are hit): 1% increase

idiosyncratic shock (only one country is hit): 2% increase

Three different scenarios:

Scenario 3: symmetric shock

Scenario 4: idiosyncratic shock, country F (lower λ) is hit

Scenario 5: idiosyncratic shock, country H (higher λ) is hit

$\rightarrow$ Optimal MP in face of a symmetric shock in an asymmetric union?
$\rightarrow$ Does it matter for optimal MP which country is hit by a shock?

Short-run implications - asymmetric union II

Redistribution through money (CBDC) Liquidity

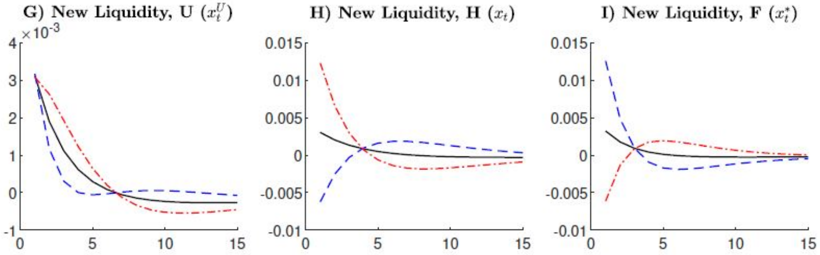

Figure 3: Impulse response functions of a positive productivity shock depicting absolute deviations from steady state

Scenario 3: symmetric shock

Scenario 4: idiosyncratic shock, country F (lower λ) is hit

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Short-run implications - asymmetric union III

More expansive nominal interest rate and higher inflation volatility

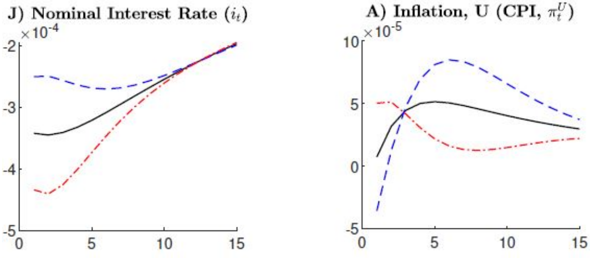

Figure 4: Impulse response function of a positive productivity shock depicting absolute deviations from steady state.

scenario 3: symmetric shock

scenario 4: idiosyncratic shock, country F (lower λ) is hit

scenario 5: idiosyncratic shock, country H (higher λ) is hit

Short-run implications - asymmetric union IV

Stabilizing consumption of N

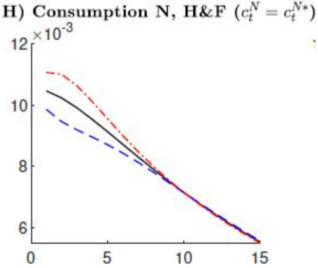

Figure 5: Impulse response functions of a positive productivity shock depicting absolute deviations from steady state.

scenario 3: symmetric shock

scenario 4: idiosyncratic shock, country F (lower λ) is hit

scenario 5: idiosyncratic shock, country H (higher λ) is hit

Short-run implications - asymmetric union V

Importance of $\lambda \neq \lambda^*$ for optimal MP (λ^U constant)

If the more distorted country is hit:

- $\Rightarrow$ Instrument liquidity becomes more important: more liquidity injections
- $\Rightarrow$ CB tolerates more inflation volatility
- $\Rightarrow$ optimal MP is more expansionary

CB sacrifices inflation stabilization in favor of consumption stabilization (i) across countries and (ii) household types