To Cap or Not to Cap? Energy Crises in a Currency Union

Momo Komatsu

University of Oxford

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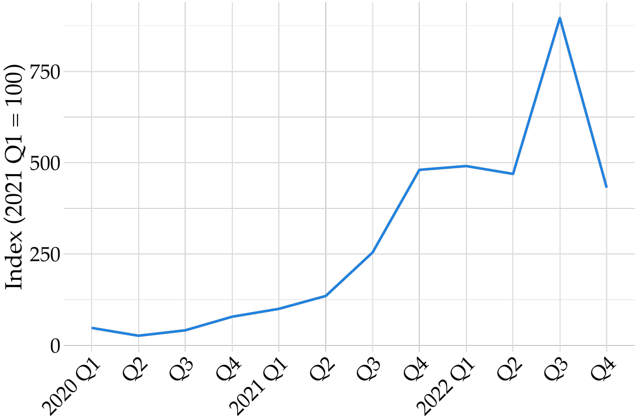
Exogenous energy supply shock to Europe in 2022 ...

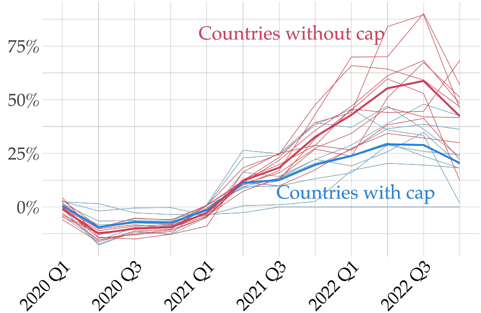
Figure: Gas price in the European Union



Source: IMF Data (2024)

... lead to increased inflation in Euro Area, in levels and in dispersion

Figure: Energy inflation rates 2020 – 2022



Countries with cap (9): France, Germany, Portugal, Spain, ... Countries without (10): Belgium, Greece, Italy, The Netherlands, ... Bold lines are weighted averages for each group.

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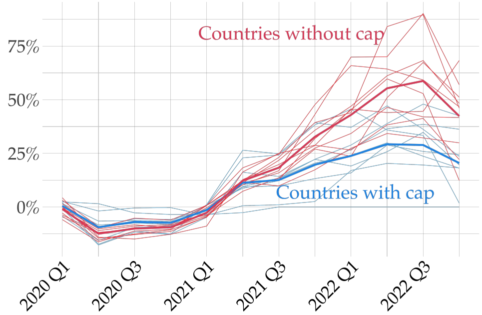

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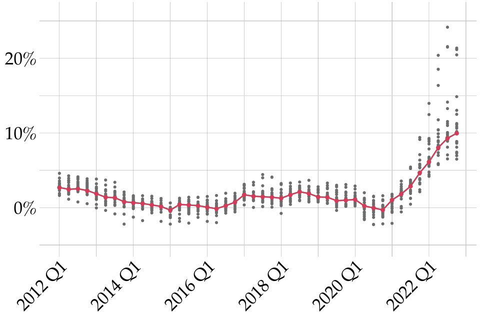
Figure: Headline inflation rates 2012 – 2022



Note: Red dots are the weighted average values for the Euro Area as a whole. Data source: Eurostat. decomposition

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  - **Targeted transfers** more effective in boosting consumption + no divergence.

literature

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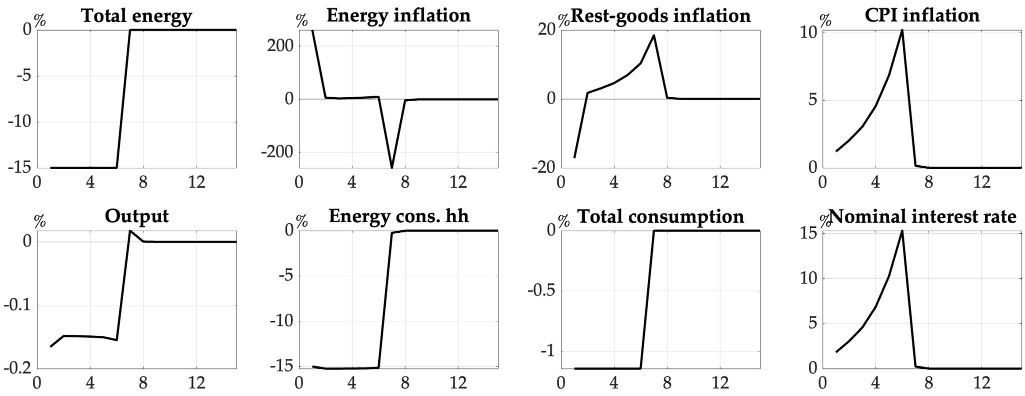
- **Shock**: Energy supply decreases by 15% for 6 quarters.
  - Gas consumption reduction target agreed by EU & duration of price caps.

equations

Energy crisis: No caps

Figure: Responses to an adverse energy supply shock



Summary baseline results

1. Energy crisis: High **energy inflation** + **cost-push** shock in **core** sector.

Energy crisis: Large spillovers from cap to no cap

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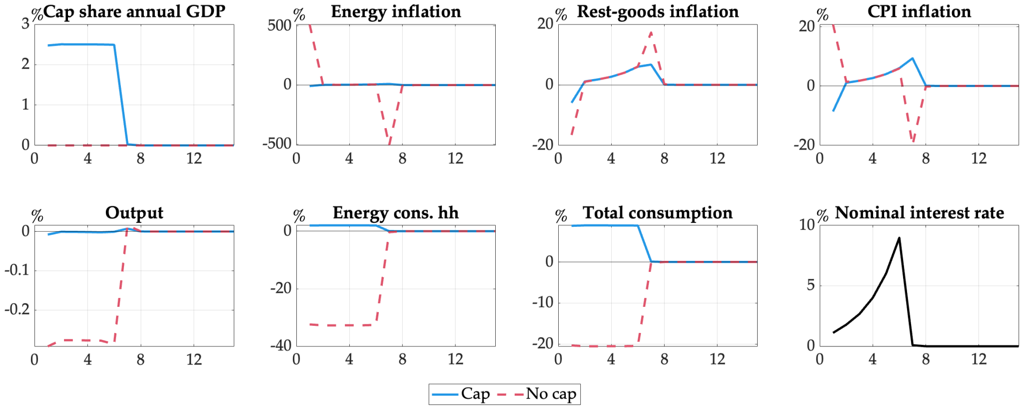

Welfare implications

Table: Welfare gains/losses after energy supply shock

	%	Country B Cap	Country B No cap
Country A	Cap	$(-15, -15)$	$(\ , \ )$
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- Cooperative case: No cap & no cap $\gg$ cap & cap.

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  - Fixed energy supply $\rightarrow$ energy price cap is a distortion.

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- Given no cap in country B, country A prefers a price cap.
  - Avert crisis, borrow on international markets $\rightarrow$ spillover to no-cap country.

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- Given no cap in country B, country A prefers a price cap.
- Given cap in country A, country B prefers cap.
  - Negative spillovers costlier than implementing cap.

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Welfare implications : Classic prisoner's Dilemma

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- Given cap in country A, country B prefers cap.

$\Rightarrow$ **Dominant strategy** (cap) for both countries, leading to **Prisoner's Dilemma**.

Summary baseline results

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2. Policy decisions and welfare during energy crisis:
   - Price cap is a **distortion**.
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   - Price cap **always worth it**, despite the distortion (Prisoner's Dilemma).

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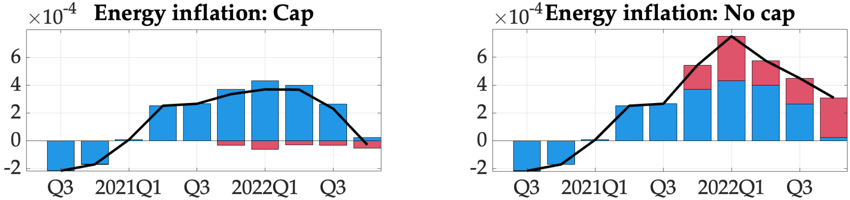

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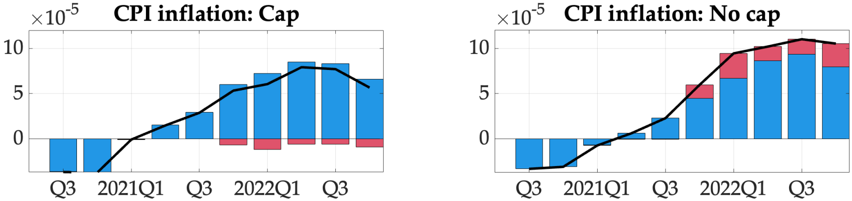

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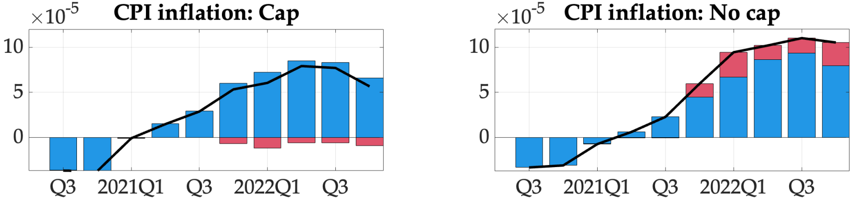

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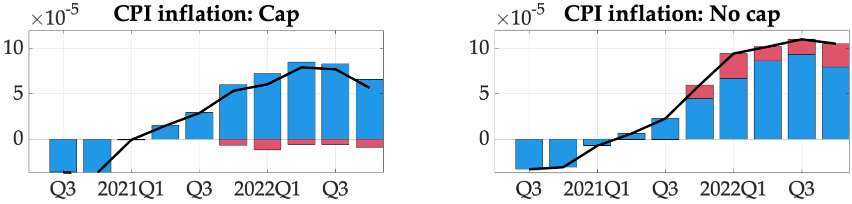

- **Targeted transfers** in model with hand-to-mouth households
  - Cheap & effective in boosting consumption of poor, without creating divergence.

Conclusion

- **Two-country** currency **union** model with exogenous energy.
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- **Counterfactuals**
  - **Estimation** of extended model & quantification **contribution** of energy price cap
  - **Targeted transfers** preferred over price caps.

Overview

- **Currency union** with two countries, Home and Foreign $\{H, F\}$
  - Home: size $\Theta \in (0, 1)$; Foreign: size $1 - \Theta$
- **Exogenous energy supply** to integrated market (Bayer, et al., 2023)
- Households consume energy (non-homothetic) and firms use energy as input.
- Firms only produce tradable goods. LOOP holds.

back

Households: Maximization problem

Indirect utility function by Boppart (2014)

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{1}{\varepsilon_1} \left[\left(\frac{exp_t}{P_{Rt}} \right)^{\varepsilon_1} - 1 \right] - \frac{\alpha_{ENG}}{\varepsilon_2} \left[\left(\frac{P_{Et}}{P_{Rt}} \right)^{\varepsilon_2} - 1 \right] \right\} \quad (1)$$

subject to

$$exp_t = P_{Et} E_t^h + P_{Rt} C_{Rt} = W_t N_t + D_t + R_{t-1} B_{t-1} - B_t - HC_t - T_t \quad (2)$$

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Price of rest goods

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Relative total expenditure

Relative price energy

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Households: Preferences

Choice between energy and rest goods

$$\frac{C_{Rt}}{E_t^h} = \frac{1 - \alpha_{ENG}\varpi_t}{\alpha_{ENG}\varpi_t} \frac{P_{Et}}{P_{Rt}} \tag{3}$$

where the energy expenditure wedge is

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When $\varepsilon_1 = \varepsilon_2 = 0$, standard preferences $\frac{C_{Rt}}{E_t^h} = \frac{1-\alpha_{ENG}}{\alpha_{ENG}} \frac{P_{Et}}{P_{Rt}}$.

back

Households: Preferences

Non-energy (rest) goods consumption bundle:

$$C_{Rt} = \left[(1 - \alpha_{IMP})^{1/\gamma} (C_{Ht})^{(\gamma-1)/\gamma} + (\alpha_{IMP})^{1/\gamma} (C_{Ft})^{(\gamma-1)/\gamma} \right]^{\gamma/(\gamma-1)} \tag{5}$$

Choice between Home and Foreign goods

$$\frac{C_{Ht}}{C_{Ft}} = \frac{1 - \alpha_{IMP}}{\alpha_{IMP}} \left(\frac{P_{Ht}}{P_{Ft}} \right)^{-\gamma} \tag{6}$$

back

Firms

Production function

$$Y_t(i) = A_t \left[\left(\alpha^f\right)^{1/\theta^f} \left(E_t^f(i)\right)^{(\theta^f-1)/\theta^f} + \left(1-\alpha^f\right)^{1/\theta^f} (N_t(i))^{(\theta^f-1)/\theta^f} \right]^{\theta^f/(\theta^f-1)} \quad (7)$$

Profit maximization with adjustment costs à la Rotemberg.

back

Market clearing

Goods market clearing

$$Y_t = C_{Ht} + C^*_{Ht} + HC_t + FC_t \tag{8}$$

$$Y^*_t = C_{Ft} + C^*_{Ft} + HC^*_t + FC^*_t \tag{9}$$

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Energy market clearing

$$E_t = E^h_t + E^f_t + E^{h*}_t + E^{f*}_t \tag{10}$$

where E_t is determined exogenously.

back

Monetary and fiscal policy

Union-wide Taylor rule

$$R_t = \frac{1}{\beta}\left(\frac{\Pi_t^W}{\bar{\Pi}^W}\right)^{\phi_\pi} \exp(\nu_t) \tag{11}$$

where

$$\Pi_t^W = (\Pi_t)^{\Theta}(\Pi_t^*)^{1-\Theta} \tag{12}$$

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Energy price cap

$$P_{Et}^{eff} = \begin{cases} P_{Et} & \text{without cap} \\ \bar{P}_E & \text{with cap} \end{cases} \tag{14}$$

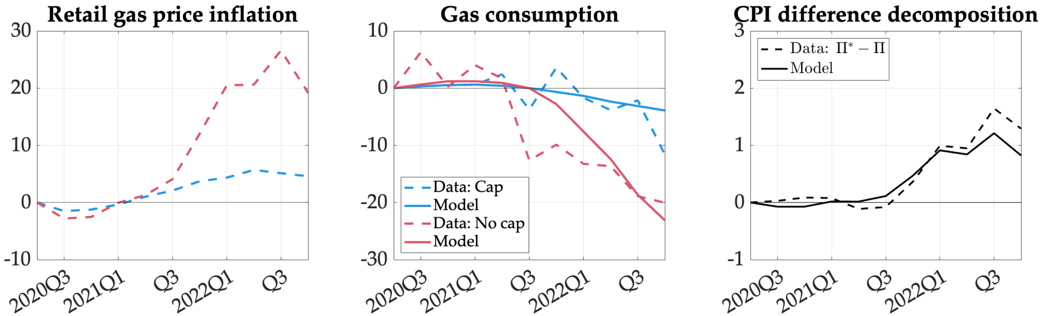
Price cap financed by lump-sum taxes (Ricardian Equivalence). back

Calibration: Relevant parameters

Parameter	*Description*	*Value*	*Source*
α_{IMP}	Share of imports in consumption	0.25	Eurostat
α_{ENG}	Share of energy in consumption	0.066	Eurostat
γ	Elasticity of subst. between Home and Foreign goods	6	Benigno (2009) and data exercise
ϵ	Elasticity of subst. within goods	9	Literature
ε_1	Non-homotheticity parameter	0.77	Data exercise
ε_2	Non-homotheticity parameter	0.77	Data exercise
$\tilde{\nu}$	Adjustment cost for bonds	0.001	Schmitt-Grohé and Uribe (2003)
β	Discount factor	0.99	Literature
α^f	Share of energy in production	0.011	European Commission (2020) & Eurostat
θ^f	Elasticity of subst. between energy and labor	0.2	Bachmann et al. (2024), Bayer et al. (2023)
ξ	Price-adjustment cost	15.84	Literature
ϕ_π	Taylor-coefficient on inflation	1.5	Literature
Θ	Relative size Home country (with cap)	0.68	Own calculations

Calibration: Data exercise for non-homotheticity

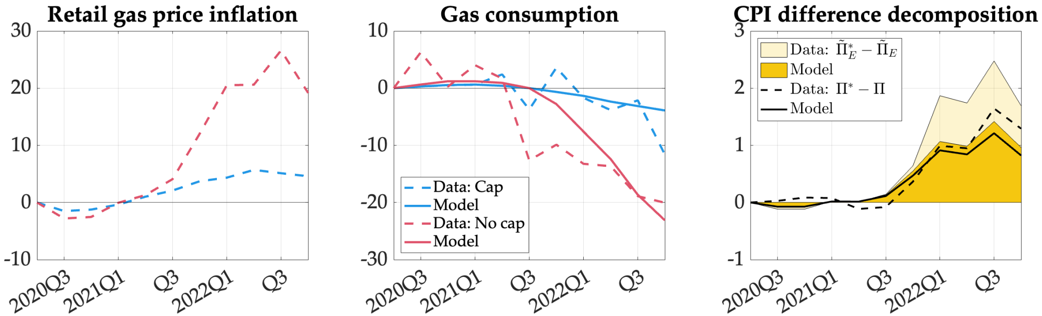
Figure: Minimizing MSE between IRFs and gas consumption data



Y-axis: Percentage deviations from steady state

Calibration: Data exercise for non-homotheticity

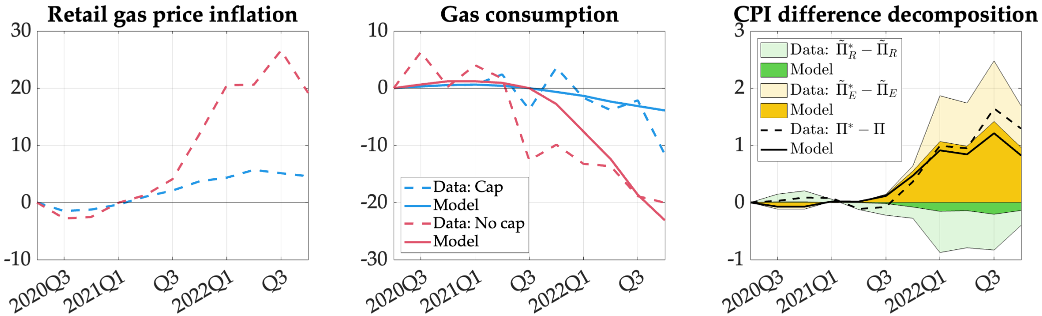
Figure: Minimizing MSE between IRFs and gas consumption data



Y-axis: Percentage deviations from steady state

Calibration: Data exercise for non-homotheticity

Figure: Minimizing MSE between IRFs and gas consumption data



Y-axis: Percentage deviations from steady state

Calibration: Shock specification

Recall energy market clearing:

$$E_t = E_t^h + E_t^f + E_t^{h*} + E_t^{f*} \tag{15}$$

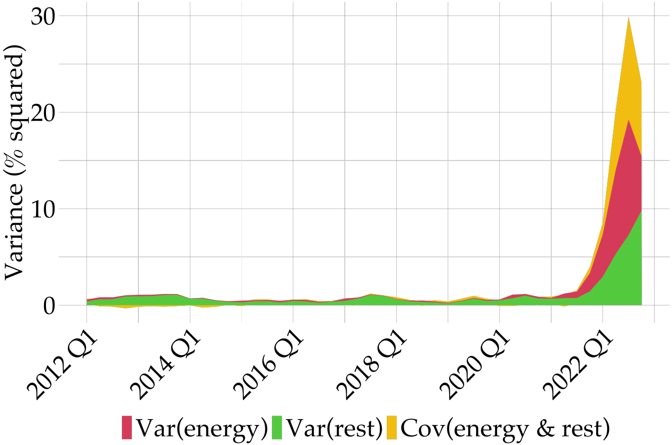
Shock: E_t decreases by **15%** for **6 quarters** (perfect foresight).

- Gas consumption reduction target agreed by EU members in July 2022.

Decomposition of the variance in headline inflation

Figure: Decomposition of the variance in headline inflation

$$Var_t(\Pi_{it}) = Var_t(\tilde{\Pi}^R_{it}) + Var_t(\tilde{\Pi}^E_{it}) + 2cov_t(\tilde{\Pi}^R_{it}, \tilde{\Pi}^E_{it})$$



Decomposition of the variance in headline inflation

Headline inflation in country i in quarter t:

$$\Pi_{it} = (1 - \alpha_{it}^{ENG})\Pi_{it}^{R} + \alpha_{it}^{ENG}\Pi_{it}^{E} \tag{16}$$

Variance across countries per quarter:

$$\begin{aligned} Var_t(\Pi_{it}) &= Var_t\left[(1 - \alpha_{it}^{ENG})\Pi_{it}^{R} + \alpha_{it}^{ENG}\Pi_{it}^{E}\right] & (17) \\ &= Var_t(\tilde{\Pi}_{it}^{R} + \tilde{\Pi}_{it}^{E}) & (18) \\ &= Var_t(\tilde{\Pi}_{it}^{R}) + Var_t(\tilde{\Pi}_{it}^{E}) + 2cov_t(\tilde{\Pi}_{it}^{R}, \tilde{\Pi}_{it}^{E}) & (19) \end{aligned}$$

back

Related literature

Monetary and fiscal policy in a currency union Benigno (2004), Beetsma and Jensen (2005), Galí and Monacelli (2008), Ferrero (2009), ...

Contribution 1. Focus on symmetric shock 2. Coordination of energy price cap

Energy crisis Bayer et al. (2023), Chan et al. (2023), Auclert et al. (2023)

Contribution Game-theoretic approach to determine cooperative price cap policy

back

Calibration: All parameters

Parameter	*Description*	*Value*	*Source*
α_{IMP}	Share of imports in consumption	0.25	Eurostat
α_{ENG}	Share of energy in consumption	0.066	Eurostat
γ	Elasticity of subst. between Home and Foreign goods	6	Benigno (2009) and data exercise
ϵ	Elasticity of subst. within goods	9	Literature
ε_1	Non-homotheticity parameter	0.77	Data exercise
ε_2	Non-homotheticity parameter	0.77	Data exercise
$\tilde{\nu}$	Adjustment cost for bonds	0.001	Schmitt-Grohé and Uribe (2003)
β	Discount factor	0.99	Literature
α^f	Share of energy in production	0.011	European Commission (2020) & Eurostat
θ^f	Elasticity of subst. between energy and labor	0.2	Bachmann et al. (2024), Bayer et al. (2023)
ξ	Price-adjustment cost	15.84	Literature
ϕ_π	Taylor-coefficient on inflation	1.5	Literature
Θ	Relative size Home country (with cap)	0.68	Own calculations

back

Bayesian estimation: Parameters

- Time period: 2008Q1 – 2019Q4
- Data series
  - Union-wide: Energy infl., gas infl., gas cons. pc., interest rate
  - Per country bloc: GDP pc, energy cons. pc, CPI infl.
- Shocks: TFP, TFP energy, demand, cost-push, gas supply, monetary policy, measurement errors for energy cons. and energy inflation.
- Parameters: Non-homotheticity parameters $(\varepsilon_1, \varepsilon_1^*)$, elast. of substitution between gas and non-gas (ζ, ζ^*)

back

Bayesian estimation: Parameters

Figure: Data series used

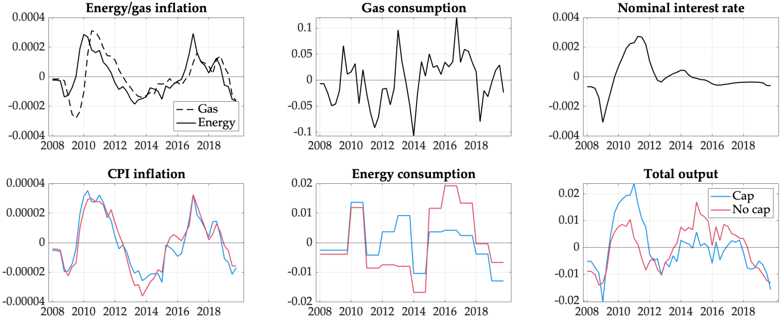


Table: Priors and posteriors

Param.	Prior dist.	Prior mean	Prior std.	Posterior mean	Posterior std.	90% HPD interval
ε_1	Gamma	0.8	0.1	0.2534	0.0711	[0.1397,0.3766]
ε_1^*	Gamma	0.8	0.1	0.7527	0.1168	[0.5836,0.9566]
ζ	Beta	2	1	14.3089	1.9438	[11.1635,17.8216]
ζ^*	Beta	2	1	36.481	3.3527	[30.5412,41.3174]

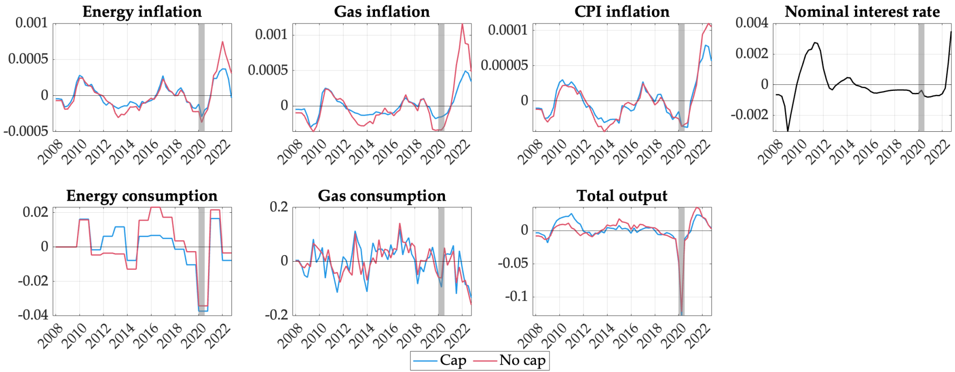
Bayesian estimation: Shocks

- Time period: 2008Q1 – 2022Q4
- Data series
  - Union-wide: Interest rate
  - Per country bloc: GDP pc, energy cons. pc, CPI infl., energy infl., gas infl., gas cons. pc.
- Shocks: TFP, TFP energy, demand, cost-push, gas supply, monetary policy, price cap, measurement errors for energy cons.

back

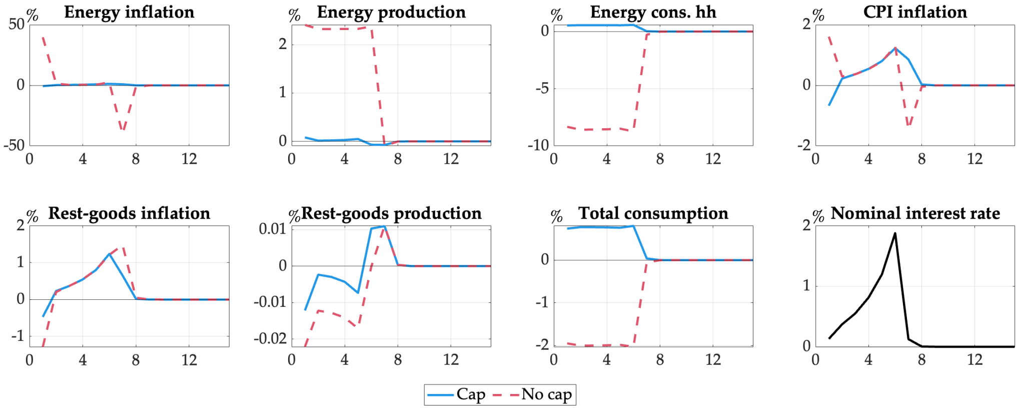
Bayesian estimation: Shocks

Figure: Data series used



Two-agent version: Aggregate IRFs

Figure: Responses to an adverse energy supply shock



back

Flexible nominal exchange rates

Table: Welfare gains/losses after energy supply shock

%		1/3 of union: Cap	1/3 of union: No cap
2/3	Cap	(−15.0, −15.0)	(7.7, −16.7)
	No cap	(−15.6, 6.1)	(−0.7, −0.7)

(a) Union

%		1/3 of world: Cap	1/3 of world: No cap
2/3	Cap	(−15.0, −15.0)	(8.1, −17.7)
	No cap	(−14.7, 5.6)	(−0.7, −0.7)

(b) Flexible nominal exchange rate

Benefits the bigger country:

- Bigger gains when they impose an energy price cap.
- Smaller losses when the other country imposes an energy price cap.