Asset Purchases in a Monetary Union with Default and Liquidity Risks

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This Paper

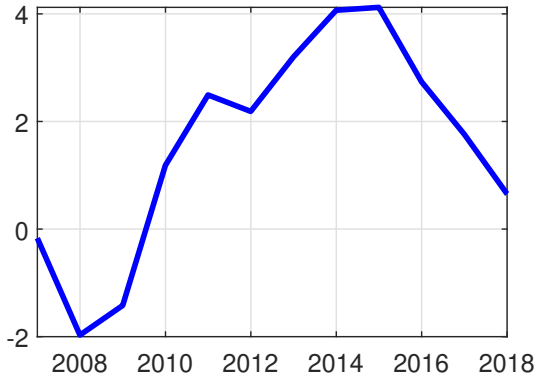
- Motivation: ECB's 2012 OMT and 2022 TPI programs
  - Targeted asset purchases to counter default and liquidity risks
- How do default risks risks, when interacted with liquidity risks, impact the economy?
- How useful are asset purchases to counter them and how does anticipation of such purchases affect the economy?

This Paper

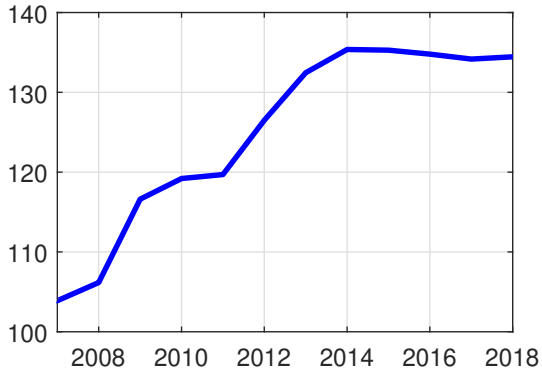
- Build a two-country monetary-union model with both default & liquidity risks and examine effects of a large increase in debt.
  - Allow cross-country holdings of gov. debt
- Findings:
  - Both risks dampen economic & financial conditions in the affected country, while spillovers crucially depend on cross-country holdings of government debt.
  - Targeted asset purchases (or their anticipation) can help stabilize the economy.
  - Expectations of a crisis and credit intervention can distort the economy in normal times, raising or lowering economic activity depending on how frequently crises occur.

Modeling a Debt Crisis

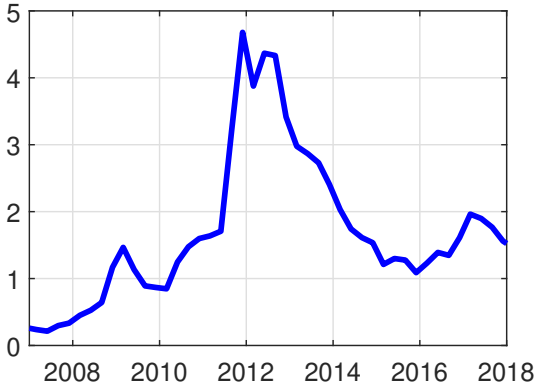
- Use Italian data in 2012 debt crisis as motivation



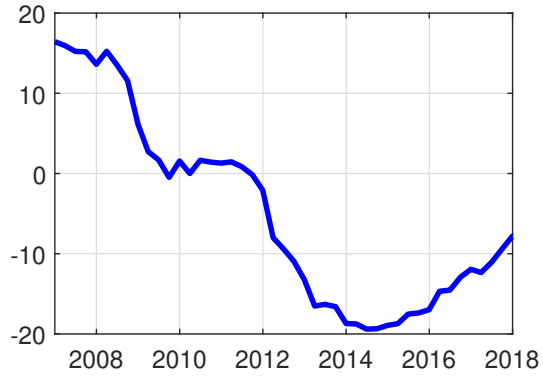
Detrended Debt Level (%)



Debt/GDP (%)



Yield Spread (pp)



Investment (% Dev from 2010-Q1)

Model Overview

- **Home country:**
  - Government
    - Sets taxes and public expenditures, and issues bonds.
    - Default risks : endogenous regime switching process
  - Financial intermediaries
    - Channel funds from households to Home firms and Home & Foreign governments.
    - Liquidity risks : tightness of financial friction varies with default probability.
- **Foreign country:** segmented financial markets without default and liquidity risks.
- **Central bank:** follows Taylor rule and can purchase government bonds.

Home Government

- Budget constraint:

$$\rho_{H,t} g + (1 - \Delta_t)(1 + \kappa^b Q_t^b) \frac{b_{t-1}}{\pi_t} = Q_t^b b_t + t_t + \tau^i p_t^w y_t + \tau^c c_t$$

- Lump-sum tax follows fiscal rule:

$$\frac{t_t - t}{t} = \phi_t \frac{Q_{t-1}^b b_{t-1} - Q^b b}{Q^b b}$$

- Government may default on bonds by taking a haircut δ_b:

$$\Delta_t = \begin{cases} \delta_b, & \text{if default} \\ 0, & \text{otherwise} \end{cases}$$

Modeling Default

- Modeling Default through regime switching: if default, $def_t = 1$; otherwise, $def_t = 0$.
- Transition matrix:

$$\mathbb{P}_t = \begin{bmatrix} \mathbb{P}_{00,t} & \mathbb{P}_{01,t} \\ \mathbb{P}_{10,t} & \mathbb{P}_{11,t} \end{bmatrix} = \begin{bmatrix} 1 - pdef_t & pdef_t \\ 1 - pdef_t & pdef_t \end{bmatrix},$$

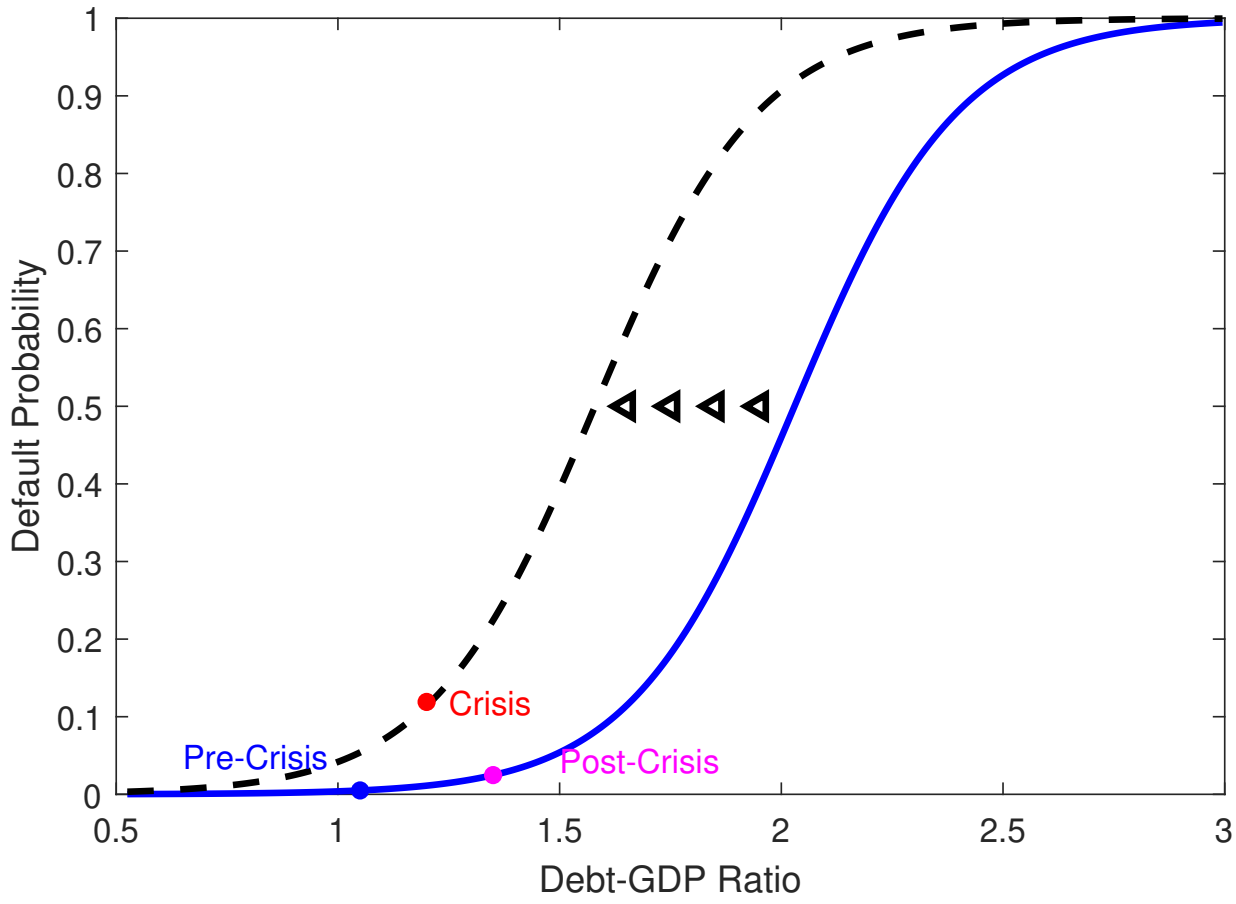
  where the probability of default $pdef_t$ follows a logistic function of debt-to-GDP ratio s_t and sentiment shock ϵ_t^p:

$$P(def_t = 1 | s_{t-1}, \epsilon_t^P) = \frac{\exp[\eta_0^{FL} + \eta_s^{FL}(s_{t-1} + \epsilon_t^P)]}{1 + \exp[\eta_0^{FL} + \eta_s^{FL}(s_{t-1} + \epsilon_t^P)]}$$

- Captures the idea of a "fiscal limit":
  - Can arise from dynamic Laffer curves (Bi, 2012)
  - May depend on nonfundamental ϵ_t^p (investor sentiment)

Default Risks

- Default probability increases with debt-to-GDP ratio.
- Changes in sentiment also shift the distribution of fiscal limits.



Details

Financial Intermediary

- Extension of Gertler and Karadi (2011)
- Collect deposits and purchase government & private bonds.

$$Q_t^b b_t^{H,j} + Q_t^{b,*} b_t^{F,j} + Q_t^f f_t^j = d_t^j + n_t^j.$$

- Net worth depends on realized returns on holding bonds,

$$R_t^b = (1 - \Delta_t) \frac{1 + \kappa^b Q_t^b}{Q_{t-1}^b}, R_t^f = \frac{1 + \kappa^f Q_t^f}{Q_{t-1}^f}$$

Financial Intermediary: Gov Bond Portfolio

- Assume domestic and foreign government bond allocations are imperfect substitutes
- Intratemporal portfolio decision from CES composite [Alpanda and Kabaca (2018), Krenz (2022)]:

$$\max \quad E_t \left(R^b_{t+1} Q^b_t b^{H,j}_t + R^{b,*}_{t+1} Q^{b,*}_t b^{F,j}_t \right)$$

$$s.t. \quad m^{b,j}_t = \left[\gamma_b^{\frac{1}{\sigma_b}} \left(Q^b_t b^{H,j}_t \right)^{\frac{\sigma_b - 1}{\sigma_b}} + (1 - \gamma_b)^{\frac{1}{\sigma_b}} \left(Q^{b,*}_t b^{F,j}_t \right)^{\frac{\sigma_b - 1}{\sigma_b}} \right]^{\frac{\sigma_b}{\sigma_b - 1}}$$

Financial Intermediaries

- Maximize expected net worth with a survival rate of σ:

$$\begin{aligned} \max \quad & V_t^j = E_t \Lambda_{t,t+1} \left((1-\sigma) n_{t+1}^j + \sigma V_{t+1}^j \right) \\ s.t. \quad & V_t^j \geq \eta_t^v (Q_t^f f_t^j + \theta^b m_t^{b,j}) \end{aligned}$$

- Liquidity channel: η_t^v can vary with default risk (Bocola, 2016)

$$\eta_t^v = \bar{\eta}^v \left[1 + \phi_\eta \Pr \left(def_t = 1 | s_{t-1}, \epsilon_t^P \right) \right]$$

Details

The Rest: Firms and Households

- Wholesale firms:
  - Issue long-term private bonds to finance private investment with a loan-in-advance constraint (Sims and Wu, 2021).
  - Produce output using labor and private capital.
- Home investment producers: assemble investment with adjustment costs.
- Households: Hold deposits at financial intermediary as well as hold one-period cross-region bond.

◂ Details

The Rest of the Model

- Foreign economy:
  - Symmetric except no default/liquidity risks.
- Monetary policy:
  - Union-wide Taylor rule.
  - Unconventional policy of asset purchases:

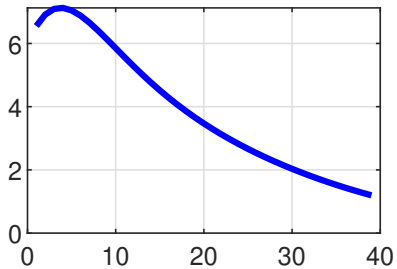
$$b_t^{cb} = b^{cb} + \phi_{cb} \left(\ln \underbrace{R_t^{spread}}_{E_t R_{t+1}^b - R_t^d} - \ln R^{spread} \right)$$

Solution Method & Analysis

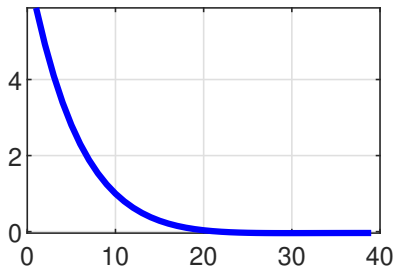
- Our model is large: 63 equations/unknowns, 25 state variables
- Use perturbation approach for solving endogenous regime-switching models (Benigno, Foerster, Otrok & Rebucci, 2020).
- Calibrate Home country to Italy and Foreign to Germany Details
- Consider a case with increase in Home debt level combined with a downward shift in the fiscal limit

Increase in Debt Tightens Financial Markets

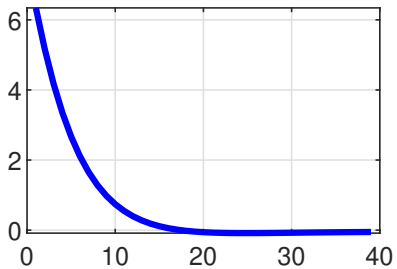
Debt (%)



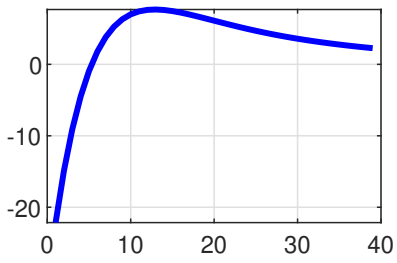
Exp. Govt Return (pp)



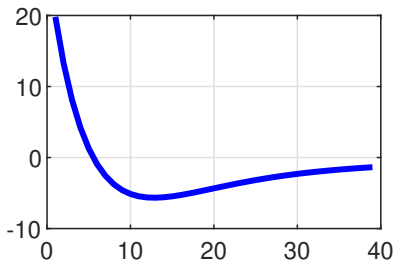
Exp. Priv Return (pp)



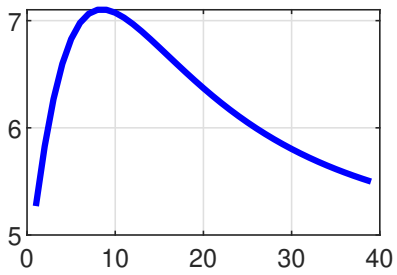
Net Worth (%)



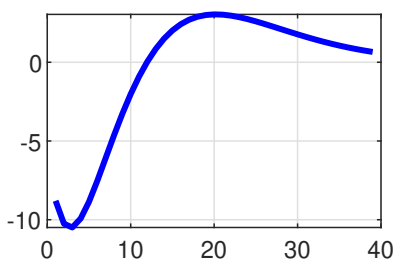
Leverage (%)



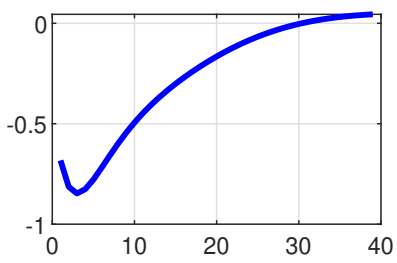
Default Probability (%)



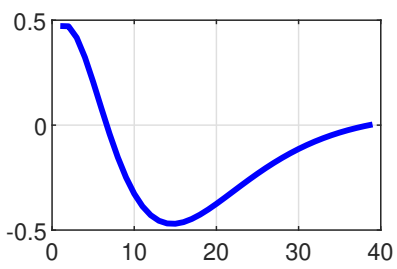
Investment (%)



Output (%)

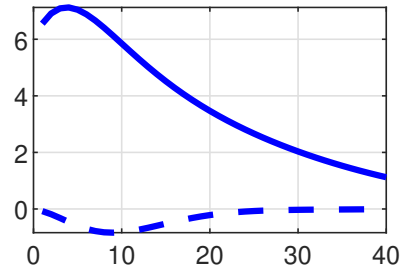


Consumption (%)

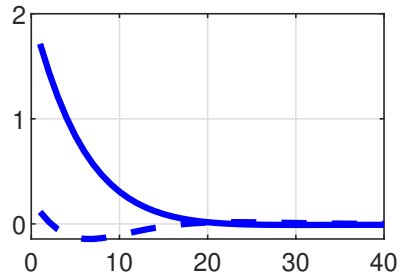


Home (solid lines) versus Foreign (dotted)

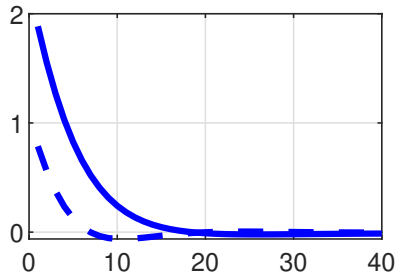
Debt (%)



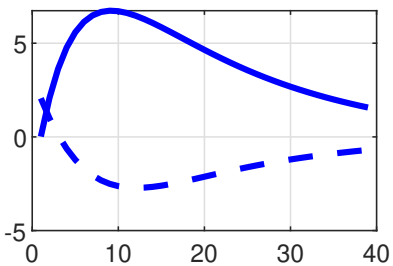
Exp. Govt Return (pp)



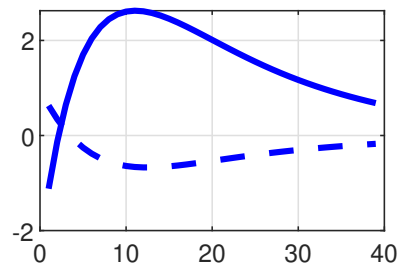
Exp. Priv Return (pp)



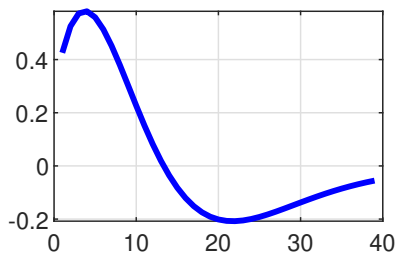
FI own govt bond (% of GDP)



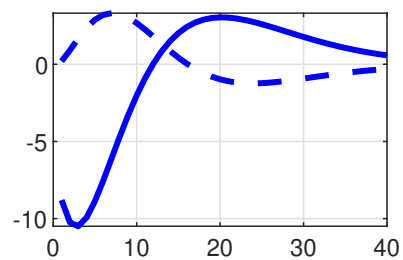
FI foreign govt bond (% of GDP)



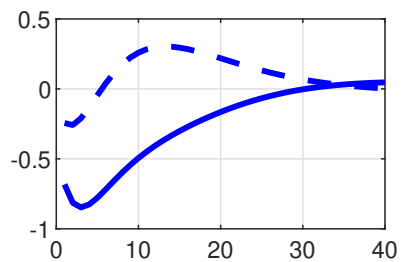
Net exports (% of GDP)



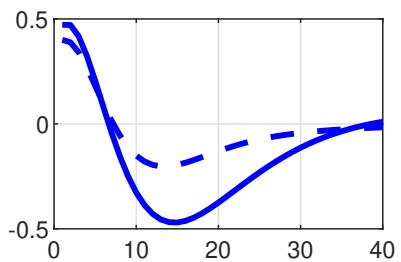
Investment (%)



Output (%)

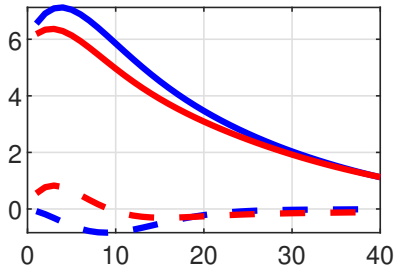


Consumption (%)

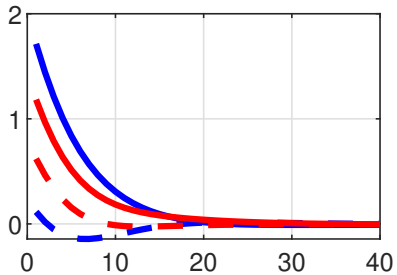


Higher Bond Substitutability (red)

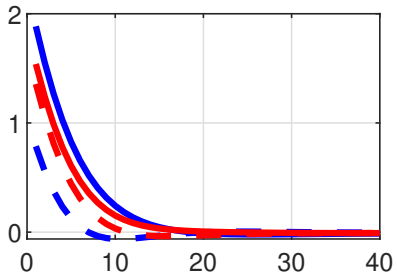
Debt (%)



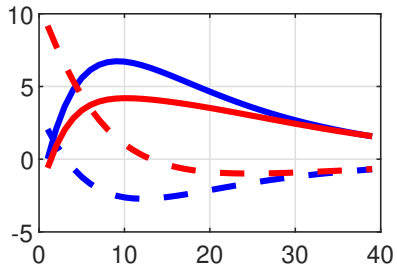
Exp. Govt Return (pp)



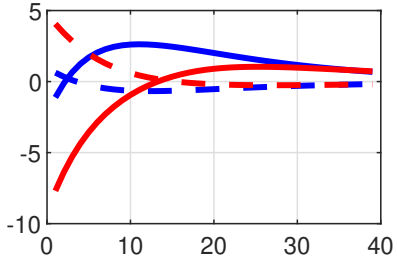
Exp. Priv Return (pp)



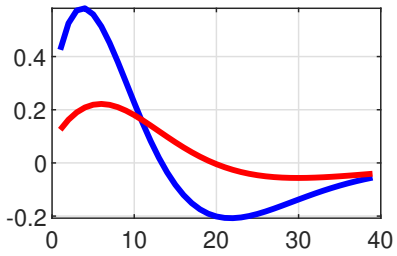
FI own govt bond (% of GDP)



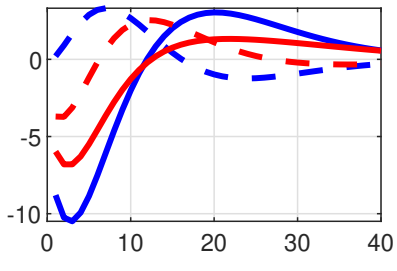
FI foreign govt bond (% of GDP)



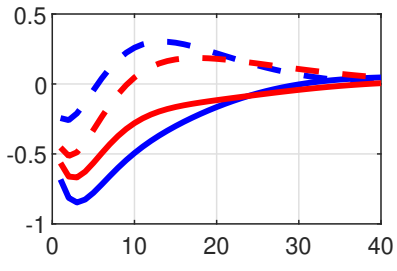
Net exports (% of GDP)



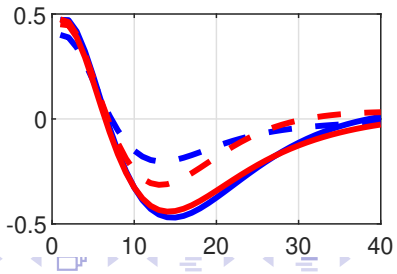
Investment (%)



Output (%)

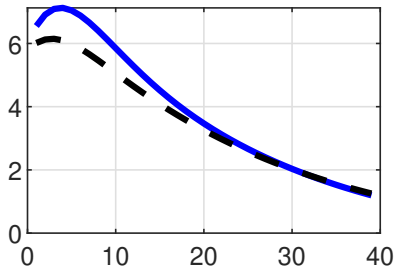


Consumption (%)

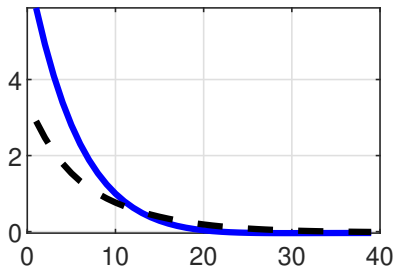


Asset Purchases Lessen the Effect of Debt Increase

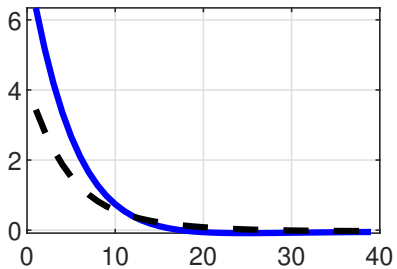
Debt (%)



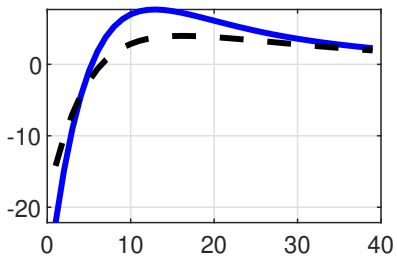
Exp. Govt Return (pp)



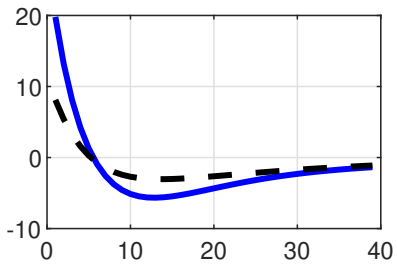
Exp. Priv Return (pp)



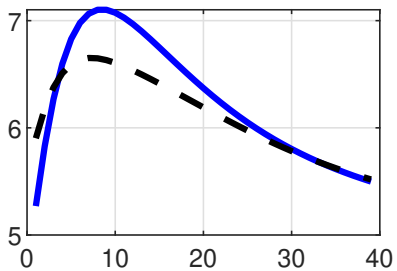
Net Worth (%)



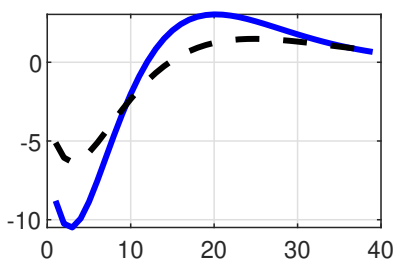
Leverage (%)



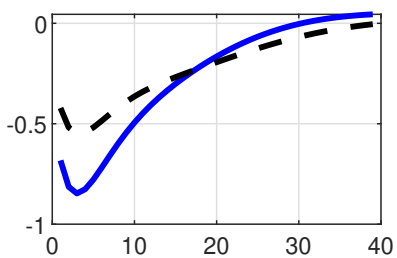
Default Probability (%)



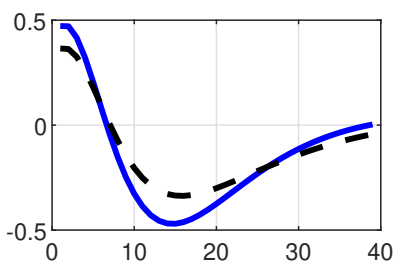
Investment (%)



Output (%)

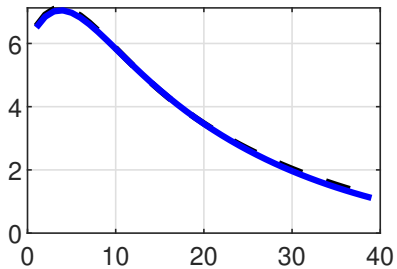


Consumption (%)

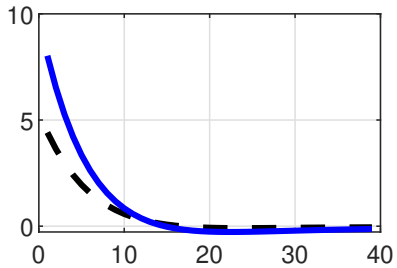


50% prob. vs. 0% prob. of credit intervention

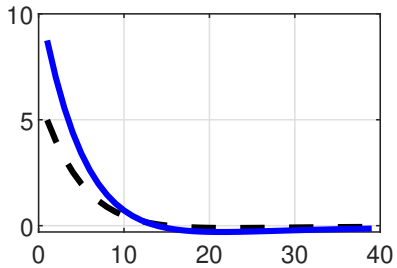
Debt (%)



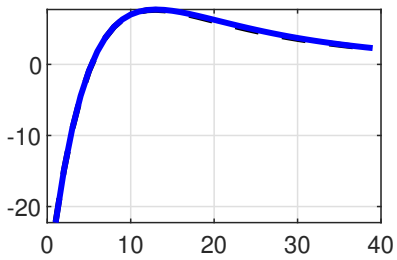
Exp. Govt Return (pp)



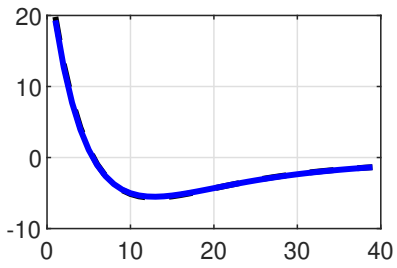
Exp. Priv Return (pp)



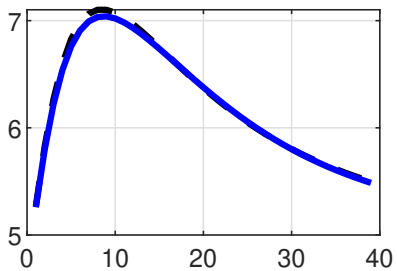
Net Worth (%)



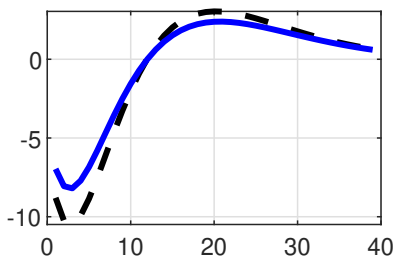
Leverage (%)



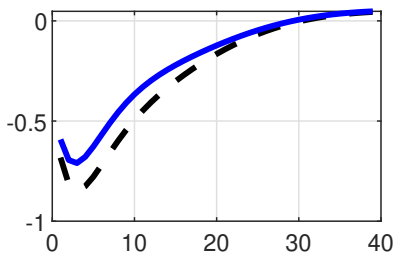
Default Probability (%)



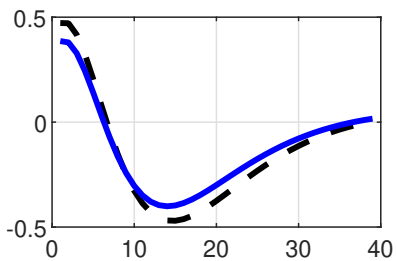
Investment (%)



Output (%)



Consumption (%)



Anticipation Effects in Normal Times

- With probability p_c, agents expect a one-time large increase in debt coupled with a leftward shift in the fiscal limit $\rightarrow$ debt crisis
- Compare stochastic steady state relative to case with no crisis ($p_c = 0$)

	Low Prob (10% annual)		High Prob (20% annual)	
Variable	No Purch (A)	Purch (B)	No Purch (C)	Purch (D)
Output	0.10	0.07	-0.06	0.01
Investment	0.18	0.09	-0.39	-0.24
Consumption	0.04	-0.04	-0.06	-0.20
Net Worth	-0.07	0.14	-0.98	-0.66
Deposit	0.52	0.40	0.46	0.33
Inflation	0.02	0.02	0.05	0.05
Foreign Output	-0.10	-0.10	-0.17	-0.24
Foreign Investment	-0.32	-0.28	-0.57	-0.63

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Conclusion

- Liquidity and default risks dampen Home economic & financial conditions, while spillovers depend on cross-country bond adjustments.
- Asset purchases (or anticipation of purchases) can help stabilize economy.
- Expectations of a crisis and credit intervention can distort the economy in normal times, raising or lowering economic activity depending on how frequently crises occur.

Appendix

Breaking Down A Crisis

Table: Changes Following a Debt Crisis

	Data	Baseline	No Liquidity Risk	No FL Shift	No Debt Change
Debt	6.1	7.1	5.7	5.6	2.1
Investment	-34	-10.3	-2.4	-2.2	-7.3
Yield Spread	5.0	6.5	2.2	1.5	4.9
Excess Return	5.1	5.4	1.2	1.1	4.2

Connections to Literature

- Fiscal policy in a monetary union:

  Erceg & Lindé (2013); Nakamura & Steinsson (2014); Farhi & Werning (2017), Maćkowiak & Schmidt (2022); Bianchi, Melosi & Rogantini-Picco (2023)

- Cross-country effects of credit policies:

  Kollmann, Enders & Muller (2011); Kollmann (2013); Dedola, Karadi & Lombardo (2013); Kirchner & Wijnbergen (2016); Auray, Eyquem & Ma (2018); Krenz (2022)

- Sovereign default and liquidity risks:

  Bocola (2016); Bianchi & Mondragon (2022)

Households

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- Consumption c_t aggregates Home and Foreign consumption sub-baskets, $c_{H,t}$ and $c_{F,t}$, in Armington form:

$$c_t = \left[\alpha_H^{\frac{1}{\phi}} \left(c_{H,t} \right)^{\frac{\phi-1}{\phi}} + \left(1 - \alpha_H \right)^{\frac{1}{\phi}} \left(c_{F,t} \right)^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}}$$

- Budget constraint:

$$d_t + z_t + c_t \left(1 + \tau^c \right) = \frac{R_{t-1}^d d_{t-1}}{\pi_t} + \frac{R_{t-1}^d z_{t-1}}{\pi_t} + w_t l_t + \Pi_t^f + div_t - x - t_t + T_t^{cb}$$

- Endogenous discount factor ensures stationarity [Uzawa (1968); Schmitt-Grohe and Uribe (2003)]

Wholesale Firms

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- Issue long-term private bonds to finance private investment with loan-in-advance constraint [Sims and Wu (2021)]

$$(\zeta_t^1) \qquad K_t = I_t^w + (1-\delta)K_{t-1}$$

$$(\zeta_t^2) \qquad Q_t^f \left(f_t - \kappa^f \frac{f_{t-1}}{\pi_t} \right) \geq \eta^I p_t^k I_t^w$$

- Produce output using labor and private capital

$$y_t^w = A_t I_t^{1-\alpha} K_{t-1}^{\alpha}$$

- Optimal conditions:

$$\begin{aligned} \zeta_t^1 &= p_t^k (1 + \eta^I \zeta_t^2) \\ Q_t^f (1 + \zeta_t^2) &= \beta E_t \Lambda_{t+1} \frac{1}{\pi_{t+1}} \left(1 + \kappa^f Q_{t+1}^f (1 + \zeta_{t+1}^2) \right) \\ \zeta_t^1 &= \beta E_t \Lambda_{t+1} \left(\frac{p_{t+1}^w \alpha y_{t+1}}{K_t} (1 - \tau_{t+1}^i) + (1-\delta)\zeta_{t+1}^1 \right) \end{aligned}$$

Financial Intermediary

The first-order conditions are,

$$E_t \beta(c_t) \Lambda_{t,t+1} \Omega_{t+1} \frac{R^f_{t+1} - R^d_t}{\pi_{t+1}} = \frac{\lambda^v_t}{1+\lambda^v_t} \eta^v$$

$$E_t \beta(c_t) \Lambda_{t,t+1} \Omega_{t+1} \frac{R^b_{t+1} - R^d_t}{\pi_{t+1}} = \frac{\lambda^v_t}{1+\lambda^v_t} \eta^v$$

$$E_t \beta(c_t) \Lambda_{t,t+1} \frac{\Omega_{t+1}}{\pi_{t+1}} R^d_t = \frac{\phi_t}{1+\lambda^v_t} \eta^v$$

- λ^v_t measures the tightness of the costly enforcement constraint.
- $E_t R^b_{t+1} - R^d_t$: excess returns
- $\phi_t = \frac{Q^f_t f_t + Q^b_t b^j_t}{n_t}$: leverage ratio
- $\Omega_t = 1 - \sigma + \sigma \eta^v_t \phi_t$

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Calibrated Parameters

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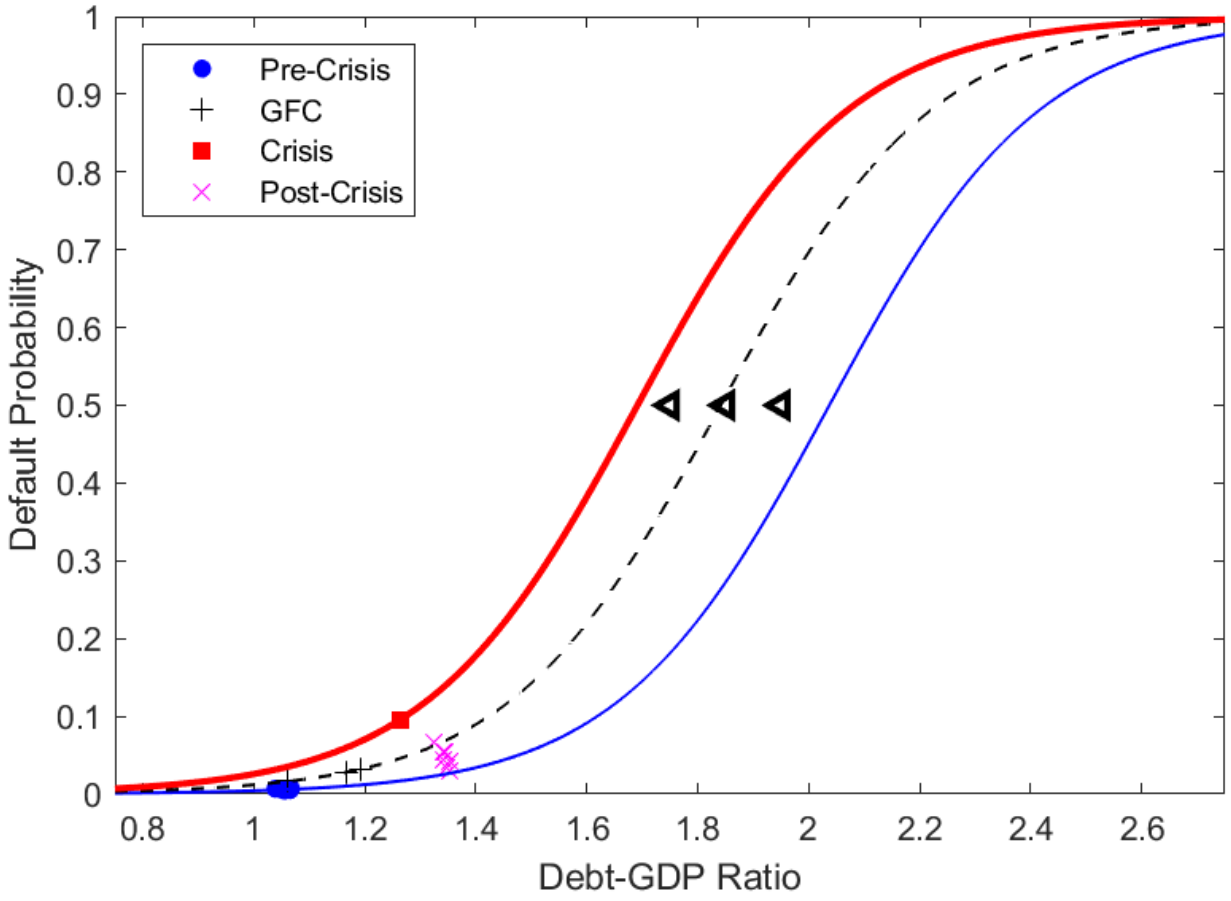
Parameter	Value	Description
		Home Country
κ^f	$1 - 40^{-1}$	Coupon decay parameter for private bonds
κ^b	$1 - 28^{-1}$	Coupon decay parameter for government bond
η^l	0.65	Fraction of investment from debt
ϕ	4	Leverage ratio
η^v	0.59	Recoverability parameter
$\frac{Q^f f}{4y}$	1.1	Private bonds as share of GDP
$\frac{Q^b b}{4y}$	1.05	Government bonds as share of GDP
τ^c	0.22	Consumption tax rate
τ^i	0.2	Income tax rate
$\frac{g^c}{y}$	0.19	Government consumption as share of GDP
		Foreign Country
$\kappa^{f,*}$	$1 - 40^{-1}$	Coupon decay parameter for private bonds
$\kappa^{b,*}$	$1 - 24^{-1}$	Coupon decay parameter for government bond
$\eta^{l,*}$	0.75	Fraction of investment from debt
ϕ^*	4	Leverage ratio
$\eta^{v,*}$	0.59	Recoverability parameter
$\frac{Q^{f,*} f^*}{4y^*}$	1.2	Private bonds as share of GDP
$\frac{Q^{b,*} b^*}{4y^*}$	1.05	Government bonds as share of GDP
$\tau^{c,*}$	0.19	Consumption tax rate
$\tau^{i,*}$	0.25	Income tax rate
$\frac{g^{c,*}}{y^*}$	0.2	Government consumption as share of GDP

Estimating Fiscal Limit



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