Optimal Bailouts in Banking and Sovereign Crises

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June 15, 2023

Introduction

- We study optimal bailouts in the presence of banking and sovereign crises
  - banking crises $\longrightarrow$ bailouts $\longrightarrow$ sovereign debt crises
  - sovereign debt crises $\longrightarrow$ banking crises
- Tradeoff: bailouts relax financial frictions and $\uparrow$ output, but also $\uparrow$ fiscal needs and default risk (i.e., create a 'diabolic loop').
- Main finding: Economy is ex ante better off without bailouts
  - economy without bailouts has larger default costs

  $\rightarrow$ better borrowing opportunities

  $\rightarrow$ higher debt capacity and liquidity
  - fewer defaults in equilibrium

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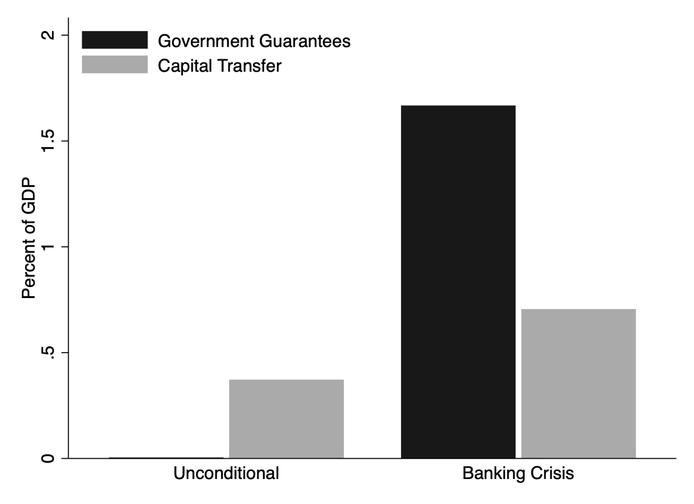
3. Our own empirical contribution: The most prevalent form of government intervention to alleviate banking crises is the issuance of sovereign guarantees

Government guarantees in banking crises



Source: Eurostat data on 23 countries (2007–2019) ▸ details

Model

Model

- Closed economy (build on Sosa-Padilla, 2018)
- Four agents:
  - households supply labor and pay taxes
  - firms borrow from banks (working capital)

    + productivity shocks
  - banks also lend to gov't (sovereign debt)

    + shocks to its capital
  - gov't chooses debt, taxes, guarantees, and default

Timeline

- Gov't observes $\{B, z, \varepsilon\}$ and decides repay/default
- If repay ($d = 0$)
  1. the government announces a bailout policy
  2. given the bailout policy, banks decide their loan supply
     - w/ prob. π, bank capital is reduced by ε (i.e. banking crisis) + gov disburses promised bailouts
     - w/ prob. $1 - \pi$, bank capital is unaffected + no bailouts paid
  3. all other private decisions + new gov't borrowing and taxes
- If default ($d = 1$)
  1. gov cannot promise bailouts and is excluded from fin. mkts
  2. banks determine their loan supply
     - w/ prob. π, the bank capital is reduced by ε
  3. all other private decisions + gov. taxes

Households

- Households choose consumption (c) and labor (n) to solve

$$\max_{\{c,n\}} \quad U(c,n)$$
$$\text{s.t. } c = (1-\tau)wn + \Pi^F$$

  - w: wage rate
  - τ: labor income tax rate
  - Π^F: firms' profits

- Optimality condition:

$$-U_n/U_c = (1-\tau)w \tag{1}$$

Firms

- Firms choose labor (N) and loans (ℓ^d) to solve

$$\max_{\{N,\ell^d\}} \quad \Pi^F = zF(N) - wN - r\ell^d$$

$$\text{s.t. } \gamma wN \leq \ell^d \text{ (working capital constraint)}$$

  - z: aggregate productivity
  - r: interest rate charged for working capital loans
  - γ: fraction of the wage bill that must be paid up-front
- Optimality condition:

$$zF_N(N) = (1 + \gamma r)w \tag{2}$$

Banks

- Banks lend to both the government (b) and the firms (ℓ^s).
- Bank's capital is subject to aggregate shocks

$$A = \begin{cases} \overline{A} & \text{with prob. } 1-\pi \\ \overline{A}(1-\varepsilon) & \text{with prob. } \pi \quad \text{(i.e. a banking crisis)} \end{cases}$$

- Loans to firms (ℓ^s) are chosen after observing ε but before knowing whether the shock actually hits and cannot exceed the value of bank's loanable funds:

$$\ell^s \leq A + b + T(B, s, A) \;\text{ for all } A$$

  - b: bank's holdings of sovereign bonds
  - T: state-contingent government transfers (bailouts)
  - $s \equiv \{z, \varepsilon\}$

Banks

- When the government has access to credit, the bank chooses loans to firms (ℓ^s), loans to the gov't (b'), and consumption (x)

$$W^R(b; B, s) = \max_{\ell^s} \mathbb{E}_A \Omega(b, \ell^s; B, s, A)$$

$$\text{s.t. } \ell^s \leq \min_A \{A + b + T(B, s, A)\}$$

$$\Omega(b, \ell^s; B, s, A) = \max_{x, b'} x + \delta \mathbb{E}_{s'|s} \left[(1 - d') W^R(b'; B', s') + d' W^D(s') \right]$$

$$\text{s.t. } x + q(B', s) b' \leq T(B, s, A) + b + r(B, s, A) \ell^s$$

  - δ: bank's discount factor
  - $q(B', s)$: price of government bonds
  - $r(B, s, A)$: interest rate on private loans
  - B', T, d: government policies for debt, bailouts, and default

Banks

- When the government lacks access to credit, the bank chooses loans to firms (ℓ^s) and consumption (x) to solve

$$W^D(s) = \max_{\ell^s, x} x + \delta \mathbb{E}_{s'|s} \left[\theta W^R(0; 0, s') + (1-\theta) W^D(s') \right]$$

$$\text{s.t. } x \leq r_{\text{def}}(s) \ell^s$$

$$\ell^s \leq \min_A \{ A + \cancel{b + T(B, s, A)} \}$$

  - θ: probability that the government regains access to credit
  - $r_{\text{def}}(s)$: interest rate on private loans when the government does not have access to credit
- Defaults reduce loanable funds
- No bailouts during default/exclusion (can be relaxed)

Equilibrium given government policies

- We focus on bailout policies that take the form:

$$\begin{aligned} T &= 0 && \text{if } A = \overline{A} \\ 0 \le T &\le \varepsilon \overline{A} && \text{if } A = \overline{A}(1-\varepsilon) \end{aligned}$$

- When government has access to credit, banks supply

$$\ell^s(B, s) = B + \overline{A}(1-\varepsilon) + T(B, s, \overline{A}(1-\varepsilon))$$

- When the government lacks access to credit, banks supply

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Equilibrium given government policies

- From firm optimality conditions, we obtain loan demand:

$$\ell^d(B, s, A) = \gamma \left[\frac{znF_n}{1 + \gamma r} \right]$$

- Loan market clearing interest rate:

$$r(B, s, A) = \max \left\{ \frac{zn(B, s, A)F_n}{B + \overline{A}(1-\varepsilon) + T\left(B, s, \overline{A}(1-\varepsilon)\right)} - \frac{1}{\gamma}, 0 \right\} \quad (3)$$

$$r_{\text{def}}(s) = \max \left\{ \frac{zn(s)F_n}{\overline{A}(1-\varepsilon)} - \frac{1}{\gamma}, 0 \right\} \quad (4)$$

Equilibrium given government policies

- From banks' FOCs, we obtain the bond pricing function

$$q(B';\ s) = \delta\, \mathbb{E}_{s'|s} \left\{ \left[1 - \underbrace{d(B', s')}_{\text{default premium}} \right] \mathbb{E}_{A'} \left[1 + \underbrace{r\,(B', s', A')}_{\text{lending discount}} \right] \right\} \quad (5)$$

- When government defaults next period $\left(d(B', s') = 1\right)$
  - the lender loses its original investment in sovereign bonds
  - and the future gains that those bonds would have created

Determination of government policies

- The government's optimization problem given by:

$$V(B,s) = \max_{d \in \{0,1\}} \Big\{ (1-d) V^R(B,s) + d\ V^D(s) \Big\} \qquad (6)$$

  - V^R: value of repaying
  - V^D: value of defaulting

- Let $\kappa \equiv (B, s, A)$ denote the complete aggregate state and $\Phi \equiv \{\tau, T, B'\}$ summarize the fiscal policies
- Value of repayment is given by

$$V^R(B,s) = \max_{\tau, B', T} \mathbb{E}_A \Big\{ U(c(\Phi;\kappa), n(\Phi;\kappa)) + \beta\, \mathbb{E}_{s'|s} V(B', s') \Big\}$$

$$\text{s.t. } \tau\, w(\Phi;\kappa)\, n(\Phi;\kappa) + B'\, q(B', s) = g + B + T$$

$$c(\Phi;\kappa) + x(\Phi;\kappa) + g = zF(n(\Phi;\kappa))$$

equilibrium conditions from private sector

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eqm conditions from priv. sector under default

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eqm conditions from priv. sector under default

Determination of government policies

▸ MPE

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eqm conditions from priv. sector under default

Quantitative Results

Remainder of presentation

1. Describe the model calibration

2. Model validation

3. Default and bailout policies

4. Do we even want bailouts?

Functional forms and stochastic processes

- **Utility function:** $U(c,n) = \dfrac{\left(c - \frac{n^{\omega}}{\omega}\right)^{1-\sigma}}{1-\sigma}$
- **Production function:** $zF(n)$ with $F(n) = n^{\alpha}$

- **TFP shocks** (z) follow an AR(1) process:

$$\log(z_{t+1}) = \rho_z \log(z_t) + \nu_{z,t+1} \quad \text{where } \nu_z \sim N(0,\sigma_z)$$

- **Potential bank capital shocks** take values between 0 and $\bar{\varepsilon}$, and have a cumulative distribution function,

$$F_{\sigma_\varepsilon}(\varepsilon) = \frac{1-\exp(\varepsilon)^{-\sigma_\varepsilon}}{1-\exp(\bar{\varepsilon})^{-\sigma_\varepsilon}}$$

which is a transformation of the bounded Pareto distribution

Calibration

- Annual frequency + European data (GIIPS whenever possible)
- Parameters set externally: $\sigma, \omega, \delta, \theta, \alpha, \gamma, \rho_z, \sigma_z$
- Parameters calibrated by SMM: $\beta, \pi, \bar{A}, \sigma_\varepsilon, g$

Moment	Data	Model
Default frequency (percent)	0.5	0.5
Banking crisis frequency (percent)	1.8	1.8
Bailouts in banking crises (percent GDP)	1.7	1.7
Standard deviation of output (percent)	3.4	3.4
Gov't consumption (percent GDP)	19.1	19.1

(full table)

Simulated moments: model and data

- Untargeted moments from our simulations and their data counterparts

	Model	Data
Sovereign spread		
mean (percent)	0.7	1.2
standard deviation (percent)	0.6	1.8
corr(spread,output)	–0.3	–0.7
Debt/GDP (percent)	15.5	25.8
corr(transfers, debt)	–0.3	–0.3
Bailout-output multiplier	1.5	1.5–2.0

Simulated moments

- "diabolic loop:" default probability is higher following a banking crisis, with higher and more volatile spreads

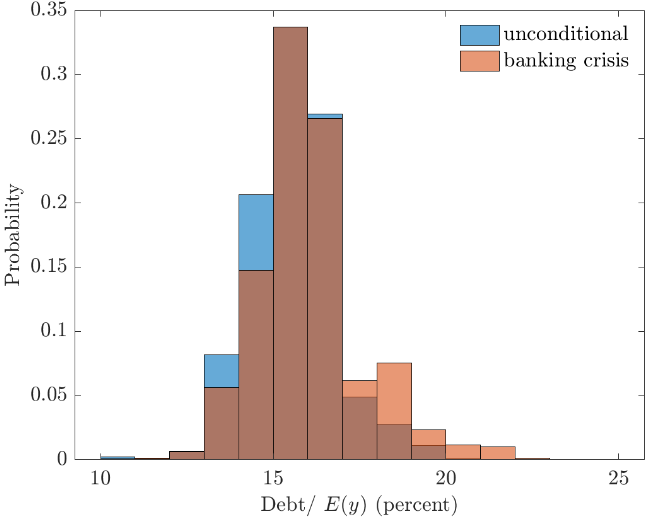
	Unconditional	Banking crisis
Default frequency	0.5*	0.7
Sovereign spread		
mean	0.7	0.9
standard deviation	0.6	1.0
Debt/GDP	15.5	16.0
Bailout/GDP	0.9	1.7*

Units: percent. * denotes targeted moments.

Dynamics around BC

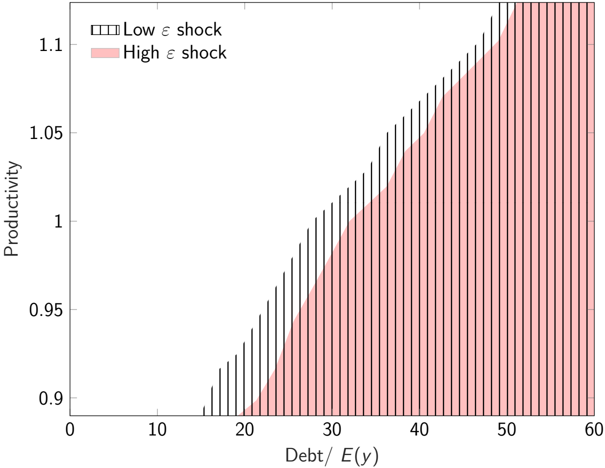
Debt dynamics

- Higher levels of debt more likely after banking crises



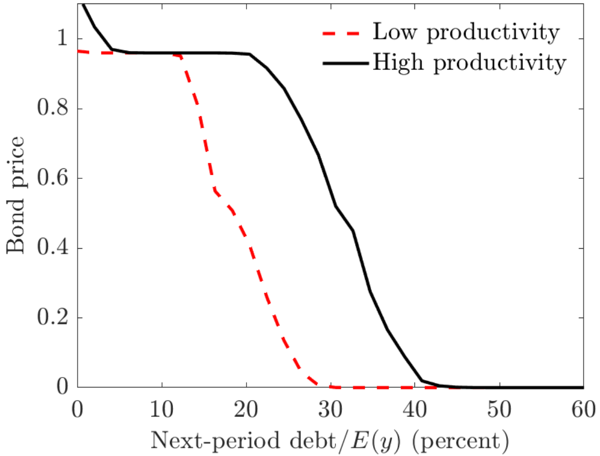
Default policy

- Default is
  - decreasing in productivity and increasing in debt
  - less likely with larger potential losses to banking capital



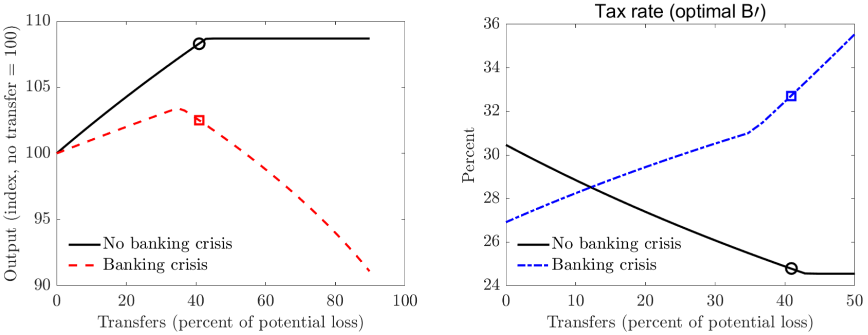
Price schedule and spreads

- Higher productivity is associated with better prices and higher debt capacity



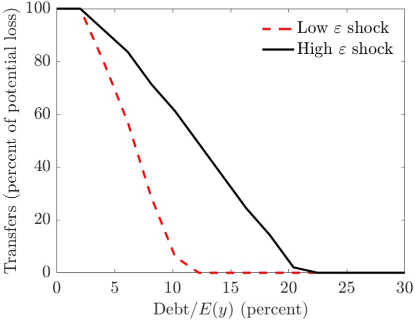
Tradeoffs faced when choosing bailouts

- Promised transfers increase credit and output (up to a point)
- Banking crisis → transfers partially financed by distortionary taxes → lower output



Properties of optimal bailout policies

- Bailouts are
  - ↓ in debt (less fiscal space)
  - ↑ in the severity of banking crisis (convex output loss)
  - ↑ in productivity (higher return and cheaper to finance)



Ex ante optimality of bailouts

- Trade-off: bailouts $\uparrow$ liquidity and output during BC *but* also $\uparrow$ debt and default risk. 'Diabolic-loop'
- Are bailouts ex ante desirable?
- The 'no-bailout' economy features:
  - Lower default risk, lower and less volatile spreads
  - Higher debt capacity
  - Higher private lending rate r
- Bailouts are ex ante sub-optimal (for the relevant initial states)

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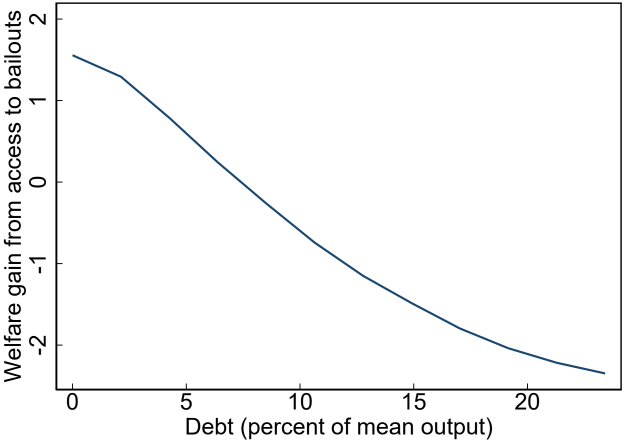
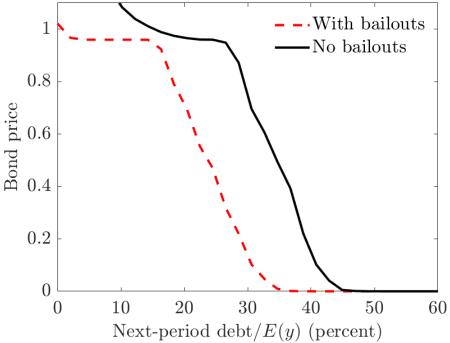


- For avg. Debt/GDP in the simulations: welfare loss of 1.5%

Economy better off without bailouts

- No-bailout economy: better prices due to larger default costs
  - endogenous default costs: reduced liquidity and output
  - during exclusion: same costs w/ and w/o bailouts
  - low liquidity continues once gov't re-accesses credit mkts
    - w/ bailouts: can prop up liquidity if hit by ε shocks $\rightarrow$ lower default costs
- Lower default costs $\rightarrow$ more frequent defaults $\rightarrow$ lower debt capacity $\rightarrow$ lower welfare
- No-bailouts economy: higher debt and liquidity $\rightarrow$ not costly to *not have bailouts*

Sub-optimality of bailouts: price schedule



- No-bailout economy faces a more favorable price schedule due to larger default costs.

▸ Value function

▸ Private consumption

Concluding remarks

- We study the dynamic relationship between sovereign defaults, banking crises, and government bailouts
- Tradeoff in bailouts: relax domestic fin. frictions and $\uparrow$ output, but also imply $\uparrow$ fiscal needs and $\uparrow$ default risk
- Optimal bailouts are increasing with the severity of banking crisis and productivity but decreasing in debt levels
- Even though bailouts mitigate the adverse effects of banking crises, the economy is ex ante better off without bailouts: bailouts lower the cost of defaults, increase the default frequency, and reduce debt capacity and liquidity

thank you!

Appendix

Government guarantees ◂ guarantees

- Arrangements whereby the guarantor undertakes to a lender that if a borrower defaults, the guarantor will make good the loss the lender would otherwise suffer ▸ website
- Data on guarantees do not include:
  - government guarantees issued within the guarantee mechanism under the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM)
  - derivative-type guarantees meeting the ESA2010 definition of a financial derivative
  - deposit insurance guarantees and comparable schemes
  - government guarantees issued on events which are difficult to cover via commercial insurance (earthquakes, etc)
  - stocks of debt already assumed by government

Recursive Equilibrium

- A *Markov-perfect equilibrium* for this economy is
  (i) government value functions $\{V(B,s), V^R(B,s), V^D(s)\}$
  (ii) government policies $\{B'(\kappa), \tau(\kappa), T(\kappa), d(B,s)\}$
  (iii) private sector decision rules $\{c(\Phi;\kappa), n(\Phi;\kappa), x(\Phi;\kappa), \ell(\Phi;\kappa)\}$ and $\{c_{\text{def}}(\tau;s), n_{\text{def}}(\tau;s), x_{\text{def}}(\tau;s), \ell_{\text{def}}(\tau;s)\}$
  (iv) prices $\{q(B'(\kappa),s), w(\Phi;\kappa), r(\Phi;\kappa), w_{\text{def}}(\tau;s), r_{\text{def}}(\tau;s)\}$

  such that:

  1. Given prices and private sector decision rules, government policies solve the government's maximization problem in (6)
  2. Given government policies, prices and private sector decision rules are consistent with the competitive equilibrium, satisfying (1)–(5).

(back)

Calibration

Parameters	Values	Target/Source
Household discount factor, β	0.81	Default probability: 0.5 percent
Risk aversion, σ	2	Sosa-Padilla (2018)
Frisch elasticity, $\frac{1}{\omega-1}$	0.67	Sosa-Padilla (2018)
Government spending, g	0.15	Gov't consumption (percent GDP): 19.1
Prob. of financial redemption, θ	0.50	Expected exclusion: 2 years
Bankers' discount factor, δ	0.96	Risk-free rate: 4 percent
Baseline bank capital, $\bar{A}$	0.28	Bailouts in banking crises (percent GDP): 1.7
Financial shock shape, σ_ε	4.26	Standard deviation of output: 3.4 percent
Prob. of banking crisis, π	0.03	Banking crisis frequency: 1.8 percent
Labor share, α	0.70	Sosa-Padilla (2018)
Working capital constraint, γ	0.52	Sosa-Padilla (2018)
TFP shock persistence, ρ_z	0.80	Standard value
TFP shock std, σ_z	0.02	Standard value

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Model fit

	Model	Data
Default frequency	0.5	0.5
Banking crisis frequency	1.8	1.8
Gov't spending/GDP	19.1	19.1
Bailouts/GDP (banking crisis)	1.7	1.7
Sovereign spread		
mean	0.7	1.2
standard deviation	0.6	1.8
corr(spread,output)	–0.3	–0.7
Debt/GDP	15.5	25.8

Units: percent.

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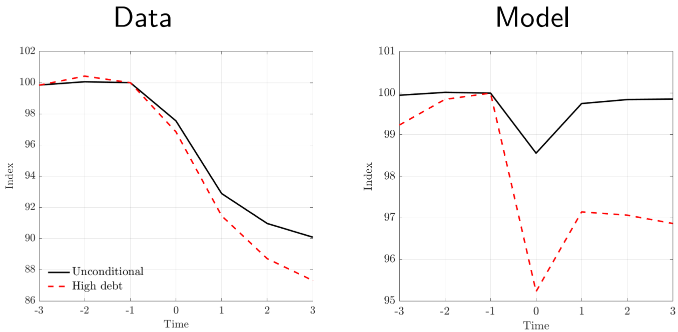
Model validation: dynamics around crises

Figure: Output around banking crises



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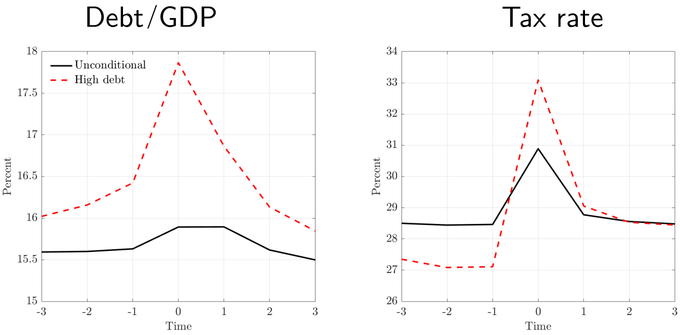
Model validation: dynamics around crises

Figure: Debt and taxes around banking crises



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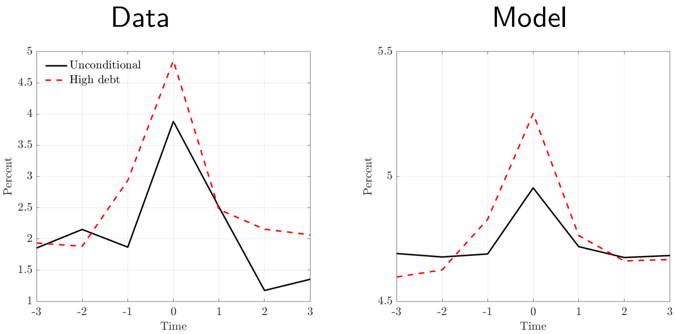
Model validation: dynamics around crises

Figure: Sovereign yields around banking crises



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Simulations for no-bailouts economy

	Baseline model	Model without bailouts
Default frequency	0.5*	0.3
Sovereign spread		
mean	0.7	0.5
standard deviation	0.6	0.5
corr(GDP, spread)	-0.2	-0.3
Debt/GDP	15.5	26.8
Mean lending rate	0.0	0.2

Units: percent. * denotes targeted moments.

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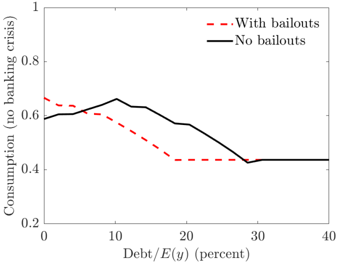
Sub-optimality of bailouts: private consumption



- No-bailout economy has higher liquidity and cheaper-to-service debt level implies higher consumption.

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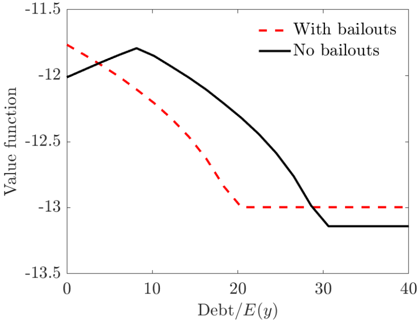
Sub-optimality of bailouts: value function



An economy with unrestricted bailouts is ex-ante preferable if there is:

- very low initial debt: access to bailouts props up liquidity
- very high initial debt: after default reentering financial markets is less painful with access to bailouts

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