Optimal Fiscal Rules and Macroprudential Policies under Sovereign Default

Gerard Maideu-Morera

Toulouse School of Economics

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Motivation

Motivation: EU sovereign debt crises (2010-12): Ireland and Spain had public debt to GDP below 40% in 2007. But high private debt

- Tighter fiscal discipline? Martin and Philippon (2017) lower private debt better
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This paper: Joint design of fiscal rules (limit sovereign debt) and macroprudential policies (limit private debt) under sovereign default

Preview results

Setting: SOE where both government and HH borrow externally

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   - Default externalities + distortionary taxation
2. Private-debt dependent fiscal rules

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Main results:

1. Rational for macroprudential policies
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2. Private-debt dependent fiscal rules

Then,

- Generalize results in a dynamic model, with heterogeneous HH, aggregate risk and rich asset structure
- Quantitative model with long-term debt

Related literature

1. **Sovereign default and private debt:** Arellano et al. (2016), Arellano and Kocherlakota (2014), Wright (2006), Reinhart and Rogoff (2011), Mendoza and Yue (2012), Kaas et al. (2020)
   - Arce (2023): macropru without pecuniary externality + joint design fiscal and macropru
2. **EU sovereign debt crises, risk-sharing in unions and Bank-Sovereign doom-loop:** Martin and Philippon (2017), Farhi and Tirole (2018), Tirole (2015), Brunnermeier et al. (2016), Brunnermeier et al. (2016), Gourinchas et al. (2017), Chodorow-Reich et al. (2019), Gourinchas et al. (2020), Abrahám et al. (2018), Liu et al. (2022) and Ferrari et al. (2020)
3. **Fiscal rules:** Halac and Yared (2014), Halac and Yared (2018), Dovis and Kirpalani (2020), Hatchondo et al. (2022), Chari and Kehoe (2007), Broner et al. (2021), Sublet (2022)
4. **Macroprudential:** Lorenzoni (2008), Bianchi (2011), Dávila and Korinek (2018),Farhi and Werning (2016), Bianchi and Lorenzoni (2021), Forbes (2021), Erten et al. (2021), Bianchi and Mendoza (2018), Farhi and Werning (2012), Jeanne and Korinek (2019)

Outline

1. Two-period example
2. General model
3. Quantitative model with long-term debt

Two-period example

Model

- $t = 1, 2$
- Three agents: Representative HH, Local government (e.g. Greek government), Central authority (e.g. EU)
  - HH produces income, consumes and borrows internationally; Cannot default
  - Local gov. taxes HH and borrows internationally to finance expenditures; Can default
  - Central authority ("the principal"), sets fiscal rules and macroprudential policies

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  - Central authority ("the principal"), sets fiscal rules and macroprudential policies
- Difference preferences central and local governments
  - Local: max HH utility
  - Central: max HH utility + externalities sovereign default

Local government's problem

- HH utility

$$u(c_t - v(y_t))$$

with $\eta \equiv \frac{v'(y_1)}{v''(y_1)y_1} > 0$ and discount factor $\beta < 1$

- Tax total income at linear rate τ_t (distortionary)
- Sovereign debt $-B_2$ and private debt $-a_2$. Budget constraints:

$$\text{(Gov.)} \quad G_1 + Q^B(B_2, a_2)B_2 = \tau_1 y_1$$

$$\text{(HH)} \quad c_1 + qa_2 = (1 - \tau_1)y_1$$

- Implementability: $1 - \tau_t = v'(y_t)$ and choose directly private debt

Local government's problem

- At $t = 2$, $G_2 = 0$ and the government can default on B_2, stochastic utility penalty $\theta > 0$
  - If repay
    $$-B_2 = \tau_2 y_2$$
    $$c_2 = a_2 + (1 - \tau_2) y_2$$
  - If default don't need to tax
    $$c_2 = a_2 + y_2$$

  $\rightarrow$ higher $(-a_2)$ makes sovereign default more attractive. Akin to a bailout

- Local government problem:

$$\max \ \mathbb{E}[\text{HH utility}] \ \ s.t \ \ \text{budget and implementability constraints}$$

How does every type of debt affect incentives to default?

- Direct effect sovereign debt: repayment more costly

$$\frac{d\mathbb{P}(\text{Default})}{d(-B_2)} \propto -\frac{dV_2^R}{d(-B_2)} = \frac{u_2'(R)}{1-\underbrace{\eta\frac{\tau_2}{1-\tau_2}}_{\text{DWL taxes}}} > 0$$

- Indirect effect private debt: higher marginal utility increases gain defaulting

$$\frac{d\mathbb{P}(\text{Default})}{d(-a_2)} \propto -\left(\frac{dV_2^R}{d(-a_2)} - \frac{dV_2^D}{d(-a_2)}\right) = u_2'(R) - u_2'(D) > 0$$

- Can show effect private debt always smaller

Central authority's problem

Default externality $S > 0$. Objective

$$W = \mathbb{E}[\text{HH utility}] + \mathbb{P}\left(\text{Default}\right)(-S)$$

Assume S high enough such that default never optimal

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$$W = \mathbb{E}[\text{HH utility}] + \mathbb{P}\left(\text{Default}\right)(-S)$$

Assume S high enough such that default never optimal

$\Rightarrow$ Impose constraint

$$V_2^R(B_2, a_2) \geq V_2^D(a_2, \theta) \;\; \forall \theta \in [\underline{\theta}, \overline{\theta}]$$

Rest is as local government's problem

Solvency constraints and private debt-dependent fiscal rules

Define

$$V_2^R(B^{max}(a_2), a_2) = V_2^D(a_2, \underline{\theta})$$

We impose the following limit on sovereign debt

$$B_2 \geq B^{max}(a_2)$$

Solve directly the decentralization:

- Give the local government a sovereign debt limit that is a function of private debt
- A private-debt dependent fiscal rule
- Works because preferences aligned as long as no default
- Spread-based rule (Hatchondo et al. 2020) equivalent if price risk private debt

Wedges

Wedges are defined relative to the laissez-faire solution of the local government's problem

Define wedge on sovereign debt as

$$\frac{u_1'}{1-\eta\frac{\tau_1}{1-\tau_1}}\left(1-\tau^B\right)=\beta q^{-1}\frac{u_2'(R)}{1-\eta\frac{\tau_2}{1-\tau_2}}$$

wedge on private debt (the macroprudential policy)

$$u_1'\left(1-\tau^a\right)=\beta q^{-1}u_2'(R)$$

Optimal distortions

Proposition

$$\tau^a = \left(-\frac{\partial B^{max}(a_2)}{\partial a_2}\right) \frac{\tau^B}{1 - \eta \frac{\tau_1}{1-\tau_1}}$$

Moreover, whenever $\tau^B > 0$, we have $\tau^B > \tau^a > 0$.

INTUITION:

- Can always set $B_2 = 0$ and prevent default, want (B_2, a_2) that minimizes distortions
- If B_2 restricted, taxes are inefficiently high at $t = 1$
- Restricting a_2 allows to increase sovereign debt by $-\frac{\partial B_2^{max}}{\partial a_2}$ and lower τ_1 with resource gain proportional to $\frac{1}{1-\eta\frac{\tau_1}{1-\tau_1}}$

Alternative formulas

- The wedge can also be written as

$$\frac{\tau^a}{1-\tau^a} = \left(1 - \frac{u_2'(D)}{u_2'(R)}\right) \frac{\tau^B}{1-\tau^B}$$

- and

$$\tau^a = \left(\frac{\partial \mathbb{P}(\text{Default})/\partial a_2}{\partial \mathbb{P}(\text{Default})/\partial B_2} |_{\mathbb{P}(\text{Default})=0} \right) \frac{\tau^B}{1 - \eta \frac{\tau_1}{1-\tau_1}}$$

Tax capacity, substitution and the effects of third best policies

Martin and Philippon (2017): Biased government responds by increasing sovereign debt after private debt restricted

Consider increase costs by $\varepsilon^B > 0$ (i.e. $q(1-\varepsilon^B)B_2$) and $\varepsilon^a > 0$ (i.e. $(q(1-\varepsilon^a)a_2$)

$\rightarrow$ substitution $\frac{\partial B_2}{\partial \varepsilon^a} < 0$ and $\frac{\partial a_2}{\partial \varepsilon^B} < 0$. **By how much?**

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Frisch elasticity (η) determines how (price-) substitutes the two types of debt are

$$\underbrace{\frac{\tau_2}{1-\tau_2} - \frac{\tau_1}{1-\tau_1}}_{\text{Pins down } B_2} \approx \frac{1}{\eta}\left[\varepsilon^a - \varepsilon^B\right]$$

$\rightarrow$ Countries with high tax capacity (low η) can substitute more

General model

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- $t = 1, 2, ..., \infty$, aggregate state s_t, transition $\pi(s_t|s^{t-1})$ (continuous)

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- Let $I_{t+1}^i(s^{t+1}) \equiv \sum_{k\in\mathcal{K}} \widetilde{R}_k(s^t, s_{t+1}) a_k^i(s^t)$ and $X_{t+1}^i(s^{t+1}) = \{I_{t+1}^i(s^{t+1}), b_{t+1}^i(s^t)\}$

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- Continuum deep-pocketed foreign lenders $\Rightarrow$ price all assets
- Government faces stochastic $\{G(s_t)\}$, allow for default penalties, probability of reentering markets after default, and extend to allow HH default after sovereign default

Generalize the solvency constraints

- State where default more "attractive" may depend on HHs' portfolios

$$V_{t+1}^{R}\left(\overline{B}(\{X_{t+1}^{i}(s^{t+1})\}_{i\in\mathcal{I}}, s^{t+1}), \{X_{t+1}^{i}(s^{t+1})\}_{i\in\mathcal{I}}, s^{t+1}\right) = V_{t+1}^{D}\left(\{I_{t+1}^{i}(s^{t+1})\}_{i\in\mathcal{I}}, s^{t+1}\right)$$

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- Then sovereign debt limit is

$$B^{max}(\{X^i_{t+1}(s^{t+1})\}_{i\in\mathcal{I}, s_{t+1}}) = \max_{s_{t+1}} \overline{B}(\{X^i_{t+1}(s^{t+1})\}_{i\in\mathcal{I}}, s^{t+1})$$

- Well defined and continuous if asset are payoffs continuous a.e

Wedge definitions

- Again, wedges are defined relative to the optimal policies of the local goverment
- Wedge sovereign debt

$$\tau^{B}(s^t) = 1 - \frac{\beta}{q\lambda^{G}(s^t)}\mathbb{E}_{s_{t+1}|s^t}\frac{\partial V^{R}(s^{t+1})}{\partial B_{t+1}(s^t)}$$

- Wedge position $a_k^i(s^t)$

$$\tau^{k,i}(s^t) = 1 - \frac{1}{q_k(s^t)\lambda^{HH,i}(s^t)}\left(\langle \mu^{\mathcal{H},i}(s^t), \mathcal{H}^i_{a_k^i}(s^t)\rangle + \beta\sum_{s^{t+1}}\widetilde{R}_k(s^t, s_{t+1})\frac{\partial V^{R}_{t+1}\left(s^{t+1}\right)}{\partial I^i_{t+1}(s^{t+1})}\right)$$

- Let $s^*_{t+1} = \underset{s_{t+1}}{\operatorname{argmax}}\overline{B}(\{X^i_{t+1}(s^{t+1})\}_{i\in\mathcal{I}}, s^{t+1})$

Optimal wedges

$$\tau^{k,i}(s^t) = \frac{\widetilde{R}_k(s^t, s_{t+1^*})}{q_k(s^t)} q \frac{\partial - \overline{B}(\{X^i_{t+1}(s^{t+1,*})\}_{i\in\mathcal{I}}, s^{t+1,*})}{\partial I^i_{t+1}(s^{t+1,*})} \frac{\lambda^G(s^t)}{\lambda^{HH,i}(s^t)} \times \tau^B(s^t)$$

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- Assuming utility with no income effects

$$\tau^{k,i}(s^t) = \frac{\widetilde{R}_k(s^t, s^*_{t+1})}{q_k(s^t)} q \left(1 - \frac{U^i_c(s^{t+1,*}, D)}{U^i_c(s^{t+1,*}, R)}\right) \frac{1 - \eta^i s^*_{t+1} \frac{\tau^i(s^{t+1,*})}{1-\tau^i(s^{t+1,*})}}{1 - \eta^i s_t \frac{\tau^i(s^t)}{1-\tau^i(s^t)}} \times \tau^B(s^t)$$

Wedge comparisons

- For any two assets k, k':

$$\tau^{k',i}(s^t) = \frac{\frac{\widetilde{R}_{k'}(s^t, s^*_{t+1})}{q_{k'}(s^t)}}{\frac{\widetilde{R}_{k}(s^t, s^*_{t+1})}{q_{k}(s^t)}} \tau^{k,i}(s^t)$$

$\Rightarrow$ Only relevant the payment in the binding state

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$\Rightarrow$ Only relevant the payment in the binding state

- For any two HH types i, i'

$$\tau^{k,i'}(s^t) = \left(\frac{U_c^{i'}(s^{t+1,*}, R) - U_c^{i'}(s^{t+1,*}, D)}{U_c^{i}(s^{t+1,*}, R) - U_c^{i}(s^{t+1,*}, D)} \right) \frac{U_c^i(s^t)}{U_c^{i'}(s^t)} \tau^{k,i}(s^t)$$

$\Rightarrow$ Ratio of gains from default, but does not depend directly on welfare weight ω^i

Wedge domestic holdings sovereign debt and HH default

- Wedge on domestic holding sovereign debt (with no income effects):

$$\tau^{b,i}(s^t) = \frac{1 - \eta^i s_{t+1,*} \frac{\tau^i(s^{t+1,*})}{1-\tau^i(s^{t+1,*})}}{1 - \eta^i s_t \frac{\tau^i(s^t)}{1-\tau^i(s^t)}} \tau^B(s^t)$$

- If HH also defaults on asset k^D:

$$\tau^{k^D,i}(s^t) = \frac{\widetilde{R}_{k^D}(s^t, s^*)}{q_{k^D}(s^t)} q \frac{1 - \eta^i s_{t+1,*} \frac{\tau^i(s^{t+1,*})}{1-\tau^i(s^{t+1,*})}}{1 - \eta^i s_t \frac{\tau^i(s^t)}{1-\tau^i(s^t)}} \times \tau^B(s^t)$$

Quantitative model with long-term debt

Set up

- Long-term debt (Hatchondo Martinez (2009)): declining coupon $\lambda, \lambda(1-\lambda), \lambda(1-\lambda)^2$...

$$Q_t^B = q\mathbb{E}[\delta_{t+1}(\lambda + (1-\lambda)Q_{t+1}^B)]$$

- Borrowing limit private debt:

$$a_{t+1} \geq \overline{a}$$

- Utility $U(c, y, s) = u(c - v(y/s))$ (CRRA) with AR(1) process s
- Fixed flow G
- Productivity costs default: $h(z) = z - \max\{\zeta_0 z + \zeta_1 z^2, 0\}$ (Chatterjee and Eyigungor (2012))

Calibration

External parameters

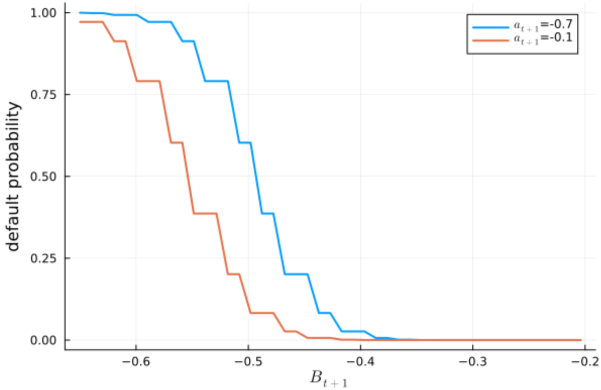
		Source
Relative risk aversion	$\gamma = 2$	Standard
Frisch elasticity	$\eta = 2$	Standard
Persistence productivity	$\rho = 0.95$	Neumeyer and Perri (2005)
Risk-free debt price	$q = \frac{1}{1+0.17}$	Average US interest rate (quarterly)
Debt decay rate	$\lambda = 0.05$	Average maturity
Government expenditures	$G = 0.14$	Gov. expenditures to GDP
Private debt limit	$\bar{a} = 0.7$	Private Debt to GDP Spain (2008) (Arce (2021))

Internal parameters

		Moment matched
Discount factor	$\beta = 0.97$	Default probability
Disutility parameter	$\chi = 0.75$	Normalization avg. income
Productivity cost default	$\zeta_0 = -0.182$	Debt to GDP
Productivity cost default	$\zeta_1 = 0.195$	Mean Spread (Hatchondo and Martinez (2009))
Std. dev. productivity	$\sigma = 0.009$	Std. dev GDP

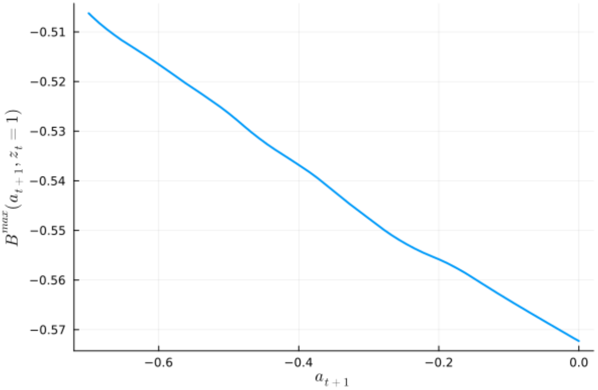
Fit

Private debt and default probabilities



⇒ Higher private debt increases default probabilities, but effect small

Private debt-dependent fiscal rule



- Implies on average have $\frac{\tau^a}{\tau^B} \approx 0.12$
- Small, but extra amplification channels (e.g. pecuniary externalities (Arce 2023)) would amplify it

Conclusions

Study how interactions between private and sovereign debt affect the optimal design of fiscal rules and macroprudential policies

Main points:

- Rationale for macroprudential policies
- Private debt-dependent fiscal rules

Then,

- Generalize fiscal rules and wedge formulas
- Quantitative: macropru wedge small but only mechanical effect through marginal utility

Model fit

	Data	Model
Std. dev GDP	$\sqrt{3.08}$	
Gov. expenditures to GDP	0.14	
Default probability, %	4.51	
Debt to GDP %	32.5	
Mean Spread %	7.44	
Private debt GDP	0.7	

Back