Monetary Policy and Sovereign Debt Vulnerability

Galo Nuño & Carlos Thomas

Banco de España

May 27 2015

Motivation: European debt crisis

- Legacy of 2007-9 financial crisis: large fiscal deficits and soaring government debt
- Before summer 2012, sovereign yields rose sharply in EMU periphery (GR, IR, IT, PT, SP) ...
  - ... but not in other highly indebted countries (US, UK, etc.)
- Many argue a key difference is: US-UK can deflate debt away, EMU periphery countries cannot

Motivation: role of monetary policy

- What role, if any, should monetary policy play in guaranteeing sovereign debt sustainability?
- Arguments for and against monetary policy involvement:
  - provide 'monetary backstop' against default fears
  - creating inflation also entails costs
  - effect on inflation expectations (and yields) if low monetary credibility
- **This paper**: analyze trade-offs between price stability and sovereign debt sustainability...
  - ... when gov't cannot make credible commitments

Framework of analysis

- Small open-economy, continuous-time model
- Benevolent government issues *nominal* defaultable debt to foreign investors
- Gov't may default on debt at any time
    - costs of default: exclusion from capital markets + output loss
- Government chooses fiscal (primary deficit) and monetary policy (inflation) under discretion
- Benefits and costs of inflation:
    - debt can be deflated away
    - direct welfare losses

Preview of results

- Calibrate to average peripheral EMU economy
- Analyze two monetary regimes:
  1. *inflationary regime*: benevolent gov't chooses inflation discretionarily
  2. *no inflation regime*: zero inflation at all times
- In (2), government *gives up* option to deflate debt away
  - issue foreign currency debt
  - join monetary union with strong anti-inflation mandate
- **Main result:** Welfare is higher in *no inflation* regime, for any debt ratio and on average

Literature review

- Links between sovereign debt vulnerability and monetary policy
  - Aguiar et al. (2013, 2015), Corsetti and Dedola (2013): self-fulfilling debt crises (à la Calvo,1988; Cole and Kehoe, 2000)
- Optimal fundamental sovereign default in quantitative models
  - Aguiar and Gopinath (2006), Arellano (2008), etc.
- Extend literature on continuous-time models of default to the pricing of defaultable nominal sovereign debt
  - Merton (1974), Leland (1994)

The model: output, prices and debt

- Single consumption good with int'l price = 1. Exogenous output endowment,

$$dY_t = \mu Y_t dt + \sigma Y_t dW_t.$$

The model: output, prices and debt

- Single consumption good with int'l price = 1. Exogenous output endowment,

$$dY_t = \mu Y_t dt + \sigma Y_t dW_t.$$

- Local currency price,

$$dP_t = \pi_t P_t dt.$$

The model: output, prices and debt

- Single consumption good with int'l price = 1. Exogenous output endowment,

$$dY_t = \mu Y_t dt + \sigma Y_t dW_t.$$

- Local currency price,

$$dP_t = \pi_t P_t dt.$$

- Sovereign debt,

$$dB_t = B_t^{new} dt - \lambda dt B_t.$$

λ : amortization rate; fully held by foreign investors

The model: output, prices and debt

- Single consumption good with int'l price = 1. Exogenous output endowment,

$$dY_t = \mu Y_t dt + \sigma Y_t dW_t.$$

- Local currency price,

$$dP_t = \pi_t P_t dt.$$

- Sovereign debt,

$$dB_t = B_t^{new} dt - \lambda dt B_t.$$

λ : amortization rate; fully held by foreign investors

- Government's flow of funds

$$Q_t B_t^{new} = (\lambda + \delta) B_t + P_t (C_t - Y_t).$$

δ : coupon rate

The state variable: debt-to-GDP ratio

- Debt-to-GDP ratio

$$b_t \equiv B_t / (P_t Y_t)$$

The state variable: debt-to-GDP ratio

- Debt-to-GDP ratio

$$b_t \equiv B_t / (P_t Y_t)$$

- Applying Itô's lemma

$$db_t = \left[\left(\overbrace{\frac{\lambda + \delta}{Q_t}}^{r_t \text{ (yield)}} - \lambda + \sigma^2 - \mu - \pi_t \right) b_t + \frac{c_t}{Q_t} \right] dt - \sigma b_t dW_t,$$

where

$$c_t \equiv (C_t - Y_t) / Y_t$$

is *primary deficit ratio*

Preferences

- Household preferences,

$$U_0 = \mathbb{E}_0 \left[\int_0^\infty e^{-\rho t} \left(\log(C_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right].$$

$\psi > 0$: distaste for inflation, reduced-form π-disutility following Aguiar et al. (2013)

Preferences

- Household preferences,

$$U_0 = \mathbb{E}_0 \left[\int_0^{\infty} e^{-\rho t} \left(\log(C_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right].$$

$\psi > 0$: distaste for inflation, reduced-form π-disutility following Aguiar et al. (2013)

- Using $C_t = (1 + c_t) Y_t$,

$$U_0 = \mathbb{E}_0 \left[\int_0^{\infty} e^{-\rho t} \left(\log(1 + c_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right] + V_0^{aut},$$

where $V_0^{aut} = \mathbb{E}_0 \left[\int_0^{\infty} e^{-\rho t} \log(Y_t) dt \right]$ is the (exogenous) autarky value

Fiscal and monetary policy

- At each point in time, choose
  - default or continue repaying debt $\Leftrightarrow$ optimal *default threshold* b^*
  - primary deficit ratio (c_t), inflation rate (π_t)

  under *discretion* (take investor's pricing scheme $Q(b)$ as given)
- First analyze default scenario
- Then lay out general optimization problem

The default scenario

- Default (at a debt ratio b) implies
  - exclusion from capital markets (reenter at rate χ)
  - and contraction in output endowment (in logs, $\epsilon \max\{0, b - \hat{b}\}$)
- At end of exclusion period, gov't reenters markets with debt ratio θb
- Value of defaulting (net of autarky value),

$$V^{def}(b) = -\frac{\epsilon \max\{0, b - \hat{b}\}}{\rho + \chi} + \frac{\chi}{\rho + \chi} V(\theta b).$$

The general problem

- Let $T(b^*)$ be *time-to-default*. Government value function,

$$V(b) = \max_{b^*,\{c_t,\pi_t\}} \mathbb{E}\left\{ \begin{array}{c} \int_0^{T(b^*)} e^{-\rho t}\left(\log(1+c_t) - \frac{\psi}{2}\pi_t^2\right) dt \\ +e^{-\rho T(b^*)} V_{def}(b^*) | b_0 = b \end{array} \right\}$$

subject to b's law of motion, and

$$\begin{aligned} V(b^*) &= V_{def}(b^*), \\ V'(b^*) &= V'_{def}(b^*), \end{aligned}$$

i.e. *value matching* & *smooth pasting* conditions

The 'no inflation' regime

- Consider an alternative scenario where

$$\pi(b) = 0$$

  for all b.
- Government *renounces* the ability to deflate debt away
- Possible interpretations:
    - Issue foreign currency debt
    - Join a monetary union with a strong anti-inflationary stance
    - (Appoint extremely conservative central banker)

International investors (bond pricing)

- Risk-neutral investors can invest elsewhere at riskless real rate $\bar{r}$
- Unit price of the nominal non-contingent bond

$$Q(b)=\mathbb{E}\left[\begin{array}{c}\int_0^{T^*} e^{-(\bar{r}+\lambda)t-\int_0^t \pi_s ds}(\lambda+\delta)\,dt \\ +e^{-\bar{r}(T^*+\tau)-\lambda T^*-\int_0^{T^*}\pi_s ds}\theta\frac{Y_{T^*+\tau}}{Y_{T^*}}Q(\theta b^*)\,|b_0=b\end{array}\right],$$

$T^*\equiv T(b^*)$, with boundary condition

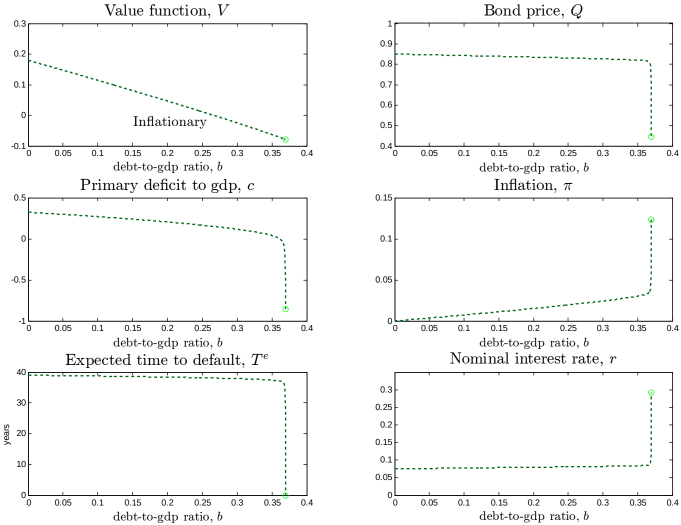
$$Q(b^*)=\mathbb{E}\left[e^{-\bar{r}\tau}\theta\frac{Y_\tau}{Y_0}Q(\theta b^*)\right]=\frac{\chi}{\bar{r}+\chi-\mu}\theta Q(\theta b^*).$$

Calibration

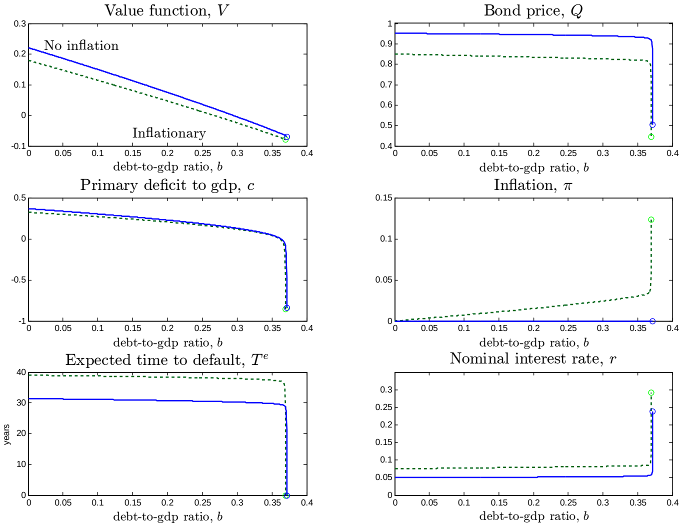
- Calibrate to the average peripheral EMU economy, time unit = 1 year

Parameter	Value	Description	Source/Target
$\bar{r}$	0.04	world real interest rate	standard
ρ	0.20	subjective discount rate	standard
μ	0.022	drift output growth	average growth EMU periphery
σ	0.032	diffusion output growth	growth volatility EMU periphery
λ	0.16	bond amortization rate	Macaulay duration = 5 years
δ	0.04	bond coupon rate	price of riskless real bond = 1
χ	0.33	reentry rate	mean duration of exclusion = 3 years
θ	0.56	recovery rate parameter	mean recovery rate = 60%
ϵ	1.50	default cost parameter	output loss during exclusion = 6%
$\hat{b}$	0.332	default cost parameter	average external debt/GDP ratio (35.6%)
ψ	9.15	inflation disutility parameter	mean inflation rate (1987-1997) = 3.2%

Equilibrium: inflationary regime

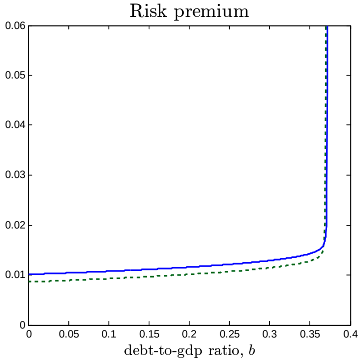


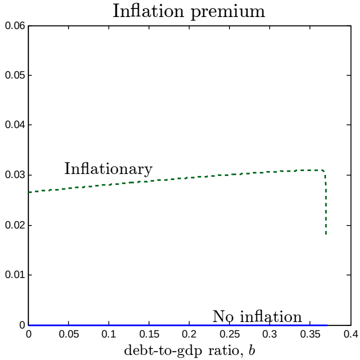
Equilibrium: inflationary vs no-inflation regime



Risk premia & inflation premia

- Nominal bond yield $r(b)$ can be decompose as *risk premium* $+$ *inflation premium*



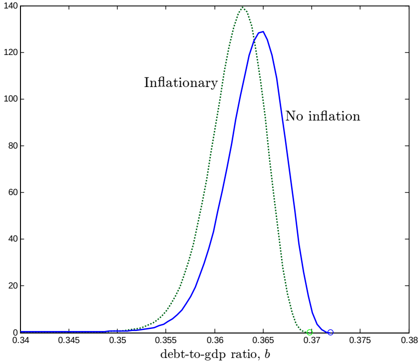


Average performance

- Inflationary regime yields lower value function $V(b)$ at any debt ratio, but...
- ... If it delivers sufficiently lower debt ratio most of the time, *average* welfare could be higher
- Compute stationary debt distribution so as to calculate unconditional average values

Stationary debt distribution

- Inflationary regime shifts distribution to the left (debt deflation)...



Average performance (cont'd)

- … but not enough to make inflationary policy better on average

	Data	Model	
	1995-2012	No inflation	Inflationary
debt-to-GDP, b (%)	35.6	35.6	35.6
primary deficit ratio, c (%)	-4.1	-0.01	-0.12
inflation, π (%)	0.4	0	3.20
bond yields (net of $\bar{r}$), $r-\bar{r}$ (bp)	187	154	448
risk premium, $r-\tilde{r}$ (bp)	154	154	139
inflation premium, , $\tilde{r}-\bar{r}$ (bp)	33	0	309
Exp. time to default, T^e (years)	-	29.4	37.1
Welfare loss, $V-V_{\pi=0}$ (% cons.)	-	0	**-0.25**

- Again, ↑ in mean risk premia dominated by ↓ in mean inflation premia & direct utility costs

Robustness

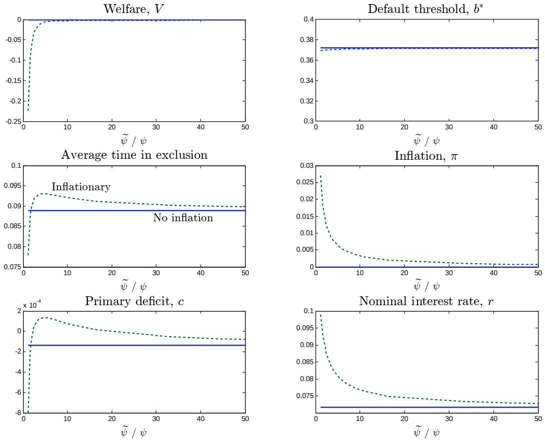
- Investigate robustness to alternative calibrations of:
  - bond amortization rate (λ)
  - bond recovery parameter (θ)
  - output loss from default ($\hat{b}$)
- For all parameter values, we continue to find higher average welfare in no-inflation regime

Monetary policy delegation

- 'No inflation' regime equivalent to appointing an extremely conservative central banker
- Consider intermediate arrangement: appoint a central banker...
  - who dislikes inflation more than society...
  - ... but not so much as to set $\pi = 0$ at all times
- Given government's $c(b)$ and b^*, central banker chooses π ...
- to maximize its value function $\tilde{V}$, defined similarly to V, but with $\tilde{\psi} \geq \psi$

Monetary policy delegation: results

- Average welfare increases monotonically with $\tilde{\psi}/\psi$ but *never* reaches $\mathbb{E}\left(V_{\pi=0}\right)$



Conclusions

- Analyzed trade-offs between price stability and sovereign debt sustainability...
  - ... in an open-economy model with nominal debt and optimal default
- Welfare is higher if gov't renounces the option to deflate debt away, e.g. by
  - issuing foreign currency debt
  - joining an anti-inflationary monetary union
- Intuition: benefits (lower inflation premia, no direct welfare costs) outweigh costs (higher risk premia)

Appendix: Robustness

	Welfare	Time to default	Inflation	Risk premium	Inflation premium
	% cons.	years	%	bp	bp
Benchmark					
No inflation	0	29.4	0	317	0
Inflationary	-0.25	37.1	2.97	298	299
Difference	*0.25*	*-7.7*	*-2.97*	*19*	*-299*
Duration = 3					
No inflation	0.1	40.4	0	311	0
Inflationary	-0.36	47.4	3.28	304	331
Difference	*0.35*	*-7.0*	*3.28*	*7*	*-331*
Duration = 7					
No inflation	0.0	26.0	0	309	0
Inflationary	-0.17	34.7	2.75	278	278
Difference	*0.17*	*-8.7*	*-2.75*	*31*	*-278*
Recovery rate = 50%					
No inflation	-0.08	30.7	0	401	0
Inflationary	-0.33	38.5	3.00	373	302
Difference	*0.25*	*-7.8*	*-3.00*	*28*	*-302*
Recovery rate = 70%					
No inflation	0.09	28.3	0	246	0
Inflationary	-0.20	35.8	2.94	236	297
Difference	*0.29*	*-7.5*	*-2.94*	*10*	*-297*
Default costs = 3.5%					
No inflation	0.43	29.7	0	318	0
Inflationary	0.33	34.6	1.87	304	189
Difference	*0.10*	*-4.9*	*-1.87*	*14*	*-189*
Default costs = 7%					
No inflation	-0.22	29.6	0	314	0
Inflationary	-0.59	38.7	3.50	293	353
Difference	*0.37*	*-9.1*	*-3.50*	*21*	*-353*