The Eurozone Debt Crisis: A New-Keynesian DSGE model with default risk

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Motivation

- Eurozone (EZ) debt crisis does not fit well the literature on sovereign debt models
- Greece:
    - Unexpected shock on 2009 public deficit (final figure: 15.2% GDP)
    - Then, painful and long reduction of deficit (via fiscal austerity)
    - Standard models assume that deficit is a control variable
- Ireland:
    - Debt soared because of contingent liabilities in relation to banking sector
    - Large shock to debt-to-GDP ratio, unrelated to deficit (Ireland was fulfilling all Maastricht criteria before the financial crisis)
    - Standard models assume rather smooth process for GDP

Our modelling strategy

- Habit consumption (for making adjustment painful)
- Discontinuous stochastic process for GDP
- Incorporate standard NK features
- Small open economy framework, in 2 flavors:
  - flexible exchange regime
  - monetary union

Outline

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Main features

- Small open economy
- Optimizing households who consume, supply labor and invest in physical capital
- Firms produce using labor and capital
- Nominal rigidities: good prices, wages
- Real rigidities: habit consumption, investment cost
- Fiscal authority with debt rule
- Government debt held both domestically and abroad
- Two model flavors:
  - flexible exchange rate (independant monetary policy)
  - monetary union (nominal interest rate determined abroad)

Modelling sovereign default

- The fiscal authority can default on external part of its debt
- In case of default, two costs: GDP loss, financial autarky
- Optimal decision by comparing two value functions
- Technical problem: dimensionality of the problem
- Our (imperfect) solution: satellite model
  - In normal times, agents do not internalize the possibility of a future default (in particular, no endogenous risk premium)
  - But allows us to compute default probabilities on simulated paths

Households

- Program for household ι:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U_t^\iota$$

where:

$$u^\iota(C_t^\iota, H_t, L_t^\iota) = \log(C_t^\iota - H_t) - \varphi \frac{(L_t^\iota)^{1+\sigma_L}}{1+\sigma_L}$$

with $H_t = h\, C_{t-1}$

- Budget constraint:

$$B_t^\iota + C_t^\iota = \frac{R_{t-1} + \Delta_{t-1}}{\pi_t} B_{t-1}^\iota + Y_t^\iota - I_t^\iota - \tau_t C_t^\iota$$

$$Y_t^\iota = w_t^\iota L_t^\iota + A_t^\iota + (r_t^k z_t^\iota - \psi(z_t^\iota))K_{t-1}^\iota + Div_t^\iota$$

Euler equation

Symmetric across households

$$\mathbb{E}_t \left[\beta \frac{C_t - H_t}{C_{t+1} - H_{t+1}} \frac{1 - \tau_t}{1 - \tau_{t+1}} \frac{R_t + \Delta_t}{\pi_{t+1}} \right] = 1$$

where Δ_t is risk premium.

Labor market

- Differentiated labor varieties
- Standard Calvo pricing
- Indexation of non-reoptimized wages on inflation
- State contingent Arrow-Debreu securities shield against idiosyncratic labor income shock

Capital accumulation

$$K_t = (1-\delta)K_{t-1} + \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t$$

where $S\left(\frac{I_t}{I_{t-1}}\right) = \frac{\kappa_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2$

$$\begin{aligned}
\mathbb{E}_t\left[\frac{1}{\beta}\left(\frac{C_{t+1} - H_{t+1}}{C_t - H_t}\frac{1-\tau_{t+1}}{1-\tau_t}\right)\right] q_t &= q_{t+1}(1-\delta) + z_{t+1} r^k_{t+1} - \psi(z_{t+1}) \\
q_t\left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] - 1 &+ \beta\mathbb{E}_t q_{t+1}\left(\frac{C_t - H_t}{C_{t+1} - H_{t+1}}\frac{1-\tau_t}{1-\tau_{t+1}}\right) \\
&= q_t S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}} \\
r^k_t &= \psi'(z_t)
\end{aligned}$$

Production

- Final good firms:

$$Y_t = \left(\int_0^1 y_{j,t}^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

- Intermediate good firms:

$$y_{j,t} = A_t (z_t K_{j,t-1})^{\alpha_K} M_t^{\alpha_M} L_{jt}^{1-\alpha_K-\alpha_M}$$

with standard Calvo pricing

Fiscal policy

- Budget constraint:

$$B_t + D_t + \tau_t C_t = \frac{R_{t-1} + \Delta_{t-1}}{\pi_t} B_{t-1} + \frac{R^*_{t-1} + \Delta_{t-1}}{\pi_t} \frac{E_t}{E_{t-1}} D_{t-1} + G_t$$

- Fiscal rule:

$$\tau_t C_t - G_t - Int_t = \alpha_B \left(B_{t-1} + \frac{E_t}{E_{t-1}} D_{t-1} - \overline{BD}_t \right)$$

where

$$Int_t = \left(\frac{R_{t-1} + \Delta_{t-1}}{\pi_t} - 1 \right) B_{t-1} + \left(\frac{R^*_{t-1} + \Delta_{t-1}}{\pi_t} - 1 \right) \frac{E_t}{E_{t-1}} D_{t-1}$$

External sector

- Exports:

$$X_t = \varepsilon_t^{\psi} Y_t^*$$

- Balance of payments equilibrium:

$$D_t = \frac{R_{t-1}^* + \Delta_{t-1}}{\pi_t} \frac{E_t}{E_{t-1}} D_{t-1} + \varepsilon_t M_t - X_t$$

Monetary policy and exchange rate

Flexible exchange rate (FLEX)

- Taylor rule:

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_\pi} \left(\frac{\pi_t}{\bar{\pi}}\right)^{r_\pi(1-\rho_\pi)}$$

- UIP:

$$R_t + \Delta_t = \mathbb{E}_t\left(R_t^* \frac{E_{t+1}}{E_t}\right) + \vartheta\left(e^{(D_t-\bar{D})} - 1\right)$$

- Risk premium:

$$\Delta_t = 0$$

Monetary policy and exchange rate

Monetary union (EMU)

- No autonomous monetary policy:

$$R_t = R_t^*$$

- Real exchange rate:

$$\frac{E_t}{E_{t-1}} = \frac{\pi_t^*}{\pi_t}$$

- Risk premium (computed on external part of debt):

$$\Delta_t = \psi_{RP} \left(e^{D_t - \bar{D}} - 1 \right)$$

Satellite default model

- After a default, proportional cost on GDP:

$$Y_t^d = (1 - \lambda_Q) Y_t$$

- Government budget constraint becomes:

$$B_t + T_t = \frac{R_{t-1} + \Delta_{t-1}}{\pi_t} B_{t-1} + G_t$$

- Other equations remain essentially the same
- This defines a default value function J^d
- Default threshold: D such that $J^d = J^r$ (given other state variables)
- Default occurs when $J^d > J^r$ (given the state variables)
- Simulation of 10,000 points for computing default probability
- Simplification: possibility of default not anticipated by agents

Outline

Calibration (selected parameters)

For a small country within the Euro area. Standard values for most parameters.

Parameter	Symbol	Value
Consumption habit	h	0.85
Discount factor	β	0.995
Total debt target	$\overline{BD}_t$	$2.4Y_t$
Back to equilibrium debt targets (fiscal rule)	α_B	1/80
Risk premium in UIP (only FLEX)	ϑ	0.001
Risk premium on debt (only EMU) Δ_t	ψ_{RP}	0.008
External debt target	$\overline{D}$	$0.3\bar{Y}$
Loss of output in autarky in the FLEX model (% of GDP)	λ_Q	0.03
Loss of output in autarky in the EMU model (% of GDP)	λ_Q	0.04

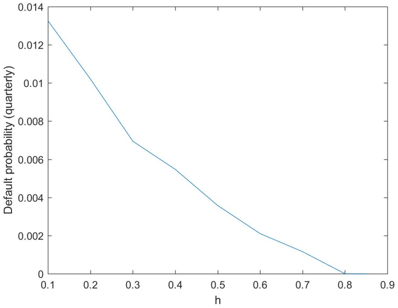
Default probabilities and debt thresholds

		Default probability	Mean external debt	Default threshold
Baseline	FLEX	0%	7.5%	60%
$(\bar{D} = 0.3\bar{Y})$	EMU	0.5%	7.5%	128%
$\bar{D} = 0.8\bar{Y}$	FLEX	0.5%	20%	60%
	EMU	2.2%	20%	117%

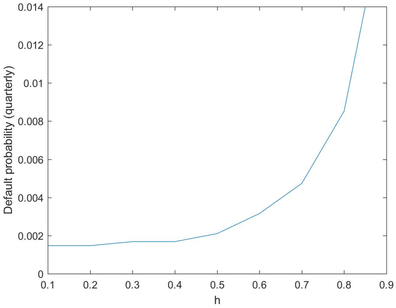
Outline

Sensitivity to habit consumption (h)

Baseline calibration ($\bar{D} = 0.3\bar{Y}$)



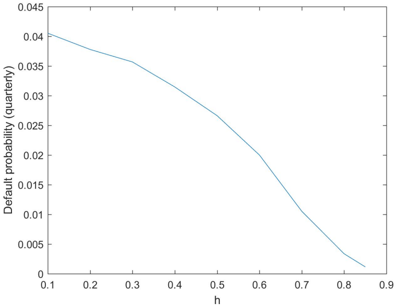
FLEX model



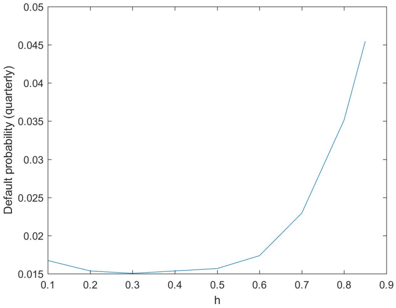
EMU model

Sensitivity to habit consumption (h)

Medium external debt ($\bar{D} = 0.8\bar{Y}$)

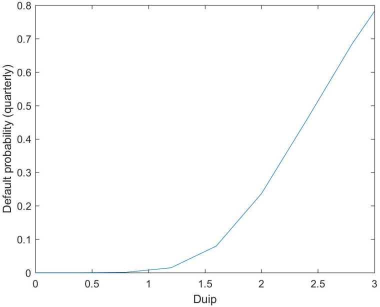


FLEX model

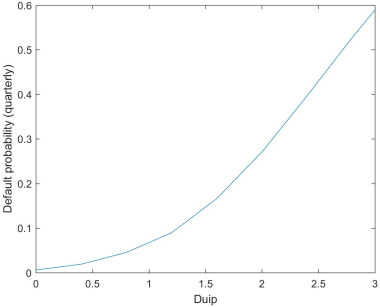


EMU model

Sensitivity to external debt target ($\bar{D}$)

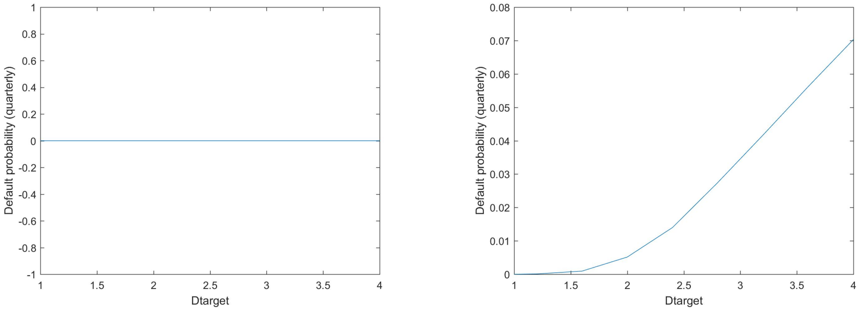


FLEX model



EMU model

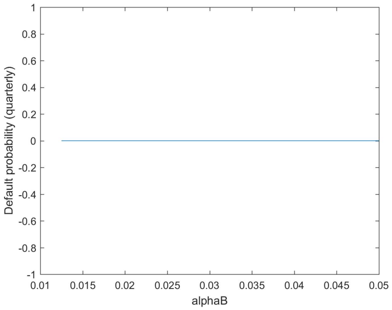
Sensitivity to total debt target ($\overline{BD}$)



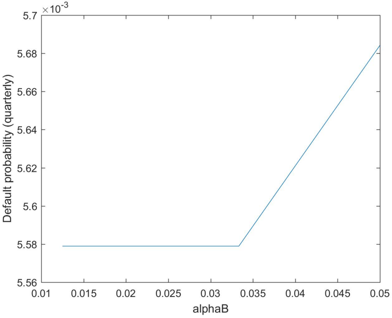
FLEX model

EMU model

Sensitivity to speed of convergence (α_B)



FLEX model



EMU model

Outline

Main preliminary results

- Critical differences between flexible regime and monetary union
- Default thresholds larger in flexible economy...
- ...but thresholds more likely to be reached in monetary union
- Fast speed of convergence increases defaults in flexible regime, diminishes them in monetary union
- In EMU, external debt plays a critical role for stabilization...
- ...as a consequence, debt more volatile and default risks are more important

Future work

- Incorporate possibility of redemption after default
- Analyze impact of a discrete shock on debt-to-GDP ratio
- Allow default on total debt (and not just external debt)
- Handle (some) nonlinearities