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 fiscal adjustment
  - Unexpected shock on 2009 public deficit (final figure: 15.2% GDP)
  - Then, painful and long reduction of deficit (via austerity)
  - Standard models assume that deficit is a control variable
- Greece and the EMU
  - Tsipras wanted to stay in the euro area
  - Schäuble wanted a grexit
  - One would have expected the reverse... How can we understand that?

Research questions

- How default risk in a monetary union differs from a small open economy usually described in default literature?
- Are policy instruments (*e.g.* fiscal compact) useful for reducing default risk?

Our modelling strategy

- New way of bridging the gap between NK DSGE models and sovereign default models
- Consumption habit (for making adjustment painful)
- Small open economy framework, in 3 flavors:
  - flexible exchange rate regime
  - monetary union, but back in flexible exchange rate regime after default
  - monetary union, and no exit after default

Outline

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: consumption habit, investment cost
- Fiscal authority with debt rule
- Government debt held both domestically and abroad
- Three model flavors:

FLEX	flexible exchange rate (independant monetary policy)
GREXIT	monetary union, but back to flexible exchange rate regime after default
EMU	monetary union, even after default

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
  - 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 i:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U_t^i(C_t^i, H_t, L_t^i)$$

where:

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

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

- Budget constraint:

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

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

Euler equation

Symmetric across households

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

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 (only among domestic households)

Capital accumulation

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

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

$$\begin{aligned}
\mathbb{E}_t\left[\frac{1}{\beta}\left(\frac{C_{t+1}-H_{t+1}}{C_t - H_t}\right)\right] q_t &= q_{t+1}(1-\delta) + z_{t+1} r^k_{t+1} - \psi(z_{t+1}) && (1)\\
q_t\left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] - 1 &+ \beta\mathbb{E}_t q_{t+1}\left(\frac{C_t - H_t}{C_{t+1}-H_{t+1}}\right) S'\left(\frac{I_{t+1}}{I_t}\right)\frac{I^2_{t+1}}{I^2_t} \\
&= q_t S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}} && (2)\\
r^k_t &= \psi'(z_t) && (3)
\end{aligned}$$

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:

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

- 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:

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

- Real exchange rate:

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

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 and GREXIT)

- No autonomous monetary policy:

$$R_t = R_t^*$$

- Real exchange rate:

$$\frac{\varepsilon_t}{\varepsilon_{t-1}} = \frac{\pi_t^*}{\pi_t}$$

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

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

- When the country defaults ($D_t = 0$), regains its monetary independance

Satellite default model

- After a default, proportional cost on GDP:

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

- Government budget constraint becomes:

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

- Financial autarky:
  - $D = 0$
  - no UIP in flexible regime
- Balance of payment becomes:

$$\varepsilon_t M_t = X_t$$

Exchange rate and monetary regimes after default

- FLEX case: no change after default (flexible exchange rate, independent monetary policy)
- GREXIT case: back to flexible exchange rate after default (hence independent monetary policy)
- EMU case:
  - Remain in monetary union after default
    $\Rightarrow$ adjustment through exchange rate not possible
  - And financial autarky
    $\Rightarrow$ adjustement through external debt no more possible
  - Something has to give in
    $\Rightarrow$ we assume adjustment through nominal interest rate (not fixed by ECB because of autarky, but neither freely adjustable through Taylor rule)
  - Other possibility (not explored):
    adjustment through debt (drop fiscal rule)

Computing default risk

- Core model (resp. satellite model) defines value function J^r (resp. 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
- Currently, simulated paths using 2^{nd} order approximation, but value functions computed at 1^{st} order

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 Δ_t (only EMU and GREXIT)	ψ_{RP}	0.008
External debt target	$\overline{D}$	$0.3\bar{Y}$
Loss of output in autarky after default (% of GDP)	λ_Q	0.03

Default probabilities and debt thresholds

		Default probability	Default threshold (at SS)
Baseline	FLEX	0.1%	223%
	GREXIT	0.0%	369%
	EMU	0.3%	366%
$\beta = 0.99$	FLEX	4.1%	111%
	GREXIT	1.4%	189%
	EMU	5.4%	191%

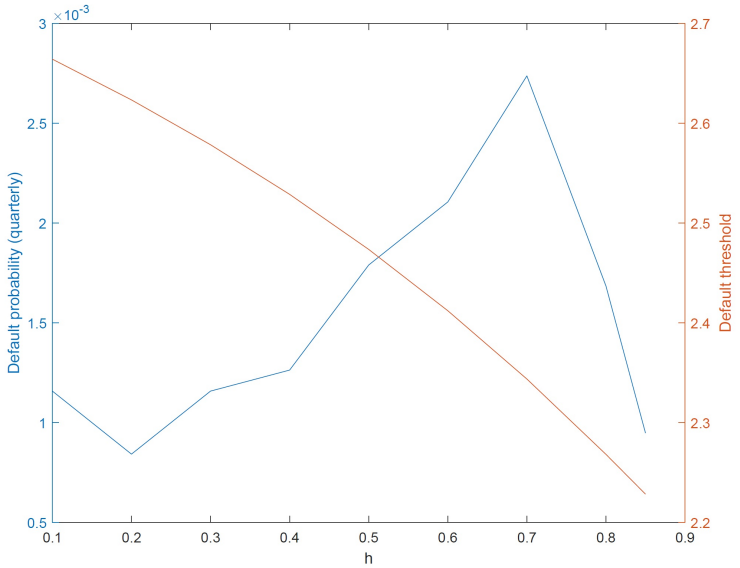
Quarterly frequency

- FLEX: default not very costly but debt not so useful for stabilization $\Rightarrow$ a few defaults
- GREXIT: debt useful but default very costly $\Rightarrow$ no default
- EMU: debt useful and default not very costly (stability brought by the fixed regime kept) $\Rightarrow$ defaults more frequent
- The "Schäuble theory": rather GREXIT than EMU model!

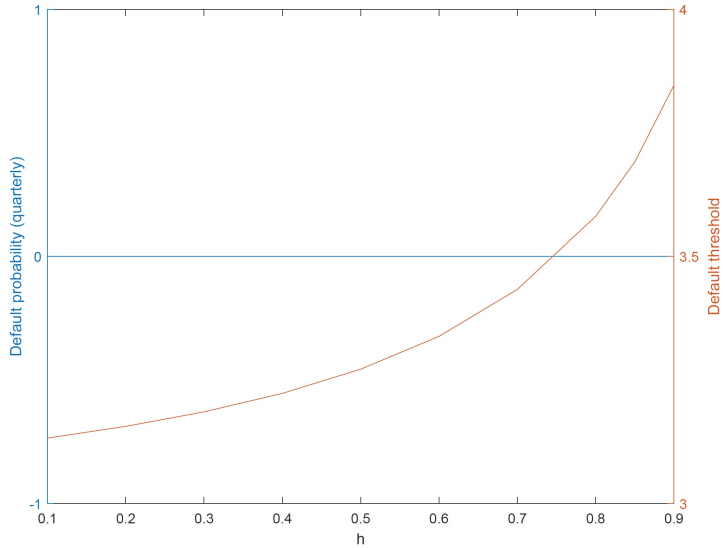
Sensitivity to consumption habit (h)

Default probabilities and debt thresholds on baseline calibration

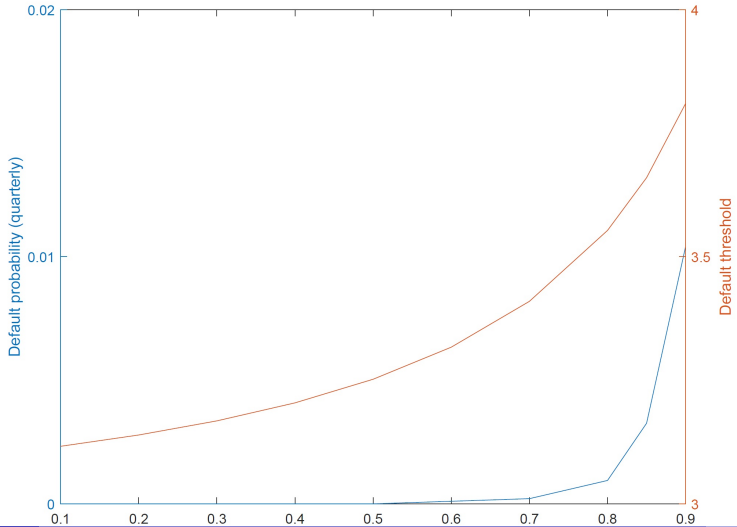
FLEX



GREXIT



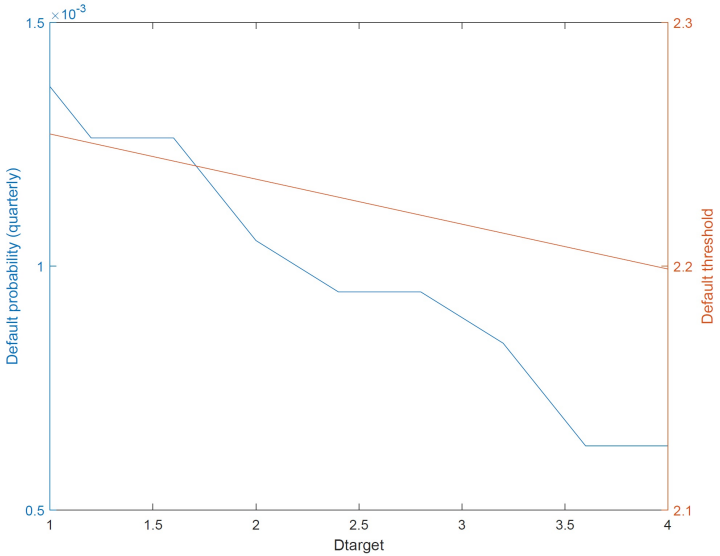
EMU



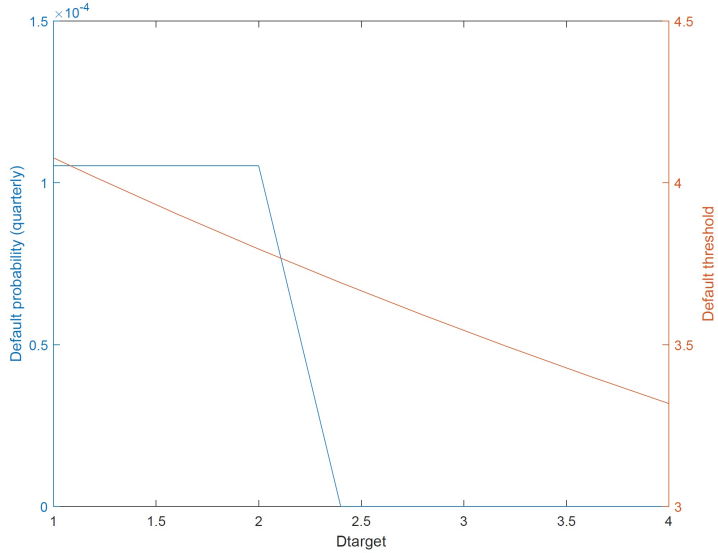
Sensitivity to total debt target ($\overline{BD}$)

Default probabilities and debt thresholds on baseline calibration

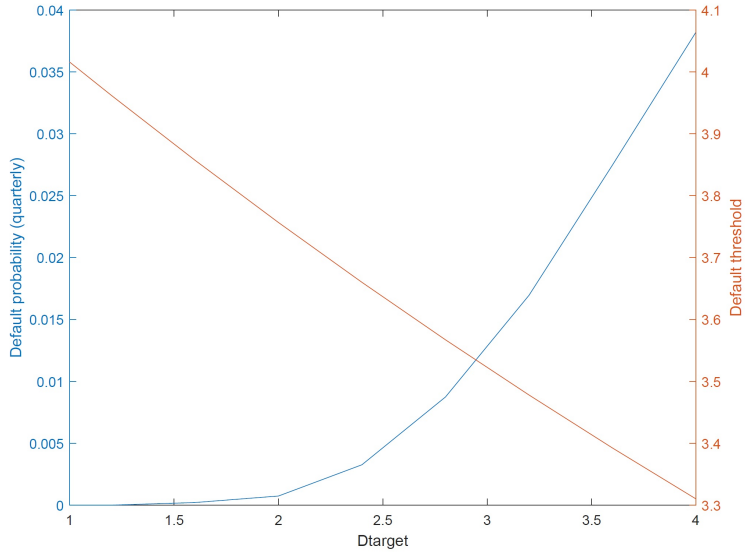
FLEX



GREXIT



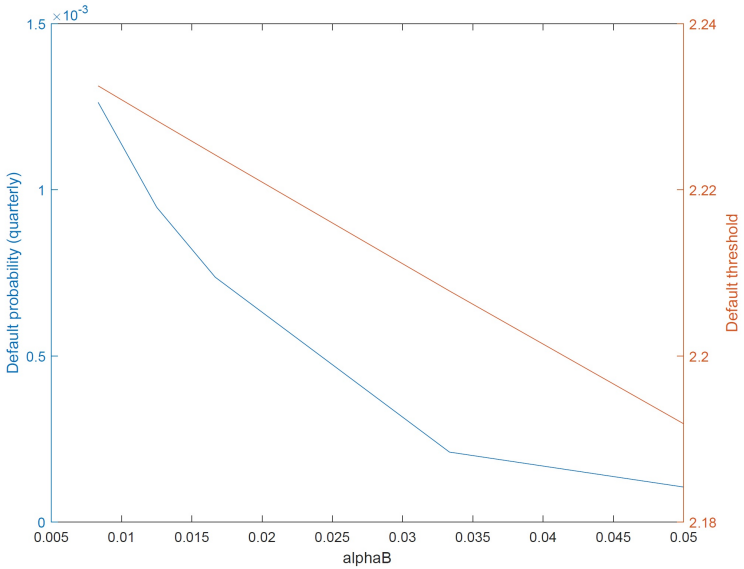
EMU



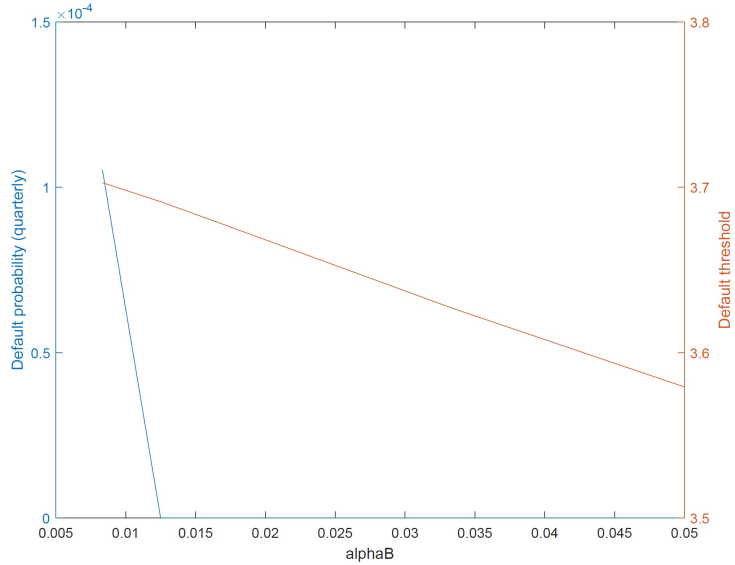
Sensitivity to speed of convergence (α_B)

Default probabilities and debt thresholds on baseline calibration

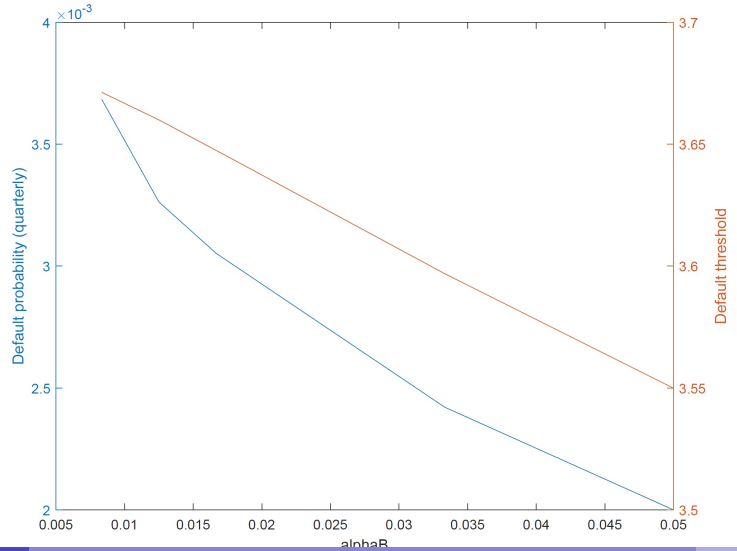
FLEX



GREXIT



EMU



Preliminary conclusions

- Critical differences between the three regimes
- In EMU, external debt plays a critical role for stabilization...
- ...as a consequence, debt more volatile and default risks are more important
- ...unless default triggers an exit $\Rightarrow$ the "Schäuble theory"
- Key role of consumption habit parameter: makes adjustment painful after large GDP shock, but also both consumption and debt less volatile
- Increasing public debt target $\Rightarrow$ increases risk in EMU but not in FLEX or GREXIT
- Faster speed of fiscal convergence decreases risk in all cases

Future work

In progress

- Analyze impact of a discrete shock on debt-to-GDP ratio and on current account (Ireland vs. Greece)
- Nominal wage ridigity: incorporate a backward looking price indexation
- Hand-to-mouth consumers (ricardian and non-ricardian responses to default)
- Solve value functions at full 2^{nd} order
- Solve the model in deterministic perfect foresight (non-linearities, endogenous default)

Extensions

- Incorporate possibility of redemption after default
- Allow default on total debt (and not just external debt)