Schäuble versus Tsipras: a New-Keynesian DSGE Model with Default Risk for the Eurozone Debt Crisis

Mathilde Viennot[1]
(Paris School of Economics)

[1] Co-authored with Daniel Cohen (PSE, CEPR) and Sébastien Villemot (OFCE)

SUERF / BAFFI CAREFIN Centre Conference
New Challenges in Central Banking: Monetary Policy Governance and Macroprudential Issues
June 8th, 2017

Motivation

- Greece fiscal adjustment
  - Unexpected shock on 2009 public deficit (final figure: 15.2% GDP)
  - Then, painful and long reduction of deficit (via austerity)

  $\Rightarrow$ Was it the right thing to do?
- Greece and the EMU
  - Tsipras wanted to stay in the Euro area
  - Schäuble wanted a Grexit

  $\Rightarrow$ Who is right?

Research questions / Contribution

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 contribution

- New way of bridging the gap between NK DSGE models and sovereign default models
- Analyze the role of consumption habit (making adjustment painful)
- We analyze a small open economy framework in three regimes:
  - F flexible exchange rate regime (F for flexible)
  - S monetary union, but back in flexible exchange rate regime after default (S for Schäuble)
  - T monetary union, and no exit after default (T for Tsipras)

Literature

Eurozone (EZ) debt crisis does not fit well the literature on sovereign debt models

- **New-Keynesian DSGE**: Smets and Wouters (2003); Calvo (1983), Gali et. al (2007); Schmitt-Grohé and Uribe (2013)
- **Default models**: Aguiar and Gopinath (2006); Arellano (2008); Carré, Cohen and Villemot (2015); Mendoza and Yue (2012); Eichengreen, Hausmann and Panizza (2003); Tsomacos and Martinez Sepulveda (2015)
- **Small open economy vs. monetary union**: Schmitt-Grohé and Uribe (2003); Kriwoluzky, Muller and Wolf (2014); Na, Schmitt-Grohé, Uribe and Yue (2014); Aguiar, Amador, Farhi and Gopinath (2015)

Main preliminary results

+ Fixed change is preferred rather than flexible because there's a noise on the exchange rate the central bank cannot control. It's even more the case after a default.
+ In a monetary union, external debt plays a critical role for stabilization
+ Key role of consumption habit parameter: makes adjustment painful after large GDP shock, but also a shock more persistent.

Schäuble theorem

In a monetary union and if habit formation is sufficiently high, if you give a country the choice between (i) default and leave the zone and (ii) default and stay in the union, it will always choose (ii), default and stay. This result is reversed in case of low habit persistence.

Policy issues:

- Decreasing public debt target does decrease default risk but only in the T regime.
- Faster speed of fiscal convergence decreases risk only if the degree of real rigidity is low (which is not the case in the EZ)

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

Modelling sovereign default

- The fiscal authority can default on external part of its debt (legal reasons, Greece: 21% of total debt)
- In case of default, two costs: GDP loss, financial autarky (forever after)
- Optimal decision by comparing two value functions
- Technical problem: dimensionality of the problem

$\Rightarrow$ construct a satellite model of a post-default small open economy in the F, S and T regimes

  - 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 (F regime)

- 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 (S and T regimes)

- 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, $D_t = 0$.

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

- Flexible case (F): no change after default (flexible exchange rate, independent monetary policy)
- Schäuble case (S): back to flexible exchange rate after default (hence independent monetary policy)
- Tsipras case (T):
  - Remain in monetary union after default
    $\Rightarrow$ adjustment through exchange rate not possible
  - And financial autarky
    $\Rightarrow$ adjustment 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 prices (dropping fiscal rule)

Welfare comparisons and moments of simulated variables

1. Core model

	Welfare	External debt	Consumption	Output
Flexible regime	$J_r = -800.2$	$\bar{D} = 0.23$ $\sigma(D) = 0.75$	$\bar{C} = 0.19$ $\sigma(C) = 0.25$	$\bar{Y} = 2.70$ $\sigma(Y) = 1.93$
Monetary union	$J_r = -799.6$	$\bar{D} = 0.23$ $\sigma(D) = 0.61$	$\bar{C} = 0.19$ $\sigma(C) = 0.25$	$\bar{Y} = 2.70$ $\sigma(Y) = 1.89$

2. Satellite model

	Welfare	External debt	Consumption	Output
Flexible regime	$J_d = -838.7$	$\bar{D} = 0$ $\sigma(D) = 0$	$\bar{C} = 0.18$ $\sigma(C) = 0.24$	$\bar{Y} = 2.66$ $\sigma(Y) = 2.73$
Monetary union	$J_d = -810.5$	$\bar{D} = 0$ $\sigma(D) = 0$	$\bar{C} = 0.19$ $\sigma(C) = 1.39$	$\bar{Y} = 2.63$ $\sigma(Y) = 0.60$

$\Rightarrow$ Fixed change is preferred rather than flexible because there's a noise on the exchange rate the central bank cannot control. It's even more the case after a default.

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 and value functions computed at 1^{st} order approximation

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	$\overline{BD}_t$	$2.4\,Y_t$
Back to equilibrium debt targets (fiscal rule)	α_B	1/80
External debt target	$\overline{D}$	$0.3\,\bar{Y}$
Steady-state inflation (target)	$\bar{\pi}$	1.0005
Steady-state gross nominal interest rate	$\bar{R}$	$\frac{\bar{\pi}}{\beta} \simeq 1.01$
Risk premium in UIP (only for F regime)	ϑ	0.001
Risk premium on debt Δ_t (only in monetary union)	ψ_{RP}	0.008
Loss of output in autarky after default (% of GDP)	λ_Q	0.03

Quarterly frequency

Default probabilities and debt thresholds

		Default probability	Default threshold (at SS)
Baseline	Flexible regime	0.05%	223%
	Schäuble regime	0.0%	369%
	Tsipras regime	0.72%	366%

Quarterly frequency

- F regime: default not very costly but debt not so useful for stabilization $\Rightarrow$ a few defaults
- S regime: debt useful but default very costly $\Rightarrow$ no default
- T regime: debt useful and default not very costly (stability brought by the fixed regime kept) $\Rightarrow$ defaults more frequent

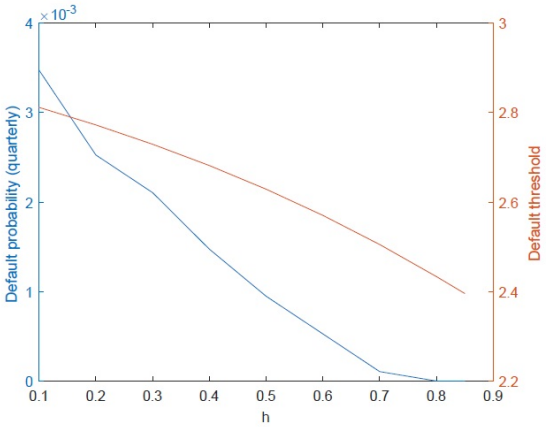
Schäuble theorem

In a monetary union, if you give a country the choice between (i) default and leave the zone and (ii) default and stay in the union, it will always choose (ii), default and stay.

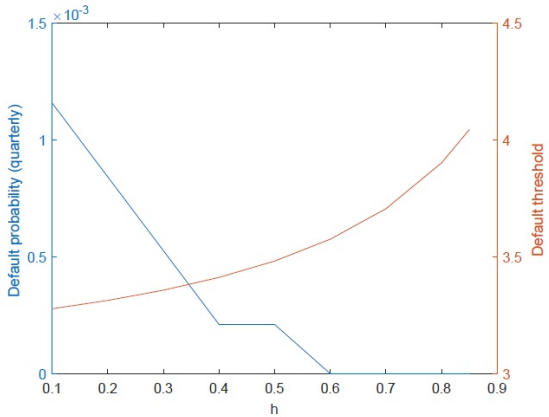
Sensitivity to consumption habit (h)

Default probabilities and debt thresholds on baseline calibration

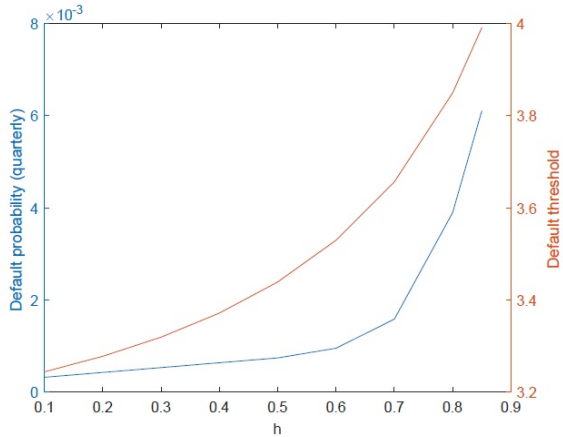
Flexible



Schäuble



Tsipras



- Remarkable influence on default risk and debt thresholds
  - F: $h \nearrow \Rightarrow$ lower default threshold and default probability
  - T: the opposite, $h \nearrow \Rightarrow$ higher default threshold and default probability
  - S: $h \nearrow \Rightarrow$ higher debt threshold and lower default probability

Sensitivity to consumption habit (h)

Default probabilities and debt thresholds on baseline calibration

- As h $\nearrow$, volatility of consumption $\searrow$, and two opposite forces operate
  - the debt needed to stabilize consumption is reduced (F regime)
  - the debt needed to stabilize consumption in response to a large negative GDP shock rises (monetary union)

1. Flexible: debt is not useful as h rises, so I do not care for it and default probability falls
2. Schäuble: I absolutely do not want to leave the zone (see welfares). Risk of default declines and sustainable debt becomes higher as the cost of default rises
3. Tsipras: I do need debt to stabilize my economy as h rises, so debt ceiling rises and my default probability also rises mechanically (as default is less costly than if I had to leave the zone)

Habit persistence and model choice (1)

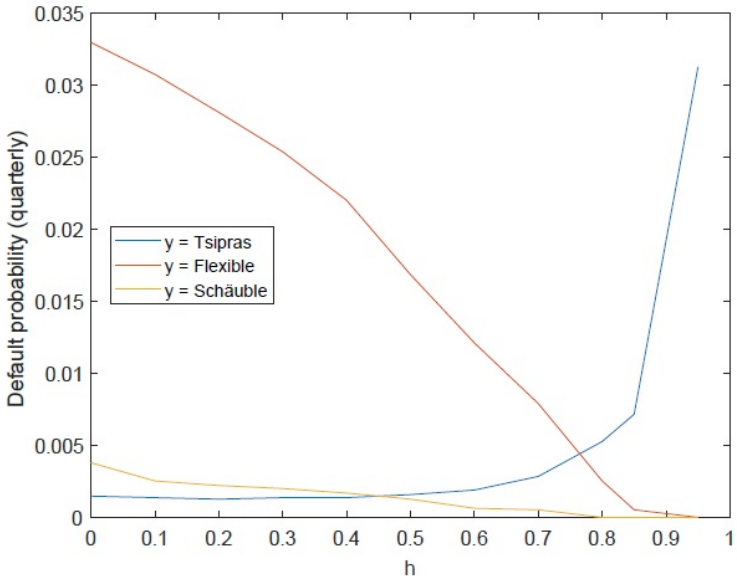
- Habit consumption makes wealth cut by hW_{-1} which gives little/no leeway when h rises.
- In the EZ after a default, you do not need this leeway to adjust in case of a GDP shock, since stability prevents you from adverse shocks. Whereas after a default in a flexible regime, you want degrees of freedom

  $\Rightarrow$ if h is small, you have enough leeway to go out of the zone and regain your monetary independence: you will prefer Schäuble rather than Tsipras.
- Moreover, high habit consumption lags your shock even more (making it more persistent)

  $\longrightarrow$ If h is small, the shock is more violent for agents, so the country will prefer to default and get out of the zone in order to regain monetary tools

  $\longrightarrow$ If h is large, the shock is smoothed and I prefer the stability of the zone rather than getting out

Habit persistence and model choice (2)



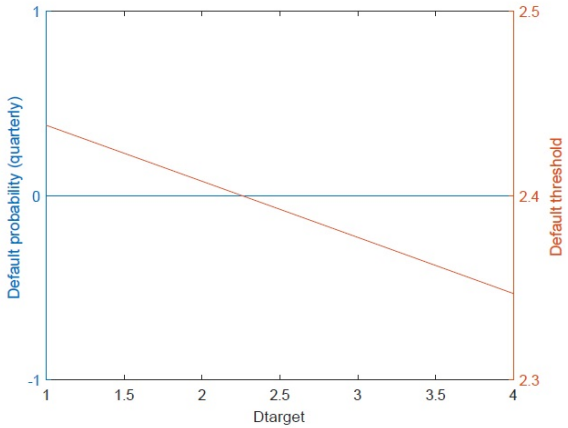
Modified Schäuble theorem

In a monetary union and if habit formation is sufficiently high ($h > 0.45$), if you give a country the choice between (i) default and leave the zone and (ii) default and stay in the union, it will always choose (ii), default and stay. This results is reversed in case of low habit persistence ($h < 0.45$).

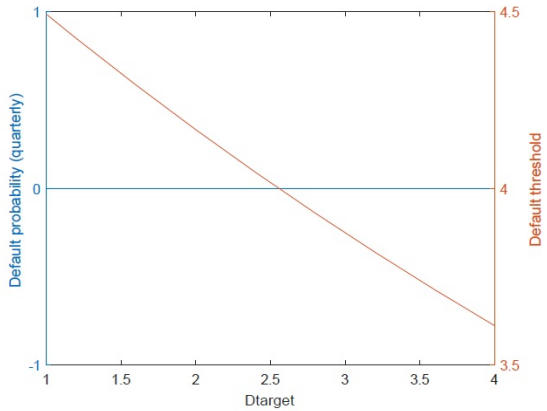
Sensitivity to total debt target ($\overline{BD}$)

Default probabilities and debt thresholds on baseline calibration

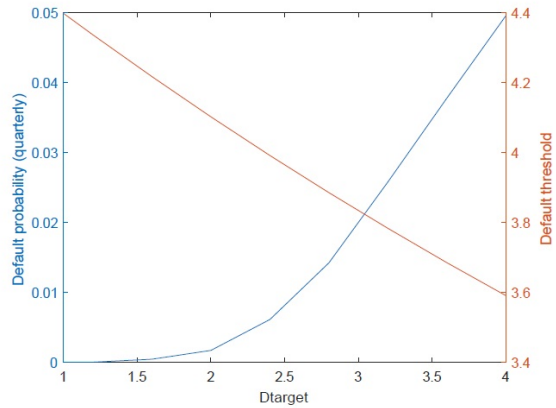
Flexible



Schäuble



Tsipras



- Qualitative opposition between the three regimes
  - No effect on default risk for F and S regimes
  - For T case, same intuition as before: with a large habit parameter (0.85), the EZ country is more likely to default to regain its monetary policy instrument. The larger the debt ceiling, the more likely it will choose to do so

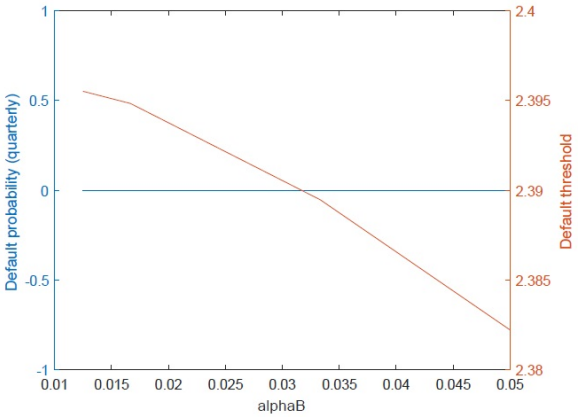
$\Rightarrow$ in a T regime, decreasing the debt target reduces default probability

$\Rightarrow$ in a F or S regime, decreasing the debt target is not an efficient policy to reduce default risk

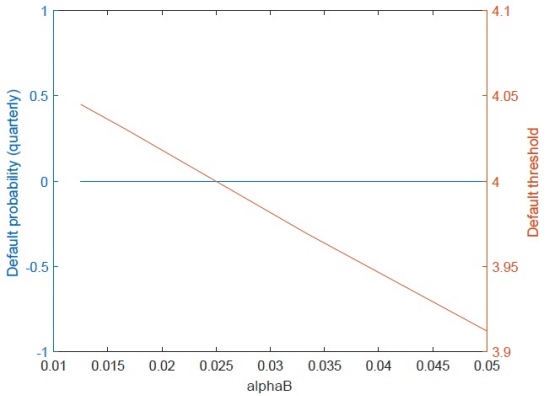
Sensitivity to speed of convergence (α_B)

Default probabilities and debt thresholds on baseline calibration

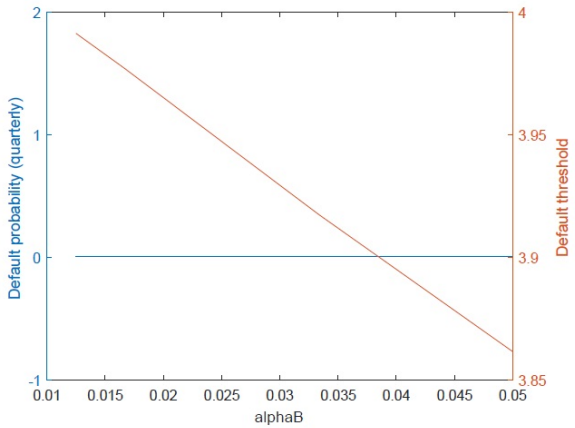
Flexible



Schäuble



Tsipras

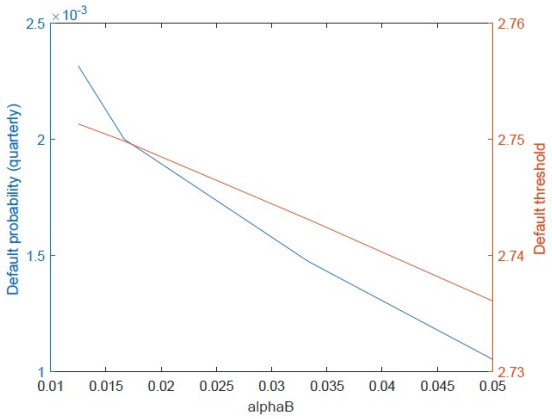


- With high degree of habit persistence, no effect on default risk, reduction of debt threshold

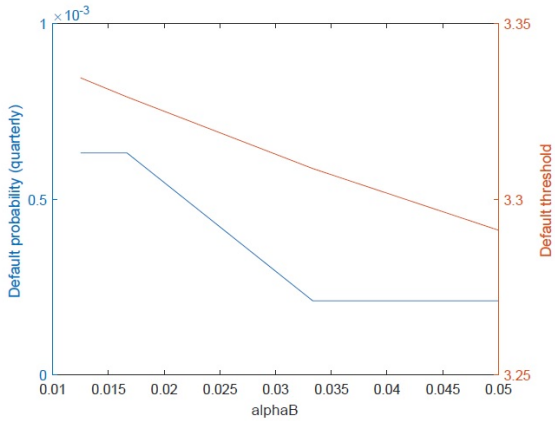
Sensitivity to speed of convergence (α_B)

Default probabilities and thresholds with low consumption habits ($h = 0.25$)

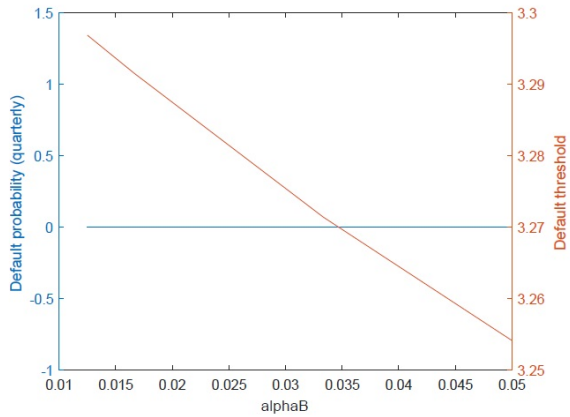
Flexible



Schäuble



Tsipras



- With high degree of habit persistence, no effect on default risk, reduction of debt threshold
- With low degree of habit persistence
  - ↗ In S and F regimes, speed of convergence limits the risk that the country will err in the side of too much debt

  $\Rightarrow$ reduces the risk of default
- Very small quantitative effect

$\Rightarrow$ tougher fiscal rules needed only for low degree of habit persistence and only in a Flexible or Schäuble framework.

Conclusion

- Fixed change is preferred rather than flexible because there's a noise on the exchange rate the central bank cannot control. It's even more the case after a default.
- In a monetary union, external debt plays a critical role for stabilization
- Key role of consumption habit parameter: makes adjustment painful after large GDP shock, but also a shock more persistent.
- In terms of policy, decreasing public debt target makes no difference in either the F and the S regimes, but does decrease default risk in the T regime. Faster speed of fiscal convergence decreases risk in all cases
- **Extensions**
  - Incorporate possibility of redemption after default
  - Allow default on total debt (and not just external debt)
  - Adjustment through prices after default in the EZ (import rationing)

Thank You!

mathilde.viennot@ens.fr