Greed versus Fear: Optimal Time-Consistent Taxation with Default

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  - Sovereign default literature (Arellano (2008), Aguiar and Gopinath (2006), etc): Ignores typically fiscal dimensions of default.
    1. No *distortionary* taxation.
    2. Only *external* debt.

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- Classic questions:
  1. How is *tax-smoothing* over states and dates affected?
  2. What is the optimal debt issuance and the optimal default policy?
  3. Are there any positive or negative drifts in taxes and debt?
- Related literature

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    - *Commitment* vs MPE *without* default vs MPE with default.
    - <u>Basic</u> result for today: even *small* default risk severely limits debt issuance.
    - $\Rightarrow$ tax-smoothing is *impaired* $\Rightarrow$ high tax volatility.

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  - (Indirect default cost as in Arellano (2008): Collapse of debt market for a stochastic number of periods.)

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$$q_t = \beta E_t \frac{u_{c,t+1}}{u_{ct}}(1-d_{t+1}) \Rightarrow \frac{r_t - r_t^F}{1+r_t^F} = \frac{E_t x_{t+1} d_{t+1}}{E_t x_{t+1}(1-d_{t+1})} = \frac{\text{Prob}^x(\text{default})}{\text{Prob}^x(\text{repayment})}$$

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- CE with policy $\{\tau_t, B_t, d_t\}$: prices (q, w) and an allocation (c, h, b) such that a) household maximizes utility b) firms maximize profits b) markets clear, $b_t = B_t$.

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  2. Take into account the optimal reaction of the *future* policy-maker $\Rightarrow$ will affect the optimal choice of debt B'.

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subject to

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- MPE: value functions V^d, V^r and policy functions c, h, B' such that $c = \mathcal{C}$, $h = \mathcal{H}$.
- Let Φ be the multiplier on IC: *excess burden of taxation.*

Generalized Euler Equation (GEE): optimality condition wrt B'

- Let $\omega(g)$: threshold value of debt above which you default.
- Let $Q_t \equiv u_{ct} \cdot q_t$ denote the price of debt in current MU units

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- *LHS:* MC of issuing more debt: costly due to more taxes tomorrow.
- *RHS*: *Marginal revenue* of new debt issuance $\times$ social value of relaxing the constraint.

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- The GEE becomes

$$-\beta \int_{\underline{g}}^{\omega^{-1}(B')} \frac{\partial V^r}{\partial B'} dF = \Phi \cdot \Big[Q + \beta \Big(\underbrace{u_c(B', \omega^{-1}(B')) f(\omega^{-1}(B')|g) \frac{d\omega^{-1}}{dB'}}_{\text{Fear (-): default region } \uparrow}$$

$$+ \underbrace{\int_{\underline{g}}^{\omega^{-1}(B')} (u'_{cc} - u'_{cl}) \frac{\partial \mathcal{C}}{\partial B'} dF}_{\text{Greed (+):} u'_c \uparrow, u_{cl} \geq 0} \Big) \cdot B' \Big]$$

One more look at the GEE: a primer on tax-smoothing and Φ_t

- *Commitment/complete markets/no default*: Lucas and Stokey (1983):

$$\Phi_{t+1} = \Phi_t$$

One more look at the GEE: a primer on tax-smoothing and Φ_t

- *Commitment/incomplete markets/no default*: Aiyagari et al. (2002):

$$E_t x_{t+1} \Phi_{t+1} = \Phi_t, \quad x_{t+1} \equiv \frac{u_{c,t+1}}{E_t u_{c,t+1}}$$

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- $m_{t+1} \equiv \frac{(1-d_{t+1})u_{c,t+1}}{E_t(1-d_{t+1})u_{c,t+1}}$: *default-and-risk-adjusted* change of measure.
- $f_t^m \equiv m_{t+1} \cdot f(.|g_t)$: *default-and-risk-adjusted* conditional density.

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- GEE with long-term debt | Optimal tax | Greed with commitment.

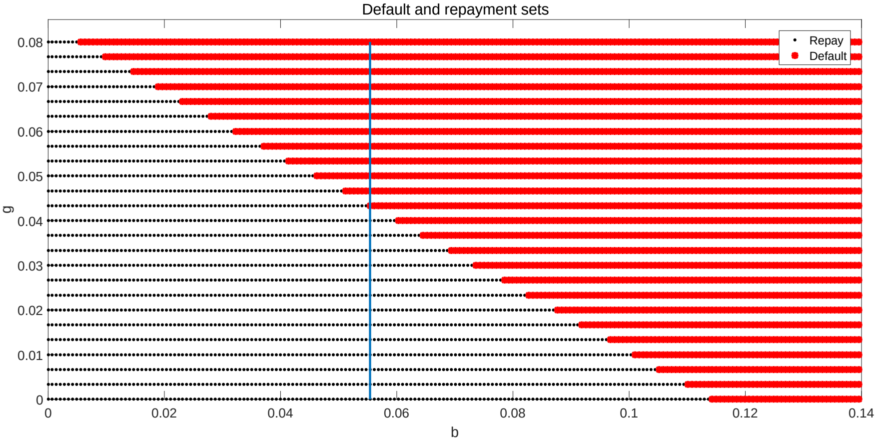
Numerical results

- Utility function: constant Frisch

$$U = \frac{c^{1-\rho} - 1}{1-\rho} - a_h \frac{h^{1+\phi_h}}{1+\phi_h}$$

- $(\beta, \phi_h, \alpha) = (.9, 1, 1)$, g i.i.d. $\sim U[0, 0.2 \times \text{FB output}]$.
- Risk aversion: $\rho = 2$.
  1. *Commitment* as in Aiyagari et al. (2002).
  2. MPE *without* default ("Greed").
  3. MPE with default ("Greed" versus "Fear").
- Limit of the finite horizon economy.
- Numerical difficulties: MPE leads to non-convexities and jumps in policy functions: Krusell et al. (2004) computational issues.
- Uncertainty *smooths* these jumps.

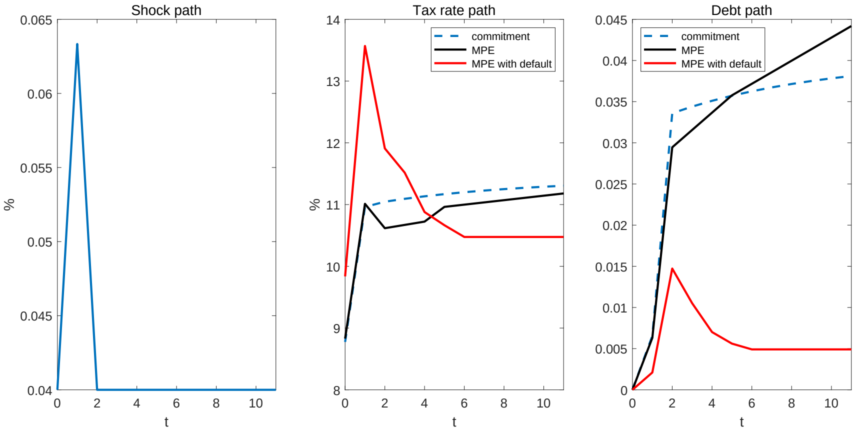
MPE with default: Default and repayment sets



- MPE *without* default: ▸ Debt Laffer curve MPE ▸ Policy functions MPE
- MPE *with* default ▸ Debt Laffer curve with default ▸ Policy functions with default

◂ Return

Commitment/ MPE no default option / MPE with default



- With default the tax rate is used more to absorb the shock.

▸ sample path debt ▸ sample path consumption

Stationary moments

	Commitment	MPE	MPE with default
Tax rate in %			
Mean	11.95	12.64	10.44
St. Dev	3.2	3.8	4.82
Corr with g	0.5075	0.6033	0.9369
Autocorrelation	0.77	0.54	0.2316
Debt-output-ratio in %			
Mean	14.03	21	1.62
St. Dev	9.65	11.4	2
Autocorrelation	0.79	0.85	0.2

- 5% probability of default.
- $E(g/y) = 10\%$, $std(g/y) = 6\%$.
- With default debt is not used anymore to absorb shocks $\Rightarrow$ large volatility of tax rates.

Spreads and taxes

	Comm. *high limit*	**Comm.** *low limit*	**Default** *low cost*	**Default** *high cost*
Tax rate in %				
Mean	21	19.23	18.56	18.69
St. Dev	2.39	1.79	3.67	2.96
Corr with g	0.08	0.45	0.9676	0.86
Autocorrelation	0.94	0.79	0.19	0.39
Debt-output-ratio in %				
Mean	53.75	12.89	0.93	3
St. Dev	41.13	8.09	1.01	2.3
Autocorrelation	0.98	0.84	0.16	0.42
Default probability in %	0	0	2.19	0.53
Spread in %				
Mean	0	0	1.97	0.075
St. Dev	0	0	3.63	0.33
Autocorrelation	-	-	0.15	0.14

$E(g/y) = 17.5\%$, $std(g/y) = 4\%$, $\beta = 0.96$. Default sets Event study

Conclusions

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- $\Rightarrow$ *front-loading* versus *back-loading* taxes.

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- *Further* quantitative analysis needed:
  - persistent shocks, larger state space.
  - long-term debt $\Rightarrow$ more debt in equilibrium.

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- *Further* quantitative analysis needed:
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  - long-term debt $\Rightarrow$ more debt in equilibrium.
- Policy implications? Contrast fiscal rules to the optimal prescriptions.

THANK YOU!

Related literature

- Optimal taxation:
  - *Commitment:* Lucas and Stokey (1983), Aiyagari et al. (2002).
  - *Markov-perfect:* Krusell et al. (2004), Klein et al. (2008), Martin (2009), Debortoli and Nunes (2013),Occhino (2012).
  - *Sustainable plans*: Chari and Kehoe (1990).
  - *Endogenously incomplete markets:* Sleet and Yeltekin (2006).
- Sovereign default: Eaton and Gersovitz (1981), Arellano (2008), Aguiar and Gopinath (2006), Hatchondo and Martinez (2009), Chatterjee and Eyigungor (2012).
- Optimal taxation and default:
  - Cuadra et al. (2010): no domestic debt.
  - Sosa-Padilla (2018): taxation but households do not hold debt.
  - Pouzo and Presno (2016): *commitment* to old tax policies but no commitment to repaying (no "Greed", only "Fear").
  - D'Erasmo and Mendoza (2018): no optimal tax policy - focus on *redistribution* through default.
  - Roettger (2019): joint monetary/fiscal but endogenous $g \Rightarrow$ no "Greed".

Default value function

- The value function when the government defaults is

$$V^d(g) = \max_{c,h} u(c, 1-h) + \beta E_{g'|g}\left[\alpha V(0, g') + (1-\alpha) V^d(g')\right]$$

subject to

$$\begin{aligned} u_c c - u_l h &= 0 \quad \text{(Balanced budget)} \\ c + g &= zh \quad \text{(default cost, } z < 1\text{)} \end{aligned}$$

- α controls the harshness of default.
- $\alpha = 0$: permanent "exclusion" from debt markets $\Rightarrow$ autarky.

Return

GEE with long-term debt

- Long-term debt as in Hatchondo and Martinez (2009):

$$q_t = \beta E_t \frac{u_{c,t+1}}{u_{ct}} (1 - d_{t+1}) \left[1 + (1 - \delta) q_{t+1} \right]$$

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- The GEE becomes

$$E_t n_{t+1} \Phi_{t+1} = \Phi_t \cdot \left[1 + (B_{t+1} - (1 - \delta) B_t) \eta_t \right]$$

where $n_{t+1} \equiv \frac{(1-d_{t+1})\left[u_{c,t+1}+(1-\delta)Q_{t+1}\right]}{E_t(1-d_{t+1})\left[u_{c,t+1}+(1-\delta)Q_{t+1}\right]}$, $\eta_t \equiv \frac{\partial Q_t}{\partial B_{t+1}} \frac{1}{Q_t}$: *price semi-elasticity.*

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- η_t follows the recursion:

$$\begin{aligned}\eta_t \quad = \quad & \left[f^n(\omega^{-1}(B_{t+1})|g_t)\frac{d\omega^{-1}_{t+1}}{dB_{t+1}} + E_t n_{t+1}\frac{u_{cc,t+1}-u_{cl,t+1}}{u_{c,t+1}+(1-\delta)Q_{t+1}}\frac{\partial \mathcal{C}_{t+1}}{\partial B_{t+1}}\right] \\ & +(1-\delta)E_t n_{t+1}\frac{Q_{t+1}}{u_{c,t+1}+(1-\delta)Q_{t+1}}\frac{\partial \mathcal{K}_{t+1}}{\partial B_{t+1}}\eta_{t+1}\end{aligned}$$

- $\mathcal{C},\mathcal{K}$: policy functions for next period. η_t: *PV of two opposing effects.*

Optimal tax

- No commitment: Choice of current tax rate is not bound by past promises.
- Proposition: The optimal tax rate is

$$\tau(B,g) = \frac{\Phi\left[\epsilon_{cc}(1-B/c)+\epsilon_{ch}+\epsilon_{hh}+\epsilon_{hc}(1-B/c)\right]}{1+\Phi(1+\epsilon_{hh}+\epsilon_{hc}(1-B/c))}$$

- $\epsilon_{i,j}$: elasticities of MU of consumption and leisure.

- Example: $U = \frac{c^{1-\rho}}{1-\rho} - a_h \frac{h^{1+\phi_h}}{1+\phi_H}$

$$\tau = \frac{\Phi(\rho(1-B/c)+\phi_h)}{1+\Phi(1+\phi_h)}$$

- Lack of commitment$\Rightarrow$ incentive to devalue current debt: For a given Φ a low τ increases consumption and reduces the value of debt in current MU units $\Rightarrow$ decrease interest rates.

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- Math:

$$\lambda_t = u_{ct} + \Phi_t \cdot \text{ effect on surplus } - \underbrace{\Phi_t u_{cct} b_t}_{\text{decreasing } R_{t,t+1} \text{ (+)}} + \underbrace{\Phi_{t-1} u_{cct} b_t}_{\text{increasing } R_{t-1,t} \text{ (-)}}$$

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- But $\Phi_t = \Phi_{t-1} \Rightarrow$ incentive to manipulate u_c is *neutralized* (except for $t = 0$)!

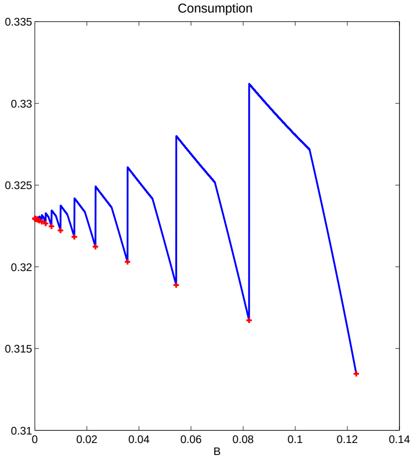
Return

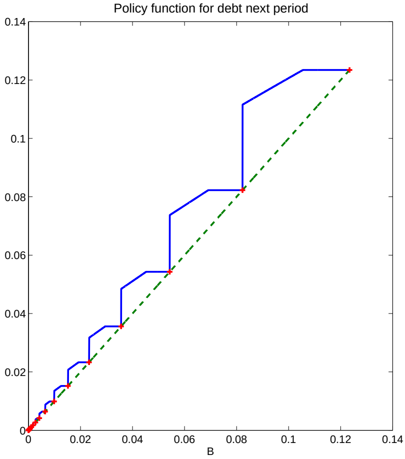
Issues about computation of the model

- Non-convexity leads to discontinuous policy functions for consumption and debt.
- Problem severe without uncertainty: Krusell et al. (2004). KMRR
- Similar behavior as in the hyperbolic discounting literature.
- It is an open issue if there exists
  1. a continuous and differentiable MPE.
  2. multiple discontinuous MPEs or none.
- Uncertainty *smooths out* discontinuities: Uniform shocks with large support.
- Use lotteries to convexify? (Luttmer-Mariotti 2003, Chatterjee-Eyigungor 2014).
- Introduce preference shocks as in Dvorkin et al. 2018?

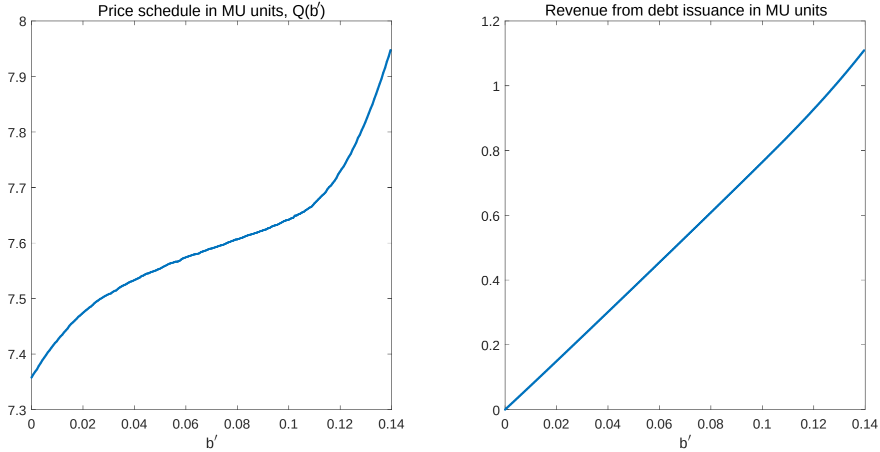
Return

Krusell et. al 2005





MPE with no default, $\rho = 2$: Price schedule and Revenue



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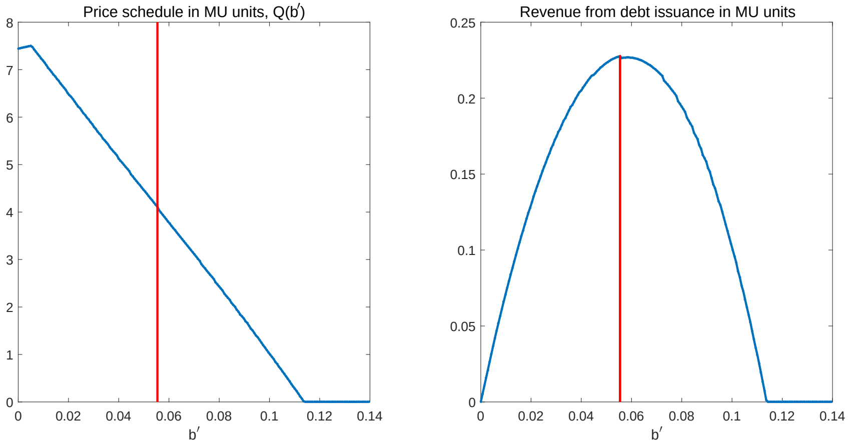
MPE with default: price schedule and debt Laffer curve



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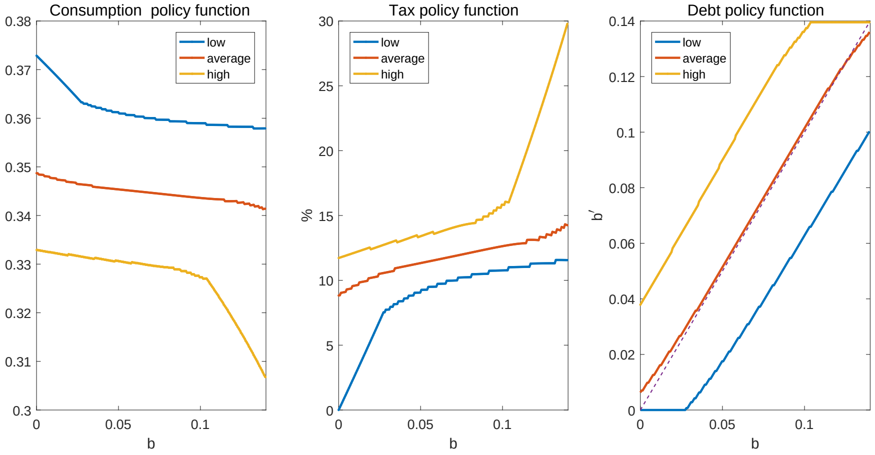
MPE with no default: Consumption/tax/debt policies



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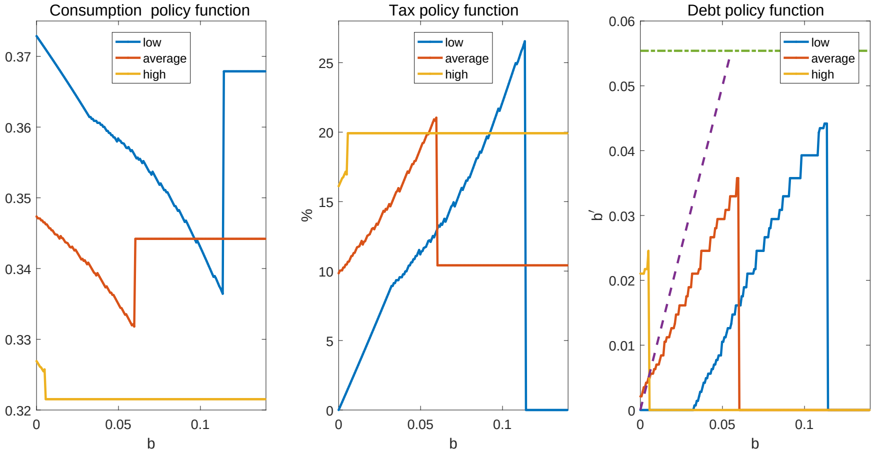

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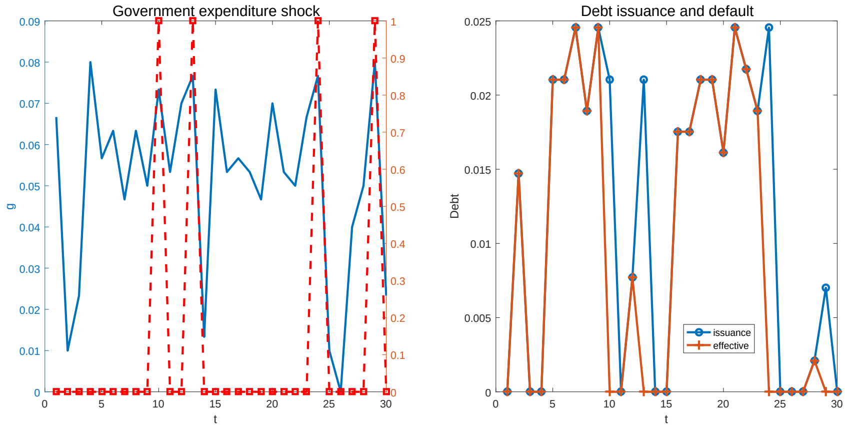
Debt issuance under default



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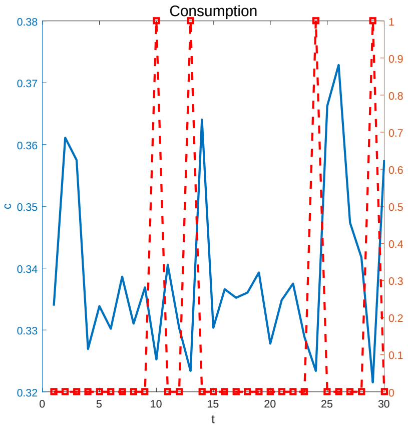
Consumption and taxes



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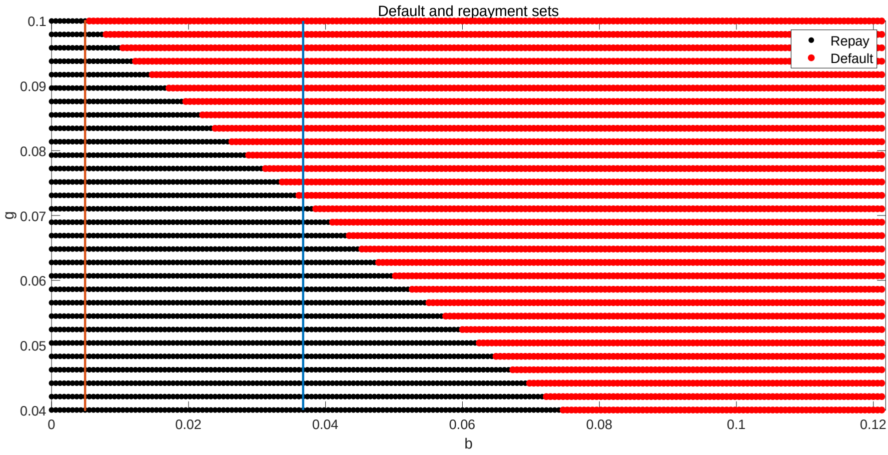
Low default costs



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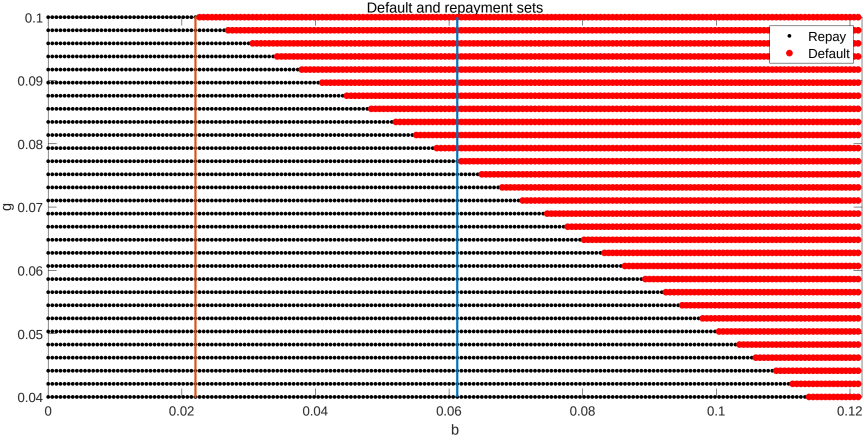
High default costs



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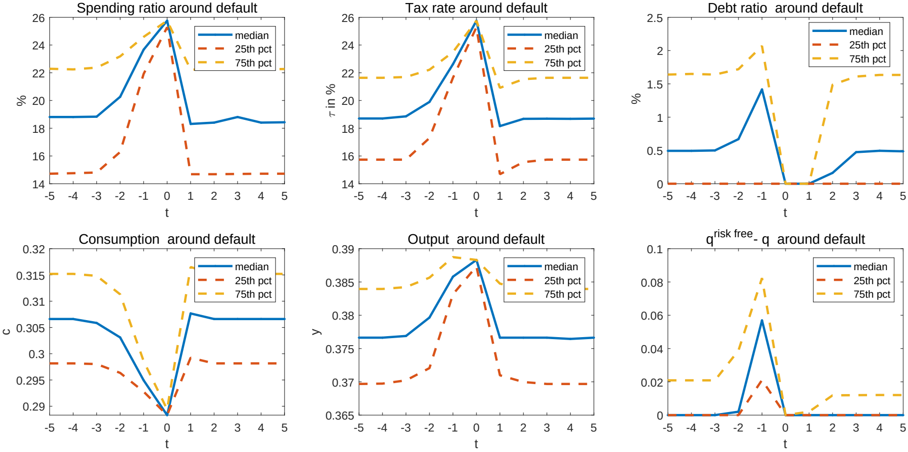
Event study around default



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