Sovereign Spreads and the Effects of Fiscal Austerity

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Motivation

- What is the effect of fiscal austerity on sovereign spreads ?

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- Important question at core of policy discussion during Eurozone debt crisis
- Empirical evidence is far from conclusive
- Need structural model to analyze the underlying mechanisms
- This paper proposes framework to analyze impact of fiscal policy shocks on Sovereign Spreads
- Uses the model to analyze the case of Spain

Model Preview

- **Strategic sovereign default**

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  - Introduces unemployment
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- **Strategic sovereign default**
- **Downward nominal wage rigidity**
  - Introduces unemployment
  - Generates potentially meaningful costs of austerity
- **Estimated fiscal rules**
  - Estimation using fiscal data
  - Represent fiscal policy in normal times
  - Use them to identify fiscal policy (austerity) shocks

Results Preview

- Fiscal austerity can increase spreads when
  1. Fiscal policy is persistent
  2. Economy is expected to be in a recession (low consumption and hours)
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- Fiscal rules parameters seem to be key to determine the chance of facing a self-defeating austerity

- Application to Spain
  - Perform a counter-factual exercise: compare economy with and without austerity
  - Find that austerity decreased sovereign spreads

Literature

- **Fiscal austerity (structural)**. Bi, Leeper and Leith (2013), Mendoza, Tesar and Zhang (2014), House, Proebsting and Tesar (2015), Arellano and Bai (2016), de Cordoba, Pujolas and Torres (2017)

  Contribution: Realistic fiscal policy + debt and spreads

- **Fiscal austerity (empirical)**. Giavazzi and Pagano (1990), Alesina and Ardagna (2010), Alesina, Favero and Giavazzi (2012), Guajardo, Leigh and Pescaroti (2014), Alesina et al (2015)

  Contribution: Effects on sovereign spreads and debt to GDP ratios

- **Sovereign Default**. Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), Arellano (2008), Cuadra, Sanchez and Sapriza (2010), Bianchi, Ottonello and Presno (2019), Conesa, Kehoe and Ruhl (2016), Arellano, Bai and Mihalache (2019)

  Contribution: Use default model to perform positive analysis

- **Eurozone crisis analysis**. Lane (2012), Shambaugh (2012), Martin and Philippon (2015), Schmitt-Grohe and Uribe (2016)

  Contribution: Focus on austerity

Roadmap

1. Model
2. Analysis
3. Application to Spain
   - Calibration
   - Counter-factual analysis

Model

Model

- 4 Agents: Household, Firms (Tradables and Nontradables), Government, International Investors
- Representative household with utility function,

$$E_t \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\sigma} - 1}{1-\sigma} - \chi \frac{H_t^{1+\theta}}{1+\theta} \right\}$$

$$C_t = \mathcal{C}(C_{Nt}, C_{Tt}) = \left[\omega \left(C_{Nt} \right)^{\frac{\mu-1}{\mu}} + (1-\omega) \left(C_{Tt} \right)^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}$$

Budget constraint,

$$p_{Nt} C_{Nt} + C_{Tt} = w_t H_t + \Pi_t - T_t$$

Model

- Firms:
  - Representative firms with following technology

$$Y_{Nt} = A_{Nt} \left(H_{Nt}^{d}\right)^{\alpha}$$
$$Y_{Tt} = A_{Tt} \left(H_{Tt}^{d}\right)^{\alpha}$$

    Where TFPs (A_{Nt} and A_{Tt}) follow a AR(1) processes in logs

- Labor market:
  - As in Schmitt-Grohe and Uribe (2016), I assume downward wage rigidity

$$w_t \geq \gamma w_{t-1}$$

    this implies that model displays unemployment for some states

Government

- Benevolent
- Policy choice default, d_t
- Policy rules G_{Nt}, G_{Tt}, B_{t+1}
- Long-run external debt (B_t) with a geometrically decaying coupon δ
- Budget constraint (determines T_t)

$$p_{Nt} G_{Nt} + G_{Tt} + (1 - d_t)\delta B_t = T_t + (1 - d_t) q_t \left(B_{t+1} - (1 - \delta) B_t\right)$$

International Creditors

- Deep pocket
- Time separable utility

$$\sum_{t=0}^{\infty} \exp\left\{\sum_{j=0}^{t-1} m_{j,j+1}\right\} C_t^*$$

- Following Ang and Piazzesi (2003) and Bocola and Dovis (2019) assume $m_{t,t+1}$ is affected by a risk premium shock χ_t More
- No arbitrage implies

$$q_t = E_t\left\{\exp\{m_{t,t+1}\}\left[(1-d_{t+1})\underbrace{(\delta+(1-\delta)q_{t+1})}_{\text{payoff if repay}}+d_{t+1}\underbrace{q_{t+1}^D}_{\text{price in default}}\right]\right\}$$

  - q_{t+1}^D Price of a bond in default (endogenous object) More

Policy Rules: G

- Follow Blanchard and Perotti (2002)

$$\log\left(\frac{G_t}{\bar{G}}\right) = \rho_G \log\left(\frac{G_{t-1}}{\bar{G}}\right) + \rho_{GX} X_{t-1} + \sigma_G \epsilon_t^G$$
$$\epsilon_t^G \sim N(0,1)$$

- Estimated using quarterly data from Eurostat

- G_t is a composite of nontradable and tradable goods

$$G_t = \left[\omega \left(G_{Nt}\right)^{\frac{\mu-1}{\mu}} + (1-\omega)\left(G_{Tt}\right)^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{\mu-1}}$$

Policy Rules: B

- The stock of external public debt B_t follows,

$$\log\left(\frac{B_{t+1}}{\bar{B}}\right) = \gamma_B \log\left(\frac{B_t}{\bar{B}}\right) + \gamma_G \log\left(\frac{p_{Gt} G_t}{\bar{p}_G \bar{G}}\right) + \gamma_Y \log\left(\frac{Y_t^{nom}}{\bar{Y}^{nom}}\right)$$

- Estimated using quarterly data

- Fits data very well for Spain ($R^2 = 0.989$) Graph

Default Decision

- Markov Perfect Equilibrium

Value Functions

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- Markov Perfect Equilibrium
- Set of states $\mathbf{S} = \{B, w_{-1}, A_N, A_T, G, \chi\}$
- Government decides whether to default or not $d = \Phi_d(\mathbf{S})$
- Value function of government is given by

$$\mathcal{V}(\mathbf{S}) = \max\left\{\mathcal{V}^R(\mathbf{S}), \mathcal{V}^D\left(\mathbf{S}\right) - \xi\right\}$$

$\mathcal{V}^R(\mathbf{S})$: Repayment Value
$\mathcal{V}^D(\mathbf{S})$: Default Value
ξ: utility cost of default iid $\mathcal{N}(0, \sigma_\xi)$

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- External debt in arrears updated by R^* every quarter in default
- Haircut $1 - \psi$ once country regains access to capital markets

Analysis

Effects of Fiscal Policy: Multipliers

- Household FOC,

$$p_{Nt} = \frac{u'(C_t)\mathcal{C}'_{C_N}}{u'(C_t)\mathcal{C}'_{C_T}}$$

where $\iota_t \equiv B_{t+1} - (1-\delta)B_t$

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$$p_{Nt} = \frac{\omega}{1-\omega}\left(\frac{C_{Tt}}{C_{Nt}}\right)^{1/\mu}$$

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$$p_{Nt} = \frac{\omega}{1-\omega}\left(\frac{Y_{Tt} - G_{Tt} + q_t \iota_t - \delta B_t}{Y_{Nt} - G_{Nt}}\right)^{1/\mu}$$

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  where $\iota_t \equiv B_{t+1} - (1-\delta)B_t$

- In principle unknown impact of austerity on p_{Nt}
- If CES aggregators are the same for C_t and G_t most important effect is through $q_t \iota_t$
  - $\downarrow G_t \rightarrow \downarrow q_t \iota_t \rightarrow \downarrow p_{Nt}$

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$$\downarrow H_{Nt}^{d} = \left(\frac{\downarrow p_{Nt} \alpha A_{Nt}}{w_t} \right)^{\frac{1}{1-\alpha_N}}$$

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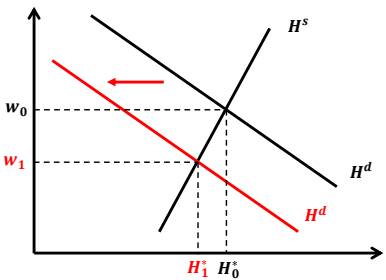
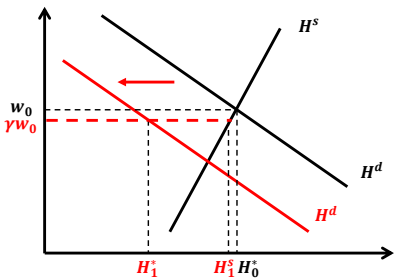
- Labor demand shifts leftwards

Effects of Fiscal Policy: Multipliers

- Downward wage rigidity increases austerity multipliers



(a) Nonbinding



(b) Binding

Effects of Fiscal Policy: Multipliers

- Fiscal multipliers are higher if wages can not drop during austerity
- How fast ι_t or B_{t+1} drops is key to determine the size of multipliers
- In other words, γ_G and γ_Y are important
- Remember,

$$\log\left(\frac{B_{t+1}}{\bar{B}}\right) = \gamma_B \log\left(\frac{B_t}{\bar{B}}\right) + \gamma_G \log\left(\frac{p_{Gt} G_t}{\bar{p_G}\bar{G}}\right) + \gamma_Y \log\left(\frac{Y_t^{nom}}{\bar{Y}^{nom}}\right)$$

Effects of Fiscal Policy: Sovereign Spreads

- What is the effect of austerity on spreads ?
- In a simplified version of the model without TFP or risk premium shocks, spreads at time t are

$$spr_t = F\left(\mathcal{V}^D(w_t, G_{t+1}) - \mathcal{V}^R(B_{t+1}, w_t, G_{t+1})\right)$$

  where F is an increasing function Simple Model
- Hence, the effect of $\downarrow G_t$ on spr_t can be divided into three channels
  1. w_t: Wage Effect
  2. B_{t+1}: Debt Effect
  3. G_{t+1}: G Persistence Effect

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     - $\downarrow G_{t+1} \rightarrow \downarrow B_{t+2}$: lower future obligations and $\uparrow \mathcal{V}^R$

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     - $\downarrow G_{t+1} \rightarrow\downarrow B_{t+2}$: lower future obligations and $\uparrow \mathcal{V}^R$
     - If fiscal multipliers are high $\downarrow G_{t+1} \rightarrow\downarrow C_{t+1}$: deeper recession $\downarrow \mathcal{V}^R$

Effects of Fiscal Policy: Sovereign Spreads

- Two main channels affecting spreads:
  1. Debt Effect ($\downarrow spr_t$)
  2. G Persistence Effect (ambiguous impact)
- Conclusions
  1. Austerity reduces spreads if it is not persistent
  2. Persistent austerity efforts can increase spreads if:
     - Future Fiscal Multipliers are high such that $\downarrow G_{t+1} \rightarrow \downarrow C_{t+1}$

Application

Application

- Spain
- Estimation:
  - Direct estimations of fiscal rules Regressions
  - Shock processes and cost of default parameters to match empirical moments (Simulated Method of Moments) More
- Counterfactual exercise:
  - Focus on G,

$$log(G_t) = (1 - \rho_G) log(\bar{G}) + \rho_G log(G_{t-1}) + \sigma_G \epsilon_t^G$$

  - Austerity: deviations from rule after 2010-Q2 (negative $\sigma_G \epsilon_t^G$) More
  - Compare economy with and without $\sigma_G \epsilon_t^G$ shocks after 2012Q2

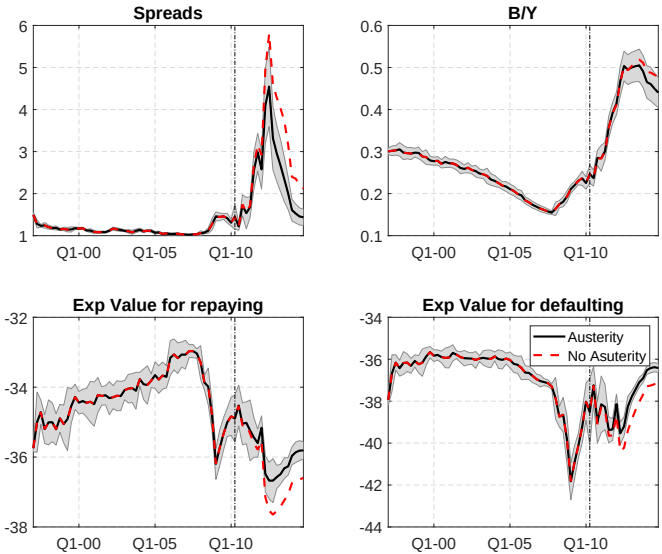
Counterfactual

- First use Particle Filter to recover paths for: A_N,A_T,G, and χ More
- Simulate model using filtered shocks but setting austerity shocks to zero after 2010Q2
- Results,

Table: Austerity Impact on Economic Activity

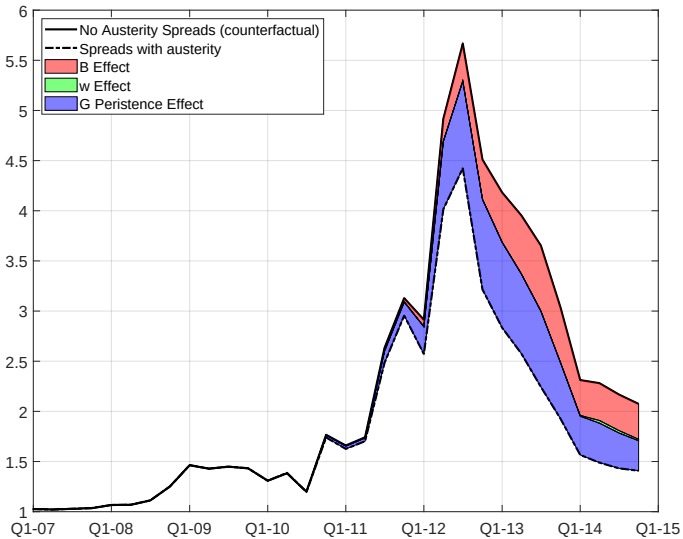
Variables	Value
$\log(G^{a}_{2014Q4}) - \log(G^{na}_{2014Q4})$	-12.5%
$\log(GDP^{a}_{2014Q4}) - \log(GDP^{na}_{2014Q4})$	-1.4%
$\log(H^{a}_{2014Q4}) - \log(H^{na}_{2014Q4})$	-1.5%
$\log(C^{a}_{2014Q4}) - \log(C^{na}_{2014Q4})$	1.3%

Results: Counterfactual



Spreads

- I perform an exact decomposition of the effect on spreads How?
  - the 3 channels: w, B_{t+1} and G_{t+1}



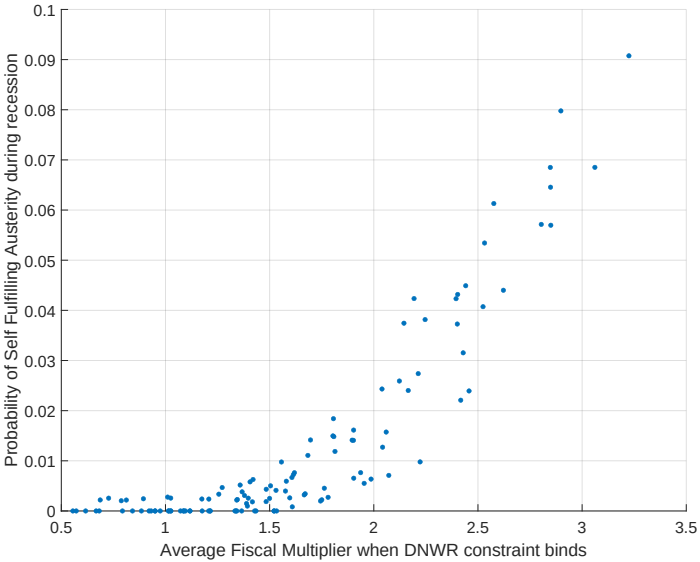
Results

- Spreads decreased in 2010-2014 as a result of austerity
- Two austerity effects moving spreads in same direction
  1. Both effects (B and G persistence) tend to decrease spreads
  2. Indicates that recessionary impact of austerity was not important enough
- Austerity decreased Debt to GDP ratios
- Lower annual growth rates of GDP and employment

Multipliers and Self-Defeating Austerity

- Recessionary impact was not big enough to generate a self-defeating austerity
- Multipliers in Spain on average are 0.85 in equilibrium
- How big multipliers need to be to have a serious chance of self-defeating consolidations ?
- Exercise:
  - Solve the model for different fiscal rule parameters γ_Y and γ_G
  - Simulate each calibration 10,000 periods and count periods when $\frac{\partial spr}{\partial G} < 0$
  - Compute average "probability of self-defeating austerity" and fiscal multipliers

Multipliers and Self-Defeating Austerity



Multipliers and Self-Defeating Austerity

- Positive relationship between multipliers and self-defeating prob
- Self-defeating austerities seem to be generally unlikely
- Multipliers need to be higher than 1.5 so that self-defeating prob $> 1\%$ during a recession
- Claiming that austerity was self defeating in Spain implies assuming high overall multipliers

Conclusion

- Proposed a model to analyze impact of fiscal policy on spreads
- Application to Spain:
  - Austerity reduced spreads
  - But with costs in terms of economic activity
- Key parameters seem to be related to fiscal rules

Rule Shocks vs Narrative Shocks

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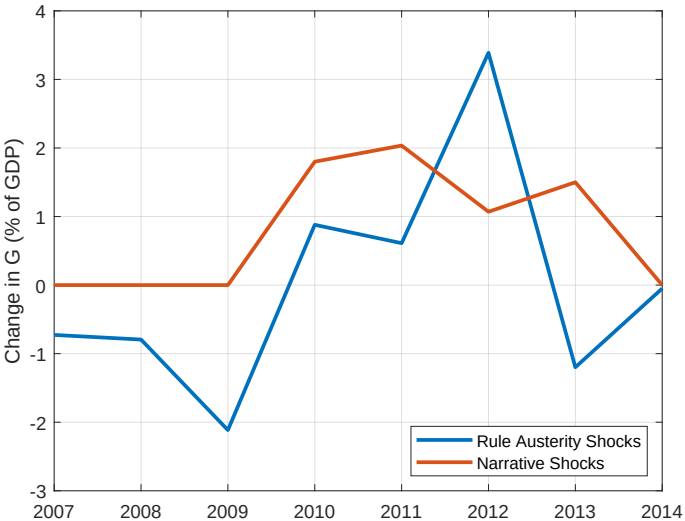

Decomposition

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- Spreads at time t are a function of B_{t+1}, w_t, G_t and other exogenous states not affected by austerity (omitted to simplify exposition)
- Define states in case of austerity B^a_{t+1}, w^a_t, G^a_t and with no austerity $B^{na}_{t+1}, w^{na}_t, G^{na}_t$

$$
\begin{aligned}
spr^a_t = spr^{na}_t &+ \underbrace{spr\left(B^a_{t+1}, w^a_t, G^a_t\right) - spr\left(B^a_{t+1}, w^a_t, G^{na}_t\right)}_{G_t effect} \\
&+ \underbrace{spr\left(B^a_{t+1}, w^a_t, G^{na}_t\right) - spr\left(B^a_{t+1}, w^{na}_t, G^{na}_t\right)}_{w_t Effect} \\
&+ \underbrace{spr\left(B^a_{t+1}, w^{na}_t, G^{na}_t\right) - spr\left(B^{na}_{t+1}, w^{na}_t, G^{na}_t\right)}_{B_{t+1} Effect}
\end{aligned}
$$

Calibration: Fiscal Rules

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Table: Estimated Fiscal Rules

Variables	$log(G_t)$ (1)	$log(B_{t+1})$ (2)
$log(G_{t-1})$	0.95***	
	(0.04)	
$log(GDP_{t-1})$	0.03	
	(0.03)	
$log(B_t)$	0.01	0.98***
	(0.02)	(0.02)
$log(G_t^{nom})$		0.13***
		(0.05)
$log(Y_t^{nom})$		-0.28***
		(0.05)
Observations	91	91
R-squared	0.949	0.997

Notes. Standard errors in parentheses, $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

Data from Eurostat and Bank of Spain. Regressions include a linear trend, not reported.

Calibration

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Description	Parameter	Value	Target
Panel A: Household, Firms and Labor Market			
Discount factor	β	0.95	Standard
Risk aversion	σ	2	Standard
Frisch elasticity	θ	1	Standard
Labor disutility	χ	1.52	Steady state labor
Elast. of subsitution	μ	0.74	Mendoza (1995)
Nontradables weight	ω	0.83	SS nontradables share
Labor elasticity	α	2/3	Standard
Downward wage rigidity	γ	0.99	Moments
Panel B: Government			
G rule AR(1)	ρ_G	0.95	Fiscal rule estimation
G rule SD	σ_G	1.75%	Fiscal rule estimation
Debt rule parameter	γ_B	0.98	Fiscal rule estimation
Debt rule parameter	γ_G	0.13	Fiscal rule estimation
Debt rule parameter	γ_Y	-0.28	Fiscal rule estimation
Bond coupon rate	δ	1/24	Avg maturity = 6 yrs

Calibration

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Description	Parameter	Value	Target
Panel C: Int'l creditors and default			
Default haircut	ψ	19.7%	Edwards(2015)
Prob. of reentry	ϕ	3.85%	Cruces and Trebesch (2013)
Risk premium shock	ϕ_0	0.0036	Estimation of χ process
Risk premium shock	ϕ_1	0.0016	Estimation of χ process
Risk premium shock	κ_0	0.16	Estimation of χ process
Risk premium shock	κ_1	0.35	Estimation of χ process
Risk premium shock	ρ_χ	0.53	Estimation of χ process
Default prod Cost	d_0	-0.33	Moments
Default prod Cost	d_1	0.38	Moments
Panel D: Shock Processes			
Tradables prod AR(1)	ρ_{AT}	0.98	Moments
Nonradables prod AR(1)	ρ_{AN}	0.87	Moments
Tradables prod SD	σ_{AT}	1.2%	Moments
Nonradables prod SD	σ_{AN}	1.7%	Moments

Calibration: Model Fit

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Target	Model	Data	Data Description
Average Spread	0.98%	0.8%	Calculated spreads 1997q1-2019q4
SD spread	0.74%	1.01%	Calculated spreads 1997q1-2019q4
Average Debt/GDP	28.1%	25.3%	External Debt to GDP 1997q1-2019q4
Serial Corr $\log(Y_N)$	0.84	0.98	Const and Serv V. Added 1997q1-2019q4
SD Δ $\log(Y_N)$	1.4%	1.7%	Const and Serv V. Added 1997q1-2019q4
Serial Corr $\log(Y_T)$	0.91	0.97	Agr and Ind V. Added 1997q1-2019q4
SD Δ $\log(Y_T)$	2.1%	2.8%	Agr and Ind V. Added 1997q1-2019q4
SD $\log(W_t)$ - $\log(W_{t-4})$	2.2%	2.9%	Annual Growth Nominal Wages 2000q1-2019q4
SD Δ $\log(H_N + H_T)$	1.3%	1.0%	SD Total Hours growth rate

International Creditors

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- Price of bond in default

$$q_t^D = E_t \left\{ \exp\{m_{t,t+1}\} R^* \left\{ \varphi \left[(1-\tilde{d}_{t+1}) \underbrace{(\delta + (1-\delta) q_{t+1})(1-\psi)}_{\substack{\text{payoff if return} \\ \text{and repay}}} + \tilde{d}_{t+1} \underbrace{q_{t+1}^D}_{\substack{\text{payoff if} \\ \text{no return}}} \right] + (1-\varphi) \underbrace{q_{t+1}^D}_{\text{no return}} \right\} \right\}$$

- φ: Prob of regaining access to markets
- ψ: Haircut
- R^*: Gross risk free interest rate

Policy Rules: B

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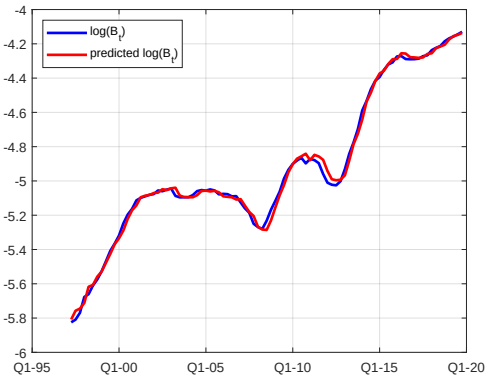

Government's Problem

- Value of repaying,

$$\mathcal{V}^R(\mathbf{S}) = u\left(C(\mathbf{S}), H(\mathbf{S})\right) + \beta E\left\{\mathcal{V}(\mathbf{S}', \xi')|\mathbf{S}\right\}$$

$st.$

$$\log\left(\frac{B'}{\bar{B}}\right) = \gamma_B \log\left(\frac{B}{\bar{B}}\right) + \gamma_G \log\left(\frac{p_G(\mathbf{S})G}{\bar{p_G}\bar{G}}\right) + \gamma_Y \log\left(\frac{Y^{nom}(\mathbf{S})}{\bar{Y}^{nom}}\right)$$

$$w'_{-1} = w(\mathbf{S})$$

$$log(G') = (1-\rho_G)log(\bar{G}) + \rho_G log(G) + \sigma_G \epsilon^G$$

$+$ Equilibrium Conditions

Government's Problem

Back

- Value in default,

$$\mathcal{V}^D(\mathbf{S}) = u\left(C(\mathbf{S_1}, \tilde{\mathbf{S}}_\mathbf{2}), H(\mathbf{S_1}, \tilde{\mathbf{S}}_\mathbf{2})\right) + \beta E\{\varphi \max\left[\mathcal{V}^D(\mathbf{S}'), \mathcal{V}^R((1-\psi)B', w'_{-1}, \mathbf{S}'_\mathbf{2})\right] + (1-\varphi)\,\mathcal{V}^D(\mathbf{S}')|\mathbf{S}\}$$

st.

$$T(\mathbf{S_1}, \tilde{\mathbf{S}}_\mathbf{2}) = p_G(\mathbf{S_1}, \tilde{\mathbf{S}}_\mathbf{2})G$$

$$B' = BR^*$$

$$w'_{-1} = w(\mathbf{S_1}, \tilde{\mathbf{S}}_\mathbf{2})$$

$$log(G') = (1-\rho_G)log(\bar{G}) + \rho_G log(G) + \sigma_G \epsilon^G$$

$+$ Equilibrium Conditions

  - R^*: international gross interest rate
  - φ: exogenous probability of re-entering markets
  - $\tilde{\mathbf{S}}_\mathbf{2} \equiv \left\{\tilde{A}_N, \tilde{A}_T, G, m\right\}, \mathbf{S_1} \equiv \{B, w_{-1}\}$
  - Following Chatterjee and Eyigungor (2012), productivity in default

$$\tilde{A}_N = A_N - max\left\{0, d_0 A_N + d_1 A_N^2\right\}$$

$$\tilde{A}_T = A_T - max\left\{0, d_0 A_T + d_1 A_T^2\right\}$$

Risk premium shock

- International lenders stochastic discount factor

$$
\begin{aligned}
m_{t,t+1} &= -(\phi_0 + \phi_1 \chi_t) - \frac{1}{2}\kappa_t^2 + \kappa_t \varepsilon_{\chi,t+1} \\
\chi_{t+1} &= \rho_\chi \chi_t + \varepsilon_{\chi,t+1} \qquad \varepsilon_{\chi,t+1} \sim \mathcal{N}(0,1) \\
\kappa_t &= \kappa_0 + \kappa_1 \chi_t
\end{aligned}
$$

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Simplifying Assumptions

- Assume country lacks commitment to repay debt at $t+1$ only
- A_{NT}, A_T, m are constant
- Government starts with debt B_t and $G_t = \bar{G}$ for $t+j$, $j > 0$
- Implements and announces the following austerity package $\Delta G_t = \Delta G < 0$, $\Delta G_{t+1} = \rho \Delta G_t$ and $\Delta G_{t+j} = 0$ for $j > 1$
- Parameter $\rho > 0$ measures how persistent the austerity package is
- Value for defaulting is given by $V^D(w_{t-1}, G_t)$ with $V_1^D < 0$, $V_2^D < 0$

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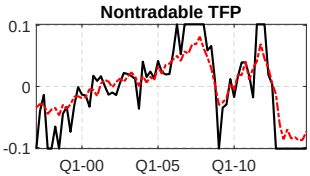
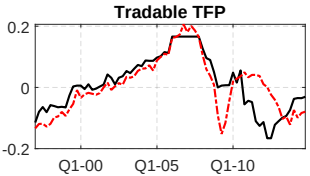
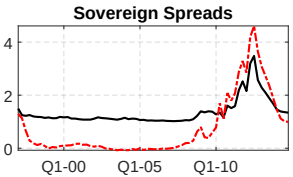
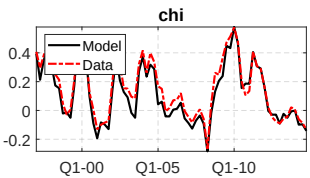
Filter


Nontradable TFP
0.1
0
-0.1
Q1-00
Q1-05
Q1-10


Tradable TFP
0.2
0
-0.2
Q1-00
Q1-05
Q1-10


Government Spending
0.2
0
-0.2
Q1-00
Q1-05
Q1-10


Sovereign Spreads
4
2
0
Q1-00
Q1-05
Q1-10


chi
Model
Data
0.4
0.2
0
-0.2
Q1-00
Q1-05
Q1-10

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