Aggregate Demand and Sovereign Debt Crises

Francisco Roldán

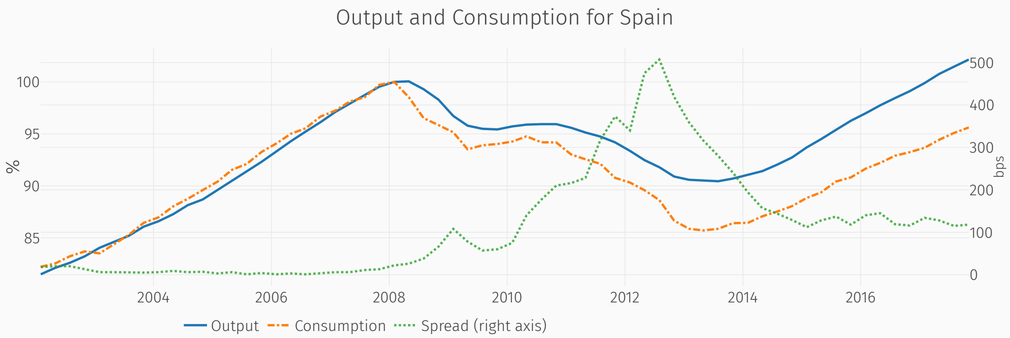
International Monetary Fund[a]

July 2020

[a]The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management.

Spain in the Eurozone Crisis

- Sovereign debt crises associated with **deep** recessions ▸ More

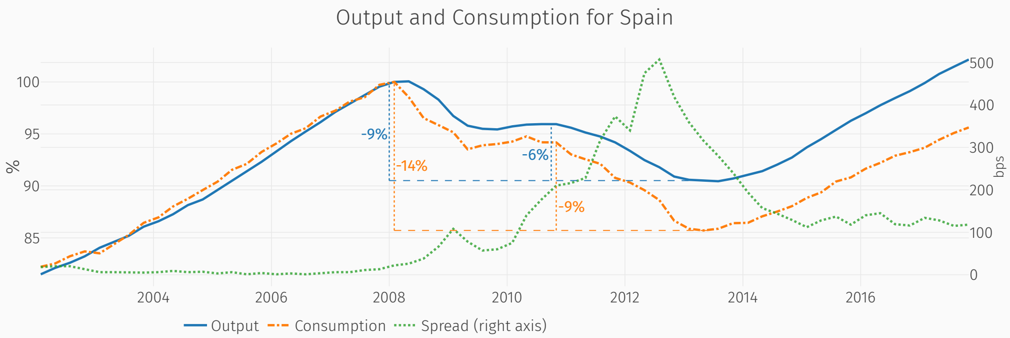


- Conventional view: low output $\Longrightarrow$ high spreads

▸ Detrended data ▸ Trade balance ▸ Low demand? ▸ Nondurable consumption

Spain in the Eurozone Crisis

- Sovereign debt crises associated with **deep** recessions ▸ More



- Conventional view: low output $\implies$ high spreads

▸ Detrended data ▸ Trade balance ▸ Low demand? ▸ Nondurable consumption

Sovereign Risk

- Spain: large output and consumption drops
  - $|\Delta C| > |\Delta Y| \implies$ Saving rate $\uparrow$ in the crisis
- IVs on Eurozone country-level data show
  1. High spreads cause output to fall
  2. High spreads cause consumption to fall more than output
- Huidrom et al. (2019): weak fiscal positions erode consumption demand

- Large literature about costs of sovereign default – silent about costs of default *risk*
  - Agg demand irrelevant with Hand-to-mouth households / Law of One Price
  - Saving rate in the crisis?
  - Consequences?

  - Household sector manages substantial wealth (avg 96% of GDP) ▸ Spanish data
  - Substantial fraction of government debt held by residents ▸ Spanish data

Sovereign Risk

- Spain: large output and consumption drops
  - $|\Delta C| > |\Delta Y| \implies$ Saving rate $\uparrow$ in the crisis
- IVs on Eurozone country-level data show
  1. High spreads cause output to fall
  2. High spreads cause consumption to fall more than output
- Huidrom et al. (2019): weak fiscal positions erode consumption demand

- Large literature about costs of sovereign default – silent about costs of default *risk*
  - Agg demand irrelevant with Hand-to-mouth households / Law of One Price
  - Saving rate in the crisis?
  - Consequences?

  - Household sector manages substantial wealth (avg 96% of GDP) ▸ Spanish data
  - Substantial fraction of government debt held by residents ▸ Spanish data

Sovereign Risk

- Spain: large output and consumption drops
  - $|\Delta C| > |\Delta Y| \implies$ Saving rate $\uparrow$ in the crisis
- IVs on Eurozone country-level data show
  1. High spreads cause output to fall
  2. High spreads cause consumption to fall more than output
- Huidrom et al. (2019): weak fiscal positions erode consumption demand

- Large literature about costs of sovereign default – silent about costs of default *risk*
  - Agg demand irrelevant with Hand-to-mouth households / Law of One Price
  - Saving rate in the crisis?
  - Consequences?
  - Household sector manages substantial wealth (avg 96% of GDP) ▸ Spanish data
  - Substantial fraction of government debt held by residents ▸ Spanish data

Sovereign Risk

- Spain: large output and consumption drops
  - $|\Delta C| > |\Delta Y| \implies$ Saving rate $\uparrow$ in the crisis
- IVs on Eurozone country-level data show
  1. High spreads cause output to fall
  2. High spreads cause consumption to fall more than output
- Huidrom et al. (2019): weak fiscal positions erode consumption demand

- Large literature about costs of sovereign default – silent about costs of default *risk*
  - Agg demand irrelevant with Hand-to-mouth households / Law of One Price
  - Saving rate in the crisis?
  - Consequences?

  - Household sector manages substantial wealth (avg 96% of GDP) ▸ Spanish data
  - Substantial fraction of government debt held by residents ▸ Spanish data

This Paper

- I propose a model of sovereign debt crises
  - Prominent role for household consumption/savings decision
    - Heterogeneous domestic savers can **choose** to be exposed to government debt
  - Endogenous wealth distribution that interacts with gov't default choice

- Model
  - Defaults create
    - Aggregate income losses $\longleftarrow$ TFP costs of default
    - Redistributive effects $\longleftarrow$ Domestic debt holdings

      ... Those who benefit from redistribution: high MPCs from current income, low from future income
  - Economy looks riskier when the default probability increases
    - Default risk **interacts** with precautionary behavior

This Paper

- I propose a model of sovereign debt crises
    - Prominent role for household consumption/savings decision
        - Heterogeneous domestic savers can **choose** to be exposed to government debt
    - Endogenous wealth distribution that interacts with gov't default choice

- Model
    - Defaults create
        - Aggregate income losses $\longleftarrow$ TFP costs of default
        - Redistributive effects $\longleftarrow$ Domestic debt holdings

        ... Those who benefit from redistribution: high MPCs from current income, low from future income
    - Economy looks riskier when the default probability increases
        - Default risk **interacts** with precautionary behavior

This Paper

- I propose a model of sovereign debt crises
  - Prominent role for household consumption/savings decision
    - Heterogeneous domestic savers can **choose** to be exposed to government debt
  - Endogenous wealth distribution that interacts with gov't default choice

How is sovereign risk costly?

Feedback loop between spreads and output

$\uparrow$ Spreads $\Longrightarrow$ $\downarrow$ Demand $\Longrightarrow$ $\downarrow$ Output

- Model
  - Defaults create
    - Aggregate income losses $\longleftarrow$ TFP costs of default
    - Redistributive effects $\longleftarrow$ Domestic debt holdings

    ... Those who benefit from redistribution: high MPCs from current income, low from future income
  - Economy looks riskier when the default probability increases
    - Default risk **interacts** with precautionary behavior

Main findings

- Sovereign risk makes the response of output to shocks
  - Nonlinear
  - State-dependent
- Feedback effect explains significant portion of the crisis
  - 20% – 40% of output contraction attributable to default
- Large welfare effects
  - Volatility of output and consumption 25% and 55% lower without default
  - Unemployment halved
  - Households would give up 10% of permanent consumption to avoid defaults
- New light on Aguiar-Gopinath facts ▸ More
  - Amplification of negative shocks, demand-driven recessions
  - In downturns volatility of $C >$ volatility of Y

Related Literature

- **Sovereign risk affecting the supply side through finance**
  Neumeyer and Perri (2005), Bocola (2016), Arellano, Bai, and Mihalache (2018), Balke (2017)
- **Domestic debt and default incentives**
  Gennaioli, Martin, and Rossi (2014), Mengus (2014), Mallucci (2015), Pérez (2016), Sosa-Padilla (2018), D'Erasmo and Mendoza (2016), Ferriere (2016), ...
- **Sovereign risk and fiscal austerity**
  Cuadra, Sánchez, and Sapriza (2010), Romei (2015), Bianchi, Ottonello, and Presno (2016), Anzoategui (2017), Philippon and Roldán (2018)
- **Shocks affecting aggregate demand through redistribution**
  Auclert (2017), Eggertsson and Krugman (2012), Korinek and Simsek (2016), ...

Roadmap

- Evidence
- Description of Model
- Model Results
- Simulations
- Crises

Evidence

Main Specification

- Regress outcome variable Q_{jt} on country j's spread

$$Q_{jt} = \beta \Delta Spread_{jt} + \gamma X_{jt} + \delta_t + \mu_j + \epsilon_{jt}$$

  where $Q_{jt} = \log Y_{jt}, \log C_{jt}$

- IV strategy (based on Martin and Philippon, 2017)

$$\Delta Spread_{jt} = \underbrace{\phi B_{j0} + \delta_t}_{Z_{jt}} + \eta_{jt}$$

- Data for 11 European countries between 2010Q1 – 2013Q1

  Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain

Feedback

	Dependent variable:			
	log Y_{jt}	log C_{jt}	log Y_{jt}	log C_{jt}
	(1)	(2)	(3)	(4)
$\Delta Spread_{jt}$	-0.008^{***}	-0.013^{***}		
	(0.001)	(0.001)		
$\Delta Spread_{jt}$ (IV)			-0.006^{**}	-0.010^{***}
			(0.002)	(0.003)
Country + Time FE	✓	✓	✓	✓
Observations	143	143	143	143
Adj. R^2	0.772	0.784	0.765	0.776

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

▸ The Cycle is the Trend

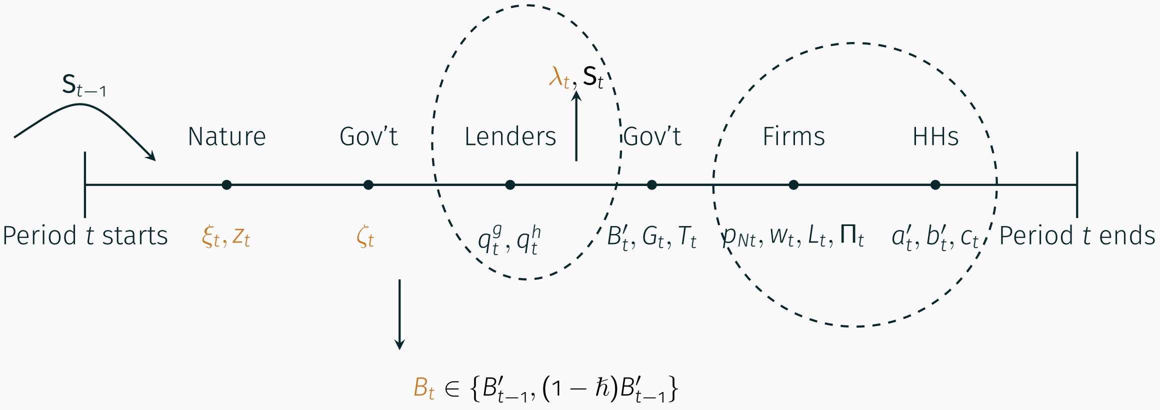
Description of Model

General Description

- Small open economy with
  - Uninsurable idiosyncratic income risk + Incomplete markets
  - Default risk
  - Nominal rigidities
- Actors:
  - A government
    - Issues long-term debt, purchases goods, decides repayment
  - Households
    - Consume, work, save in the gov't **bond** + risk-free **debt**
    - Differ in 'cash' holdings, idiosyncratic income shock
  - Firms
    - Produce the goods with labor, subject to **wage rigidities**
  - Foreigners
    - Lend to the government and to the private sector
    - Price all assets

Timeline

Jump to Gov't objective



Decisions within a period

Dashed ellipses encircle simultaneous decisions

Government Policy

At each t, the government

- Chooses repayment $h_t \in \{1, 1-\hbar\}$
- Follows fiscal rules for new **issuances** $B'(\mathbf{S}_t)$ and spending $G(\mathbf{S}_t)$
  - Can depend on full state: $(B_t, \lambda_t, \xi_t, \zeta_t, z_t)$ ▸ Fiscal rules
- Must satisfy its budget constraint

$$\underbrace{q_t^g}_{\text{debt price}} \underbrace{(B_t' - (1-\rho)B_t)}_{\text{new debt issued}} + \underbrace{T_t}_{\text{lump-sum}} + \underbrace{\tau w_t L_t}_{\text{payroll tax}} = \underbrace{G_t}_{\text{spending}} + \underbrace{\kappa B_t}_{\text{coupon}}$$

$\rightarrow$ T_t summarizes a default / austerity tradeoff

Given a government policy $h(\mathsf{S},\xi',z'), B'(\mathsf{S}), T(\mathsf{S},q^g)$, in a comp eq'm

- Risk-neutral foreigners ▸ General Formulation
  - Price all assets

$$q^h(\mathsf{S}) = \frac{1}{1+r^\star}$$

$$q^g(\mathsf{S}) = \frac{1}{1+r^\star}\mathbb{E}\left[\underbrace{\mathbb{1}_{(\zeta'=1)}(1-\xi')\kappa}_{\textit{coupon}} + \underbrace{(1-\rho)}_{\textit{depreciation}}\underbrace{\left(1-\hbar\mathbb{1}_{(\zeta=1\cap\zeta'\neq1)}\right)}_{\textit{potential haircut}}\underbrace{q^g(\mathsf{S}')}_{\textit{resale price}}\;\Big|\;\mathsf{S}\right]$$

Given a government policy $h(\mathsf{S}, \xi', z'), B'(\mathsf{S}), T(\mathsf{S}, q^g)$, in a comp eq'm

- Risk-neutral foreigners ▸ General Formulation
  - Price all assets

$$q^g(\mathsf{S}) = \underbrace{\frac{1}{1+r^\star}}_{q^h(\mathsf{S})} \mathbb{E}\left[\underbrace{\mathbb{1}_{(\zeta'=1)}(1-\xi')\kappa}_{\text{coupon}} + \underbrace{(1-\rho)}_{\text{depreciation}} \underbrace{\left(1-\hbar\mathbb{1}_{(\zeta=1\cap\zeta'\neq 1)}\right)}_{\text{potential haircut}} \underbrace{q^g(\mathsf{S}')}_{\text{resale price}} \;\middle|\; \mathsf{S}\right]$$

- Firms
  - Traded and nontraded goods, CES aggregator, wage rigidities

$$Y_{Nt} = L_{Nt}^{\alpha_N}\left(1-\Delta\mathbb{1}_{(\zeta\neq 1)}\right) \qquad Y_{Tt} = z_t L_{Tt}^{\alpha_T}\left(1-\Delta\mathbb{1}_{(\zeta\neq 1)}\right) \qquad W_t \geq \bar{W}$$

Given a government policy $h(\mathsf{S},\xi',z'), B'(\mathsf{S}), T(\mathsf{S},q^g)$, in a comp eq'm

- Risk-neutral foreigners ▸ General Formulation
  - Price all assets

$$q^g(\mathsf{S}) = \underbrace{\frac{1}{1+r^\star}}_{q^h(\mathsf{S})} \mathbb{E}\left[\underbrace{\mathbb{1}_{(\zeta'=1)}(1-\xi')\kappa}_{\text{coupon}} + \underbrace{(1-\rho)}_{\text{depreciation}} \underbrace{\left(1-\hbar\mathbb{1}_{(\zeta=1\cap\zeta'\neq 1)}\right)}_{\text{potential haircut}} \underbrace{q^g(\mathsf{S}')}_{\text{resale price}} \;\middle|\; \mathsf{S}\right]$$

- Firms
  - Traded and nontraded goods, CES aggregator, wage rigidities

$$Y_{Nt} = L_{Nt}^{\alpha_N}\left(1-\Delta\mathbb{1}_{(\zeta\neq 1)}\right) \qquad Y_{Tt} = z_t L_{Tt}^{\alpha_T}\left(1-\Delta\mathbb{1}_{(\zeta\neq 1)}\right) \qquad w_t \geq \bar{w}$$

- Households
  - Access to both assets with borrowing limits, inelastic labor supply
- Approximation: $\lambda_t = \log\mathcal{N}(\mu_t,\Sigma_t)$. So $\mathsf{S} = (B,\mu,\sigma,\xi,\zeta,z)$

- Given govt's policies, aggregates, and evolution of the state

$$v(\omega,\epsilon,\mathsf{S})^{\frac{\psi-1}{\psi}} = \max_{c,a',b'} (1-\beta)c^{\frac{\psi-1}{\psi}} + \beta\mathbb{E}\left[\left(v(\underbrace{a' + R_{\mathsf{S},\mathsf{S}'}b'}_{=\omega'},\epsilon',\mathsf{S}')\right)^{1-\gamma}\middle|\,\omega,\epsilon,\mathsf{S}\right]^{\frac{\psi-1}{\psi(1-\gamma)}}$$

$$\begin{aligned}
\text{subject to } p_C(\mathsf{S})c + q^h(\mathsf{S})a' + q^g(\mathsf{S})b' &= \omega + \ell(\mathsf{S})\epsilon - T(\mathsf{S}) \\
\ell(\mathsf{S}) &= w(\mathsf{S})L(\mathsf{S})(1-\tau) + \Pi(\mathsf{S}) \\
R_{\mathsf{S},\mathsf{S}'} &= \mathbb{1}_{(\zeta'=1)}\kappa + (1-\rho)\left(1-\hbar\mathbb{1}_{(\zeta=1)(\zeta'\neq 1)}\right)q^g(\mathsf{S}') \\
a' &\geq \bar{a}; \qquad b' \geq 0 \\
\mathsf{S}' &= \Psi(\mathsf{S},\xi',z',h') \\
&\text{Exog LoMs for } (\epsilon,\xi,z)\text{; prob of } h' \text{ given } \left(\mathsf{S},\xi',z'\right)
\end{aligned}$$

- Given govt's policies, aggregates, and evolution of the state

$$V(\omega,\epsilon,S)^{\frac{\psi-1}{\psi}} = \max_{c,a',b'} (1-\beta)c^{\frac{\psi-1}{\psi}} + \beta\mathbb{E}\left[\left(V(\underbrace{a' + R_{S,S'} b'}_{=\omega'},\epsilon',S')\right)^{1-\gamma} \middle| \omega,\epsilon,S\right]^{\frac{\psi-1}{\psi(1-\gamma)}}$$

$$\text{subject to } p_C(S)c + q^h(S)a' + q^g(S)b' = \omega + \ell(S)\epsilon - T(S)$$

$$R_{S,S'} = \mathbb{1}_{(\zeta'=1)}\kappa + (1-\rho)\left(1-\hbar\mathbb{1}_{(\zeta=1)(\zeta'\neq 1)}\right) q^g(S')$$

In crisis times

- $\pi\uparrow \implies \mathbb{E}[w'L'] = \pi\mathbb{E}[w'L'|\zeta'\neq 1] + (1-\pi)\mathbb{E}[w'L'|\zeta'=1]\downarrow$ ← Aggregate effect
- $q^g\downarrow \implies \omega\downarrow$ for all ← Distributional effect
- $\text{cov}(R_{S,S'}, sdf' \mid S)\downarrow$ ← 'Savings technology' effect

Households

- Given govt's policies, aggregates, and evolution of the state

$$v(\omega,\epsilon,S)^{\frac{\psi-1}{\psi}} = \max_{c,a',b'} (1-\beta)c^{\frac{\psi-1}{\psi}} + \beta\mathbb{E}\left[\left(v(\underbrace{a' + R_{S,S'}b'}_{=\omega'},\epsilon',S')\right)^{1-\gamma} \middle| \omega,\epsilon,S\right]^{\frac{\psi-1}{\psi(1-\gamma)}}$$

$$\text{subject to } p_C(S)c + q^h(S)a' + q^g(S)b' = \omega + \ell(S)\epsilon - T(S)$$

$$R_{S,S'} = \mathbb{1}_{(\zeta'=1)}\kappa + (1-\rho)\left(1-\hbar\mathbb{1}_{(\zeta=1)(\zeta'\neq 1)}\right)q^g(S')$$

In crisis times

- $\pi\uparrow \implies \mathbb{E}[w'L'] = \pi\mathbb{E}[w'L'|\zeta'\neq 1] + (1-\pi)\mathbb{E}[w'L'|\zeta'=1]\downarrow$ ← Aggregate effect
- $q^g\downarrow \implies \omega\downarrow$ for all ← Distributional effect
- $\text{cov}(R_{S,S'}, sdf' \mid S)\downarrow$ ← 'Savings technology' effect

Households

- Given govt's policies, aggregates, and evolution of the state

$$v(\omega,\epsilon,\mathrm{S})^{\frac{\psi-1}{\psi}} = \max_{c,a',b'} (1-\beta)c^{\frac{\psi-1}{\psi}} + \beta\mathbb{E}\left[\left(v(\underbrace{a' + R_{\mathrm{S},\mathrm{S}'}b'}_{=\omega'},\epsilon',\mathrm{S}')\right)^{1-\gamma}\middle|\,\omega,\epsilon,\mathrm{S}\right]^{\frac{\psi-1}{\psi(1-\gamma)}}$$

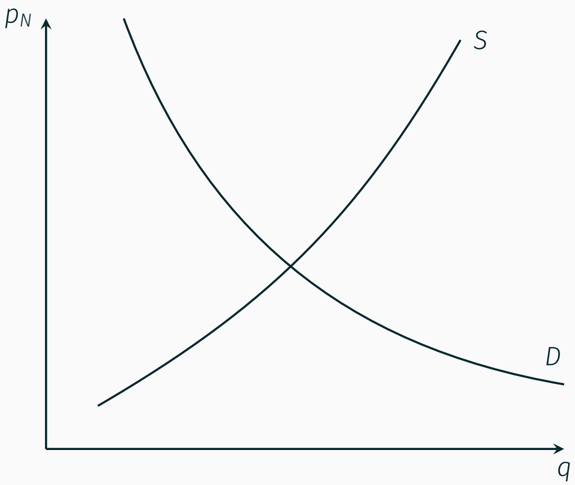
$$\text{subject to } p_C(\mathrm{S})c + q^h(\mathrm{S})a' + q^g(\mathrm{S})b' = \omega + \ell(\mathrm{S})\epsilon - T(\mathrm{S})$$

$$R_{\mathrm{S},\mathrm{S}'} = \mathbb{1}_{(\zeta'=1)}\kappa + (1-\rho)\left(1-\hbar\mathbb{1}_{(\zeta=1)(\zeta'\neq 1)}\right)q^g(\mathrm{S}')$$

In crisis times

- $\pi\uparrow \implies \mathbb{E}\left[w'L'\right] = \pi\mathbb{E}\left[w'L'|\zeta'\neq 1\right] + (1-\pi)\mathbb{E}\left[w'L'|\zeta'=1\right]\downarrow$ $\leftarrow$ Aggregate effect
- $q^g\downarrow \implies \omega\downarrow$ for all $\leftarrow$ Distributional effect
- $\mathrm{cov}(R_{\mathrm{S},\mathrm{S}'}, sdf' \mid \mathrm{S})\downarrow$ $\leftarrow$ 'Savings technology' effect

Aggregate Demand

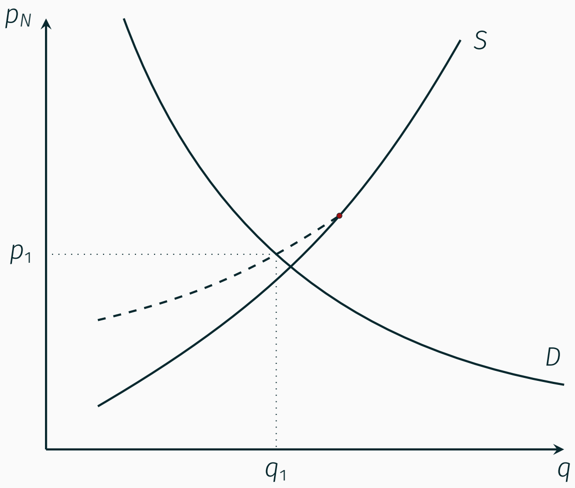


$$Y_N^d = C\varpi \left(\frac{p_N}{p_C}\right)^{-\eta} + \frac{\vartheta_N}{p_N} G$$

$$Y_N^s = L_N^{\alpha_N} \left(1 - \mathbb{1}_{(\zeta \neq 1)} \Delta\right)$$

$$L_N^d = \left(\alpha_N \frac{p_N}{w}\right)^{\frac{1}{1-\alpha_N}}$$

Aggregate Demand

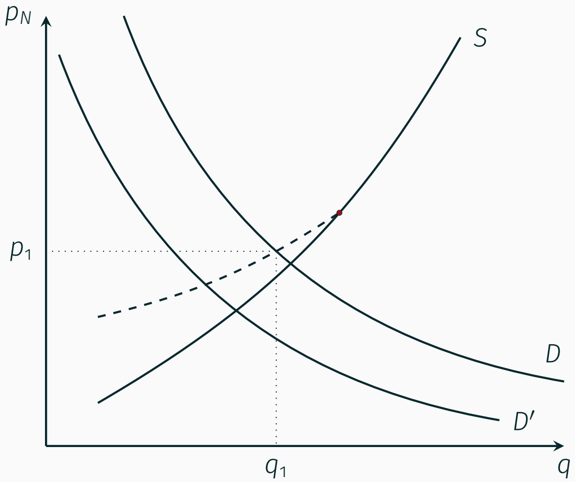


$$Y_N^d = C\varpi \left(\frac{p_N}{p_C}\right)^{-\eta} + \frac{\vartheta_N}{p_N} G$$

$$Y_N^s = L_N^{\alpha_N}\left(1 - \mathbb{1}_{(\zeta \neq 1)}\Delta\right)$$

$$L_N^d = \left(\alpha_N \frac{p_N}{\max\{w, \bar{w}\}}\right)^{\frac{1}{1-\alpha_N}}$$

Aggregate Demand

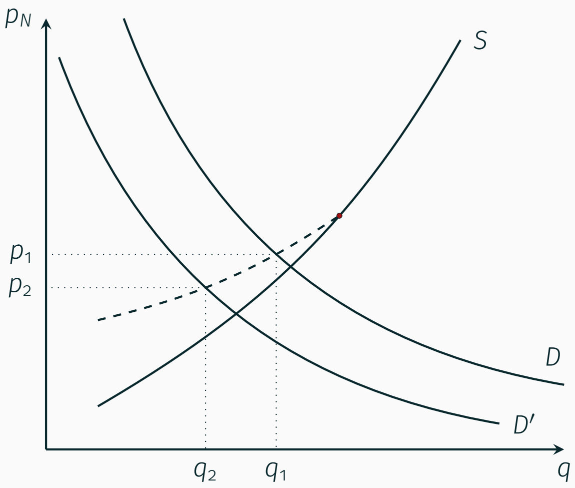


$$Y_N^d = C\varpi\left(\frac{p_N}{p_C}\right)^{-\eta} + \frac{\vartheta_N}{p_N}G$$

$$Y_N^s = L_N^{\alpha_N}\left(1 - \mathbb{1}_{(\zeta\neq 1)}\Delta\right)$$

$$L_N^d = \left(\alpha_N \frac{p_N}{\max\{w, \bar{w}\}}\right)^{\frac{1}{1-\alpha_N}}$$

- $C \downarrow \implies p_N \downarrow \implies w \downarrow$



$$Y_N^d = C\varpi\left(\frac{p_N}{p_C}\right)^{-\eta} + \frac{\vartheta_N}{p_N}G$$

$$Y_N^s = L_N^{\alpha_N}\left(1 - \mathbb{1}_{(\zeta\neq 1)}\Delta\right)$$

$$L_N^d = \left(\alpha_N \frac{p_N}{\max\{w, \bar{w}\}}\right)^{\frac{1}{1-\alpha_N}}$$

- $C \downarrow \implies p_N \downarrow \implies w \downarrow$
- Wage rigidity creates price stickiness

- B_t' and G_t are given functions of S_t
- Default / Repayment is an optimal **choice**
  - Utilitarian objective

$$\mathcal{W}(\mathsf{S}) = \int v(\mathsf{s}, \mathsf{S}) d\lambda_{\mathsf{S}}(\mathsf{s})$$

- In period t, observe S_{t-1} and (ξ_t, z_t)
- Gov't understands $\mathsf{S}_t = \Psi(\mathsf{S}_{t-1}, \xi_t, z_t, \zeta_t)$ Distribution
- Default iff

$$\underbrace{\mathcal{W}\left(\Psi(\mathsf{S}_{t-1}, \xi_t, z_t, \zeta_t \neq 1)\right)}_{\text{v under def}} - \underbrace{\mathcal{W}\left(\Psi(\mathsf{S}_{t-1}, \xi_t, z_t, \zeta_t = 1)\right)}_{\text{v under rep}} \geq \sigma_g \xi_t^{\text{def}}$$

where $\xi_t^{\text{def}} \overset{iid}{\sim} \mathcal{N}(0, 1)$

The Government's Objective

Back to Timeline

- B_t' and G_t are given functions of $\mathbf{S}_t$
- Default / Repayment is an optimal **choice**
    - Utilitarian objective

$$\mathcal{W}(\mathbf{S}) = \int v(\mathbf{s}, \mathbf{S}) d\lambda_{\mathbf{S}}(\mathbf{s})$$

    - But B_t, ζ_t are part of $\mathbf{S}_t$!
    - Gov't understands $\mathbf{S}_t = \Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t)$ Distribution
    - Default iff

$$\underbrace{\mathcal{W}\left(\Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t \neq 1)\right)}_{\text{v under def}} - \underbrace{\mathcal{W}\left(\Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t = 1)\right)}_{\text{v under rep}} \geq \sigma_g \xi_t^{\text{def}}$$

where $\xi_t^{\text{def}} \overset{iid}{\sim} \mathcal{N}(0, 1)$

The Government's Objective

Back to Timeline

- B'_t and G_t are given functions of $\mathbf{S}_t$
- Default / Repayment is an optimal **choice**
  - Utilitarian objective

$$\mathcal{W}(\mathbf{S}) = \int v(\mathbf{s}, \mathbf{S}) d\lambda_{\mathbf{S}}(\mathbf{s})$$

  - In period t, observe $\mathbf{S}_{t-1}$ and (ξ_t, z_t)
  - Gov't understands $\mathbf{S}_t = \Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t)$ Distribution
  - Default iff

$$\underbrace{\mathcal{W}\left(\Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t \neq 1)\right)}_{\text{v under def}} - \underbrace{\mathcal{W}\left(\Psi(\mathbf{S}_{t-1}, \xi_t, z_t, \zeta_t = 1)\right)}_{\text{v under rep}} \geq \sigma_g \xi_t^{\text{def}}$$

where $\xi_t^{\text{def}} \stackrel{iid}{\sim} \mathcal{N}(0, 1)$

Definition

Given fiscal rules $B'(\mathsf{S}), G(\mathsf{S})$, an *equilibrium* consists of ▸ Algorithm

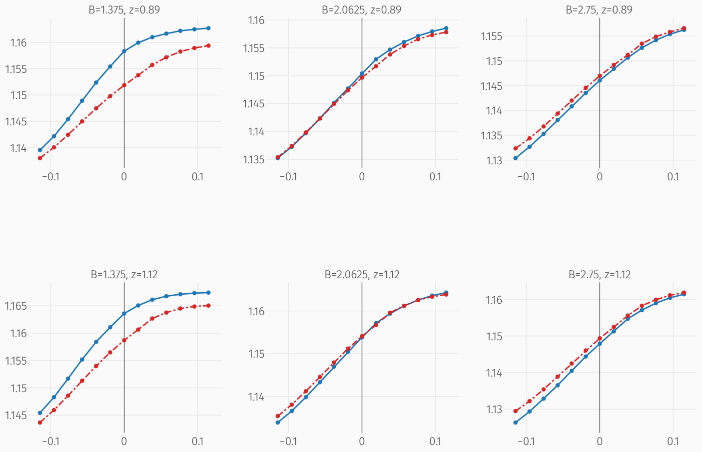
- A government policy $h'(\mathsf{S}, \xi', z'), T(\mathsf{S})$
- Policy functions $\{\phi_a, \phi_b, \phi_c\}(\mathsf{s}, \mathsf{S})$
- Prices $p_C(\mathsf{S}), p_N(\mathsf{S}), w(\mathsf{S}), q^g(\mathsf{S})$. Quantities $L_N(\mathsf{S}), L_T(\mathsf{S}), \Pi(\mathsf{S}), T(\mathsf{S})$
- Laws of motion $\mu'(\mathsf{S}, \xi', z'; h), \sigma'(\mathsf{S}, \xi', z'; h)$

such that

- The policy functions solve the household's problem
- The laws of motion are consistent with the policy functions
- Firms maximize profits, $w(\mathsf{S}) \geq \bar{w}$, markets clear ▸ Market Clearing
- h' maximizes $\mathcal{W}(\Psi(\mathsf{S}, \xi', z', \cdot))$ for gov't, taxes respect budget constraint.

Model Results

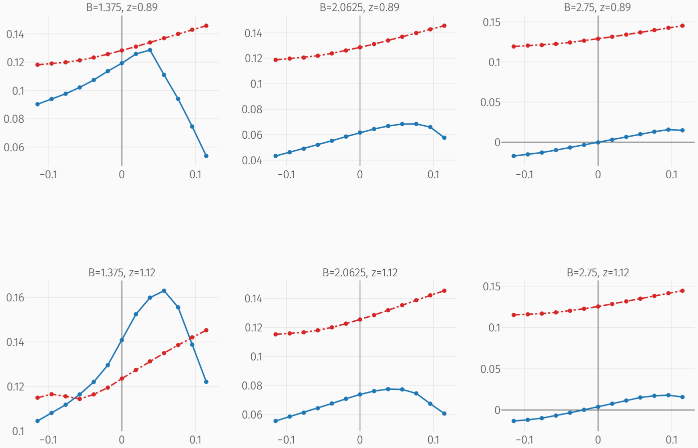
Objective function



Anticipated objective function

Blue: repayment, red: default

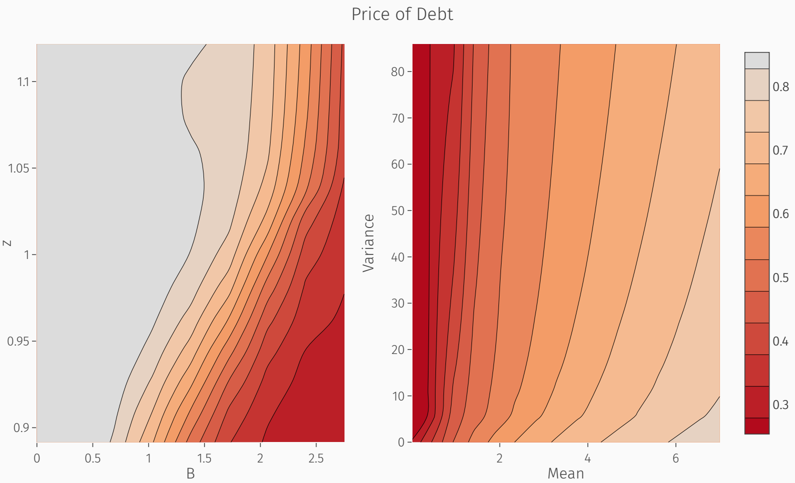
Transfers



Transfers

Blue: repayment, red: default

Price of Debt



Model: Benchmark

Unemployment

Model: Benchmark

Simulations

Calibration

Description	Parameter	Value	Source
Risk-free rate	$r^\star$	4% ann.	Anzoategui (2017)
Haircut in case of default	$\hbar$	50%	Philippon and Roldán (2018)
TFP loss in case of default	Δ	10%	Philippon and Roldán (2018)
Share of nontraded in prod	ϖ	0.74	Anzoategui (2017)
Share of nontraded in G	ϑ_N	88%	Anzoategui (2017)
Idiosyncratic income	$\rho_\epsilon, \sigma_\epsilon$	(0.978, 0.022)	D'Erasmo and Mendoza (2016)
Internally calibrated			**Target (Spain)**
Discount rate of HHs	$1/\beta - 1$	4.46% ann.	Moments in Table 1
Risk aversion	γ	14.3	Moments in Table 1
Progressivity of tax schedule	τ	19.4%	Moments in Table 1
Wage minimum	$\bar{w}$	1.15	Moments in Table 1
TFP process	ρ_z, σ_z	(0.886, 0.0371)	Moments in Table 1
Mean risk premium	$\bar{\xi}$	1.39%	Moments in Table 1
Risk premium AR(1)	ρ_ξ, σ_ξ	(0.948, 0.00195)	Moments in Table 1

Calibration (cont'd)

- Simulate model solution for 8000 years
- Agents' believe $\lambda_t = \log \mathcal{N}(\mu_t, \sigma_t)$
- Keep track of actual distribution

Target	Model	Data
AR(1) coef $\log(Y_t)$	0.994	0.966
Std coef $\log(Y_t)$	0.0399	0.0129
AR(1) coef $\log(C_t)$	0.998	0.962
Std coef $\log(C_t)$	0.0157	0.0166
AR(1) coef spread	0.987	0.967
Std coef spread	0.064	0.103
Avg Debt-to-GDP	72.8%	64.6%
Std Debt-to-GDP	17.4%	23.5%
Avg unemployment	17.4%	15.9%
Std unemployment	8.65%	6.09%
Median dom holdings	53.6%	56.5%
Avg wealth-to-GDP	56.8%	94.5%

Table 1: Model Fit

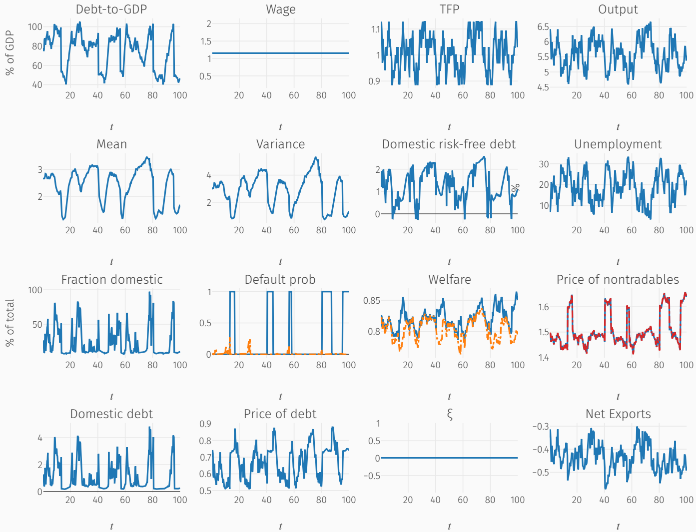
Calibration (cont'd)

- Simulate model solution for 8000 years
- Agents' believe $\lambda_t = \log \mathcal{N}(\mu_t, \sigma_t)$
- Keep track of actual distribution

Target	Model	Data
AR(1) coef $\log(Y_t)$	0.994	0.966
Std coef $\log(Y_t)$	0.0399	0.0129
AR(1) coef $\log(C_t)$	0.998	0.962
Std coef $\log(C_t)$	0.0157	0.0166
AR(1) coef spread	0.987	0.967
Std coef spread	0.064	0.103
Avg Debt-to-GDP	72.8%	64.6%
Std Debt-to-GDP	17.4%	23.5%
Avg unemployment	17.4%	15.9%
Std unemployment	8.65%	6.09%
Median dom holdings	53.6%	56.5%
Avg wealth-to-GDP	56.8%	94.5%

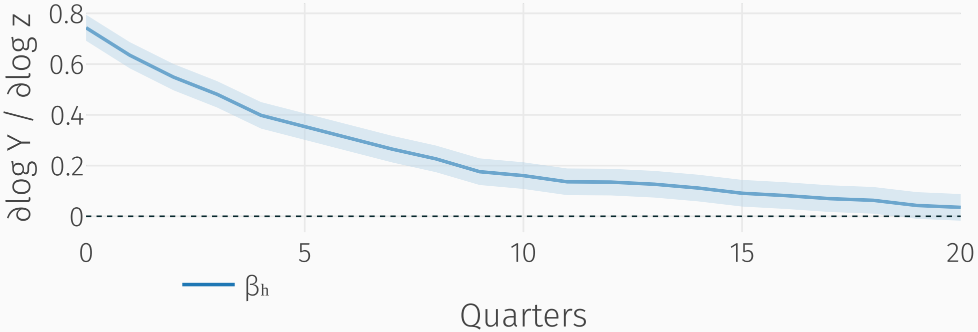
Table 1: Model Fit

Simulated Paths



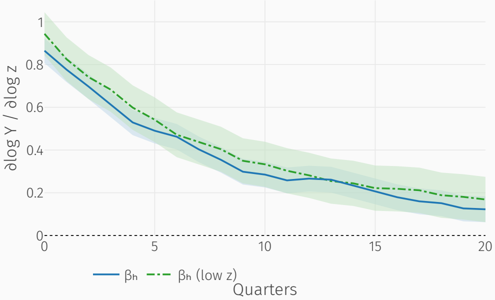
Amplification of TFP shocks

$$\log Y_{t+h} = \alpha + \beta_h \log \epsilon_t^z + \eta_{t+h}$$

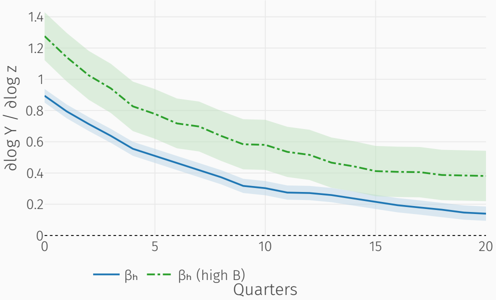


Response of Output to a TFP shock

Amplification of TFP shocks (cont'd)

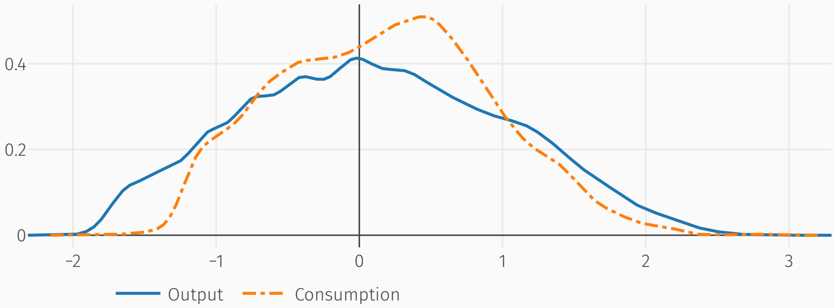


For large shocks



For indebted economies

Ergodic Distributions



Ergodic Densities for Normalized Output and Consumption

▸ Crisis ▸ Default ▸ Unconditional

Crises

Simulated Crises

In simulated data

- Record all episodes of
    i. High spreads for 7 quarters
    ii. Default
- Take 2-year windows around each
    - Left with 178 defaults ($\sim 4.5\%$ annual freq)
- Compute distribution of endogenous variables around them

Simulated Data – Crises

▸ Defaults

Red: Median, Shaded blue: [0.25, 0.75] percentiles, Dashed green: Mean

Simulated Data – Crises

- Decompose output contraction between
  - TFP + wage rigidities
  - Aggregate demand
- Compare against a no default benchmark
  - Give the no-default economy the same shocks as the benchmarks
  - Extract the same t's

Key

Conditioning on high spreads only $\implies$ economies only differ in expectations

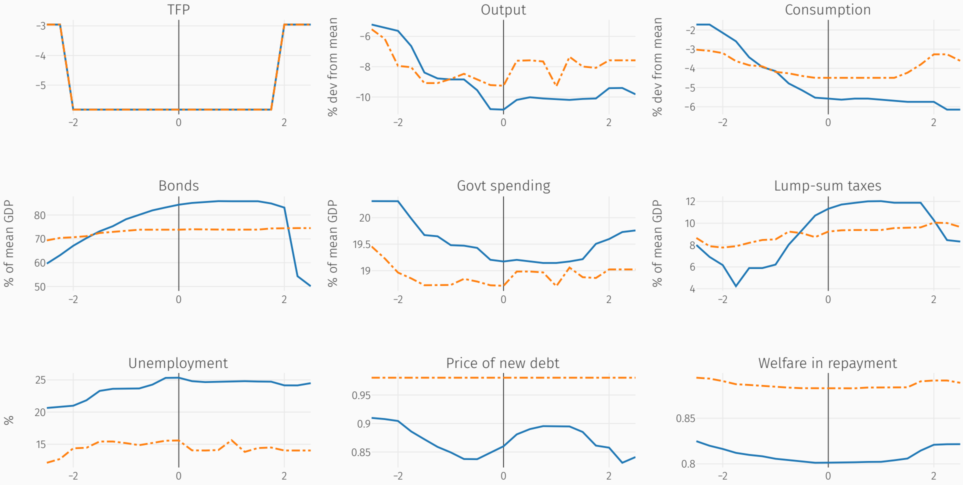
Simulated Data – Crises

- Decompose output contraction between
  - TFP + wage rigidities
  - Aggregate demand
- Compare against a no default benchmark
  - Give the no-default economy the same shocks as the benchmarks
  - Extract the same t's

Key

Conditioning on high spreads only $\Longrightarrow$ economies only differ in expectations

Simulated Data – No default Benchmark



Blue: Benchmark, Dashed orange: No default

Target	Benchmark	No default
AR(1) coef $\log(Y_t)$	0.994	0.998
Std coef $\log(Y_t)$	0.0399	0.0306
AR(1) coef $\log(C_t)$	0.998	0.998
Std coef $\log(C_t)$	0.0157	0.00699
AR(1) coef spread	0.987	1
Std coef spread	0.064	0.000471
Avg Debt-to-GDP	72.8%	57.5%
Std Debt-to-GDP	17.4%	24.5%
Avg unemployment	17.4%	8.27%
Std unemployment	8.65%	7.13%
Median dom holdings	53.6%	130%
Avg wealth-to-GDP	56.8%	93.3%

Table 2: Models

Still Missing

- Compare episodes of high spreads in simulated data against
    i. No TFP costs of default $\leftarrow$ shuts down aggregate income losses
        - $\Delta = 0$
    ii. Only TFP costs of default $\leftarrow$ shuts down redistributive wealth effects
        - Keep paying coupons in default + $\hbar = 0$
    $\rightarrow$ (*i*) + (*ii*) = no default

- Compare against representative agent benchmark

Concluding Remarks

- Interested in **interaction** of
  - Default risk
  - Precautionary behavior

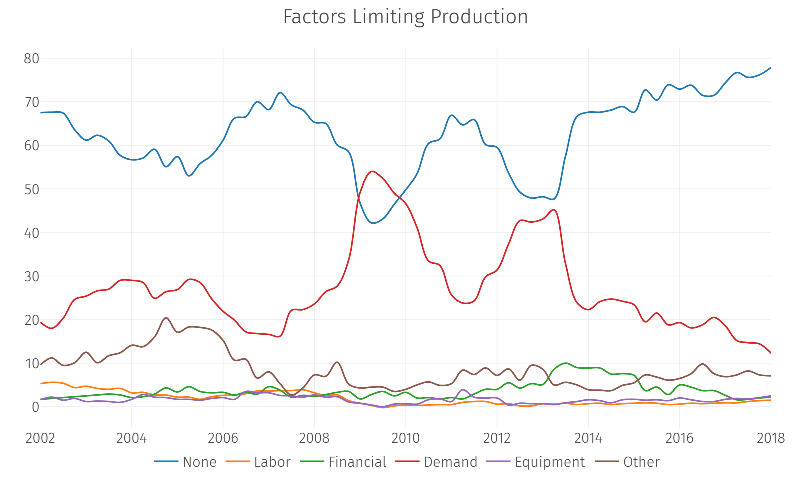
  \+ implications for amplification of shocks

- Channel helps explain severity of recessions in debt crises
  - Default risk creates high **volatility** of consumption and unemployment
  - Large welfare costs of sovereign risk – up to 10% of permanent consumption

- Key:
  - Aggregate + redistributive wealth effects if default
  - Agents take precautions against those
  - Timing flips usual MPC / transfer argument

Italy

Back

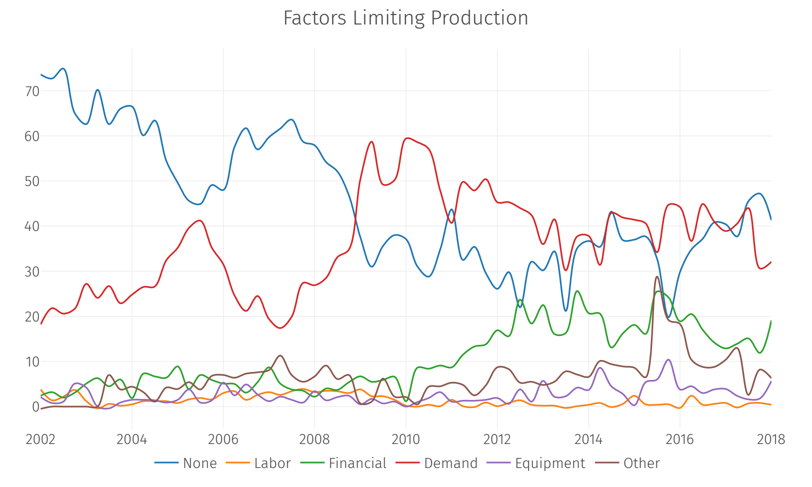


Italian firms' self-reported limits to production

Source: Eurostat

Greece

Back

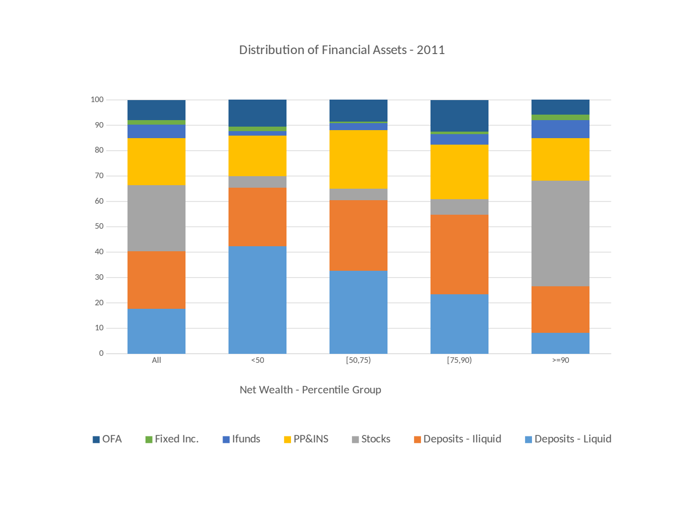


Greek firms' self-reported limits to production

Source: Eurostat

Household survey

- Companion paper: dom exp to Spanish sovereign risk ◂ Back



Measuring Exposures to Sovereign Debt - Banks

Measure exposure based on Philippon and Salord (2017)

- study European banks resolutions in Cyprus
- average total recapitalization need was around 17.4% of assets
- private investors provided 33% of need via loss in equity (91%), junior debt (53%) and senior debt (14%)
- remaining 2/3 came from government intervention

→ assumed not possible in Spain!
→ remaining need comes from senior debt and depositors

Back

Measuring Exposures to Sovereign Debt - Deposits

Work with different scenarios of loss on deposits:

Scenario	SD Loss	Dep. Loss
Extreme	25%	14%
Mild	50%	10%
Conservative	75%	5%

Table 3: Expected losses on deposits

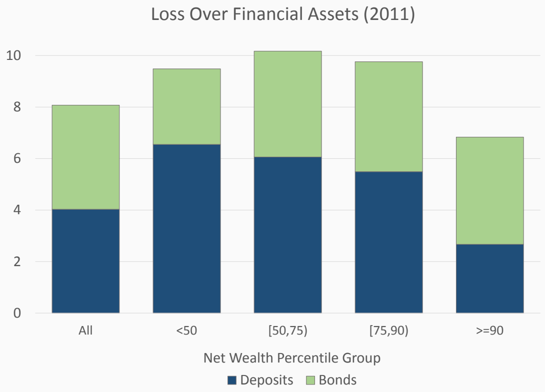
- Assume a 50% haircut on public debt that triggers a bank crisis
- Loss for depositors of 10%
- Overall, public debt and bank crisis would induce a fall of between 8% and 10% of financial assets

Back

Data - Exposures

Back

- Companion paper: dom exp to Spanish sovereign risk More
- Pension funds, mutual funds, insurance – perfect passthrough
- Deposits – more complicated
  - Philippon and Salord (2017): bank resolutions in Cyprus Details



Fiscal Rules

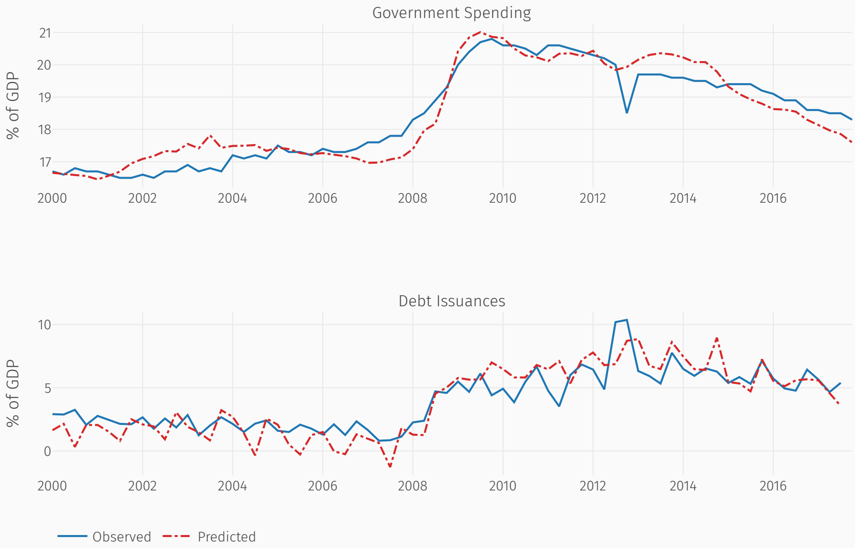
Back

	G_t/Y_t		$\left(B'_t-(1-\rho)B_t\right)/Y_t$	
	(1)	(2)	(3)	(4)
Unemployment_t	0.031	0.073^{***}	0.334^{**}	0.346^{***}
	(0.039)	(0.015)	(0.158)	(0.059)
Unemployment_t^2	0.002		0.0001	
	(0.001)		(0.006)	
B_t/Y_t	0.010^{*}	-0.017^{***}	-0.010	0.009
	(0.005)	(0.002)	(0.020)	(0.007)
$(B_t/Y_t)^2$	-0.0002^{***}		0.0001	
	(0.00004)		(0.0001)	
Net Exports_t	0.009	0.007	0.046	0.019
	(0.019)	(0.012)	(0.075)	(0.046)
Net Exports_t^2	-0.0001		-0.001	
	(0.001)		(0.003)	
Mean FE	20.675	21.085	1.079	0.571
Country + Time FE	✓	✓	✓	✓
Observations	968	968	957	957
Adj. R^2	0.904	0.901	0.697	0.698

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

Fiscal Rules (cont'd)

Back



Evolution of the Distribution

The law of motion for λ

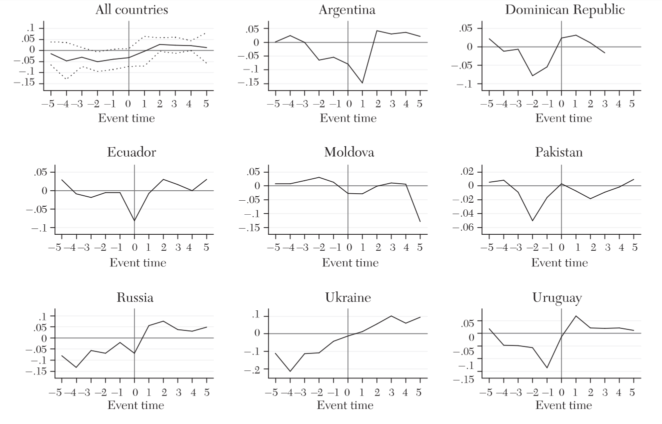
- Policy functions ϕ_a, ϕ_b at S_t determine assets at $t+1$
- After seeing z_{t+1}, the government decides **repayment**
- At S_{t+1}, relationship between $q^g(\mathsf{S}_{t+1})$, $R_b(\mathsf{S}_{t+1})$, μ_{t+1}, σ_{t+1}

$$R_b(\mathsf{S}_{t+1}) = \mathbb{1}_{(\zeta_{t+1}=1)}\kappa + (1-\rho)q^g(\mathsf{S}_{t+1})$$
$$\int \omega d\lambda_{t+1} = \int \phi_a(\mathsf{S}_t) + R_b(\mathsf{S}_{t+1})\phi_b(\mathsf{S}_t)d\lambda_t$$
$$\int \omega^2 d\lambda_{t+1} = \int \left(\phi_a(\mathsf{S}_t) + R_b(\mathsf{S}_{t+1})\phi_b(\mathsf{S}_t)\right)^2 d\lambda_t$$

Back

Output growth and defaults

Back

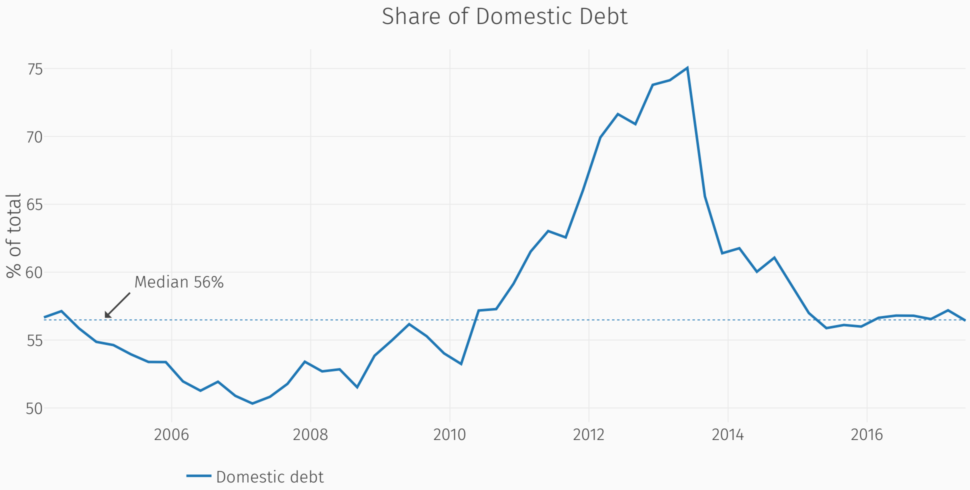


Defaults and output growth

Source: Panizza, Sturzenegger, and Zettelmeyer (2009)

Share of Domestic Debt

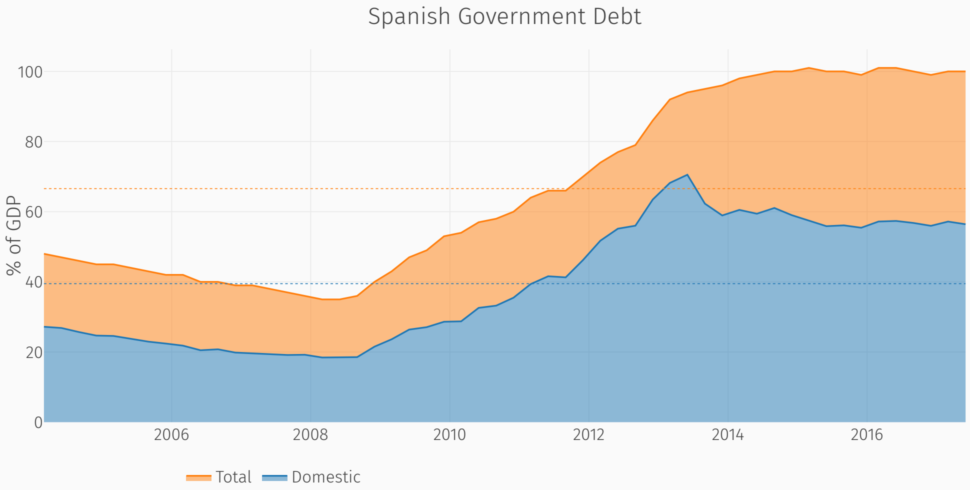
Back



Source: Morelli and Roldán (2018) on Banco de España

Share of Domestic Debt

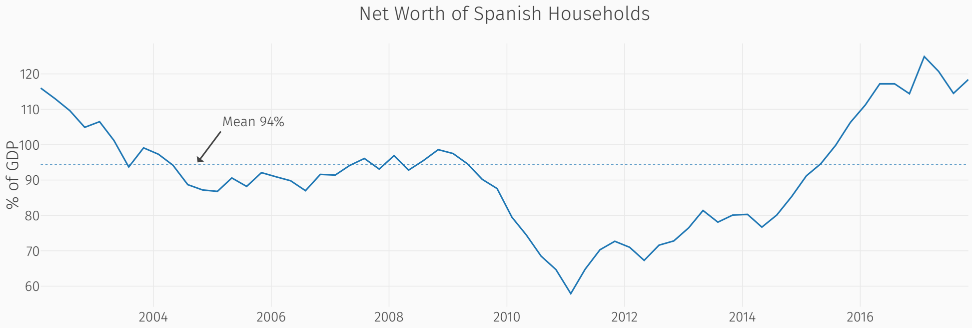
Back



Source: Morelli and Roldán (2018) on Banco de España
Dotted lines are sample averages

Net Worth

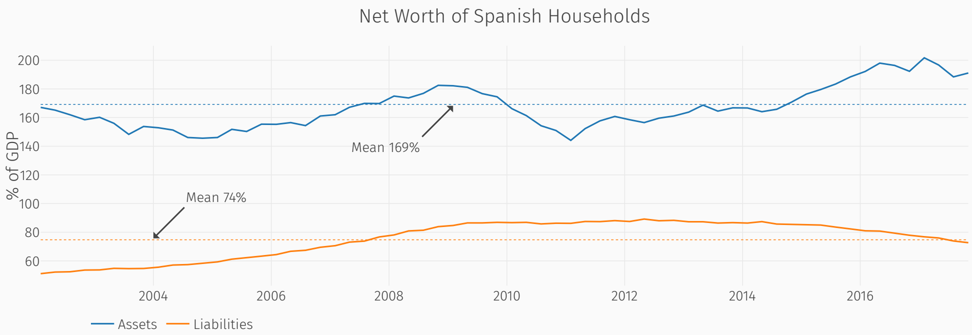
Back



Source: Eurostat
Dotted lines are sample averages

Net Worth

Back



Source: Eurostat
Dotted lines are sample averages

General SDF of Foreigners

- If risk-averse foreigners

$$q_t^h = \frac{1}{1+r^\star}\mathbb{E}_t\left[\left(\frac{C_{t+1}^f}{C_t^f}\right)^{-\gamma_f}\right]$$

$$q_t^g = \frac{1}{1+r^\star}\mathbb{E}_t\left[\left(\frac{C_{t+1}^f}{C_t^f}\right)^{-\gamma_f} R_{t,t+1}^b\right]$$

where $R_{t,t+1}^b = \mathbb{1}_{(\zeta_{t+1}=1)}\tilde{\kappa} + (1-\rho)(1-\hbar\mathbb{1}_{(\zeta_t=1\cap\zeta_{t+1}\neq 1)})q_{t+1}^g$

- Reduces to risk-neutral if

$$\text{cov}\left(\left(\frac{C_{t+1}^f}{C_t^f}\right)^{-\gamma_f}, R_{t,t+1}^b\right) = 0$$

Back

Solution Method

- Guess a policy for the government
  - Guess a law of motion for the distribution
    - Compute $q^g(\mathsf{S}), q^h$ from lenders' sdf.
    - Compute w, L_N, L_T, Π, T as functions of (S, p_N)
    - Guess a relative price of nontraded goods p_N
      - Solve the household's problem at $(\mathsf{s}, \mathsf{S}, p_N)$
      - Check market clearing for nontraded goods.
    - Iterate until $p_N(\mathsf{S})$ converges
  - Iterate until the law of motion converges
- Iterate on the government's policy

Back

Feedback

◂ Back

	Unemployment$_{jt}$			Saving rate$_{jt}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Spread$_{jt}$	1.381***			0.461***		
	(0.064)			(0.097)		
Spread$_{jt}$ (IV)		2.372***	1.951**		1.634	2.048
		(0.826)	(0.896)		(1.186)	(1.515)
Spread Non-fin$_{jt}$		−0.172	−0.450		0.654	0.832
		(0.297)	(0.306)		(0.628)	(0.626)
Spread Fin$_{jt}$		−0.364	0.076		−0.265	−0.595
		(0.530)	(0.601)		(0.666)	(0.901)
B_{jt}/Y_{jt}			0.040***			−0.035
			(0.012)			(0.035)
Model	OLS	IV	IV	OLS	IV	IV
Country FE	Y	Y	Y	Y	Y	Y
Quad Time Trend	Y	Y	Y	Y	Y	Y
Observations	968	304	304	569	179	179
Adj. R^2	0.731	0.715	0.713	0.450	0.420	0.398

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

Gilchrist-Mojon (2017) indices of corporate spreads for FRA, DEU, ITA, ESP. 2000Q1 – 2017Q4

Market Clearing

Back

- Three markets need to clear

$$Y_{Nt} = C_{Nt} + \frac{\vartheta_N}{p_{Nt}} G_t$$

$$Y_{Tt} = C_{Tt} + (1 - \vartheta_N) G_t - \texttt{NFI}_t$$

$$\left(L_{Nt} + L_{Tt} - 1\right)\left(w_t - \gamma w_{t-1}\right) = 0$$

where net foreign inflows are

$$\texttt{NFI}_t = \int \left(\omega - q_t^h \phi_a - q_t^g \phi_b\right) d\lambda_t - \kappa B_{t-1} + q_t^g \left(B_t - (1-\rho) B_{t-1}\right)$$

Feedback

Back

	Dependent variable Q_{jt}:							
	$\log Y_{jt}$				$\log C_{jt}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Spread_{jt}	-0.011^{***}				-0.011^{***}			
	(0.003)				(0.002)			
Spread_{jt} (IV)		-0.048^{**}	-0.031	-0.031		-0.088^{***}	-0.035^{**}	-0.035^{**}
		(0.019)	(0.023)	(0.024)		(0.022)	(0.017)	(0.016)
R^h_{jt}			0.054^{***}	0.049^{***}			0.004	-0.009
			(0.010)	(0.011)			(0.007)	(0.007)
R^s_{jt}				0.013				0.036
				(0.046)				(0.031)
Model	OLS	IV	IV	IV	OLS	IV	IV	IV
Country + Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	968	968	540	540	968	968	540	540
Adj. R^2	0.995	0.994	0.997	0.997	0.997	0.993	0.999	0.999

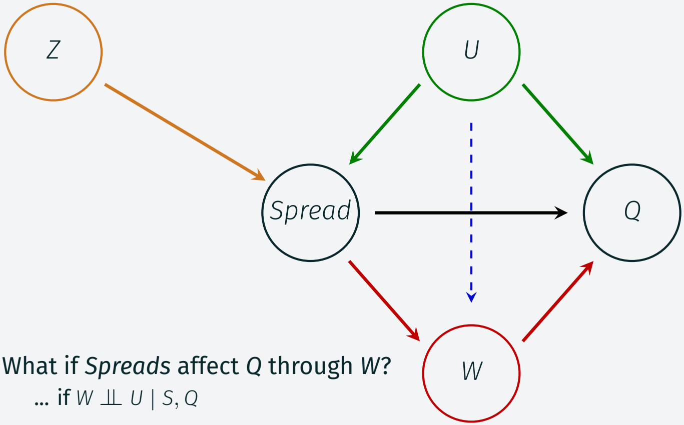
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
ECB borrowing rates for AUT, BEL, DEU, ESP, FRA, IRL, ITA, NLD, PRT. 2003Q1 – 2017Q4

Feedback

Back

	Dependent variable Q	
	(7)	(8)
Spread_{jt}		
Spread_{jt} (IV)	-0.035^{**}	-0.035^{**}
	(0.017)	(0.016)
R^h_{jt}	0.004	-0.009
	(0.007)	(0.007)
R^s_{jt}		0.036
		(0.031)
Model	IV	IV
Country + Time FE	✓	✓
Observations	540	540
Adj. R^2	0.999	0.999

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
ECB borrowing rates for AUT, BEL, DEU, ESP, FRA, IRL, ITA, NLD, PRT. 2003Q1 – 2017Q4



What if *Spreads* affect *Q* through *W*?

... if $W \perp\!\!\!\perp U \mid S, Q$

The Cycle is the Trend

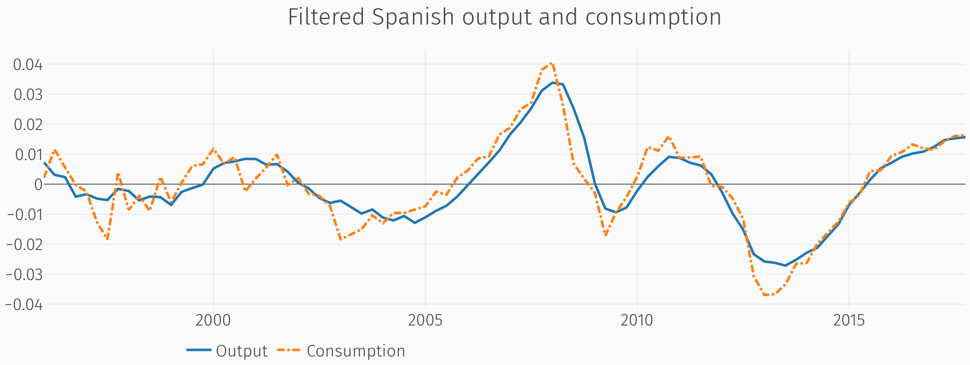
◂ Back to Motivation ◂ Back to Evidence

	$\sigma(C)$	$\sigma(Y)$	$\sigma(C)/\sigma(Y)$	$\sigma(C)/\sigma(Y)$ (AG)
Austria	0.716	0.782	0.916	0.870
Belgium	0.556	0.795	0.700	0.810
Denmark	1.047	1.178	0.889	1.190
Finland	1.278	1.957	0.653	0.940
France	0.780	0.773	1.009	—
Germany	0.692	0.867	0.799	—
Ireland	3.140	3.680	0.853	—
Italy	1.165	0.978	1.191	—
Netherlands	1.726	1.244	1.388	1.070
Portugal	1.827	1.576	1.160	1.020
Spain	1.901	1.396	1.362	1.110

HP filtered data with $\lambda = 1600$. Std deviations in %.

Spain in the Eurozone Crisis

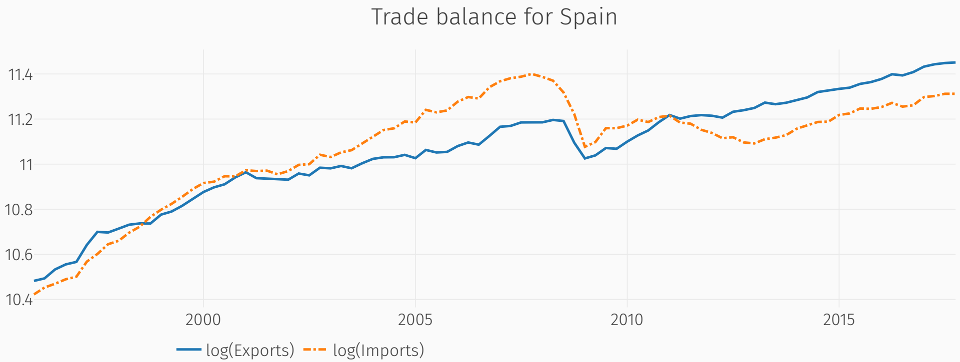
◂ Back



Spain in the 2000s

Spain in the Eurozone Crisis

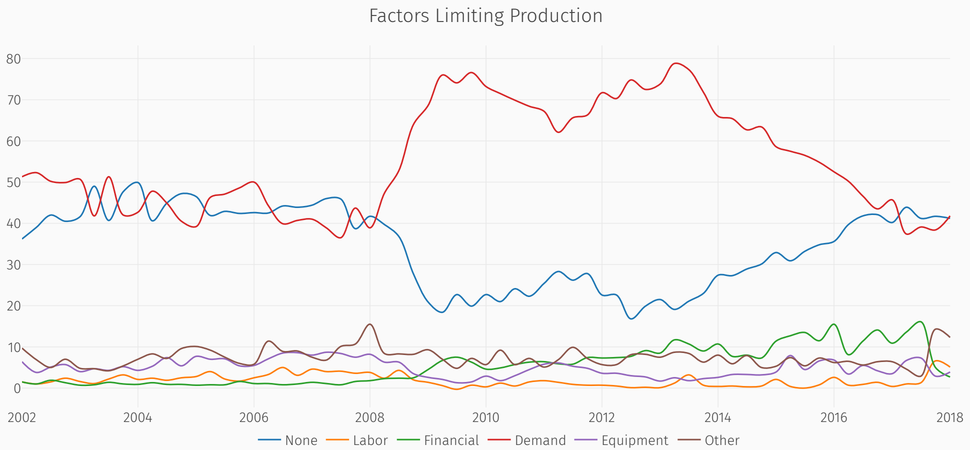
◂ Back



Spain in the 2000s

Low demand?

Back

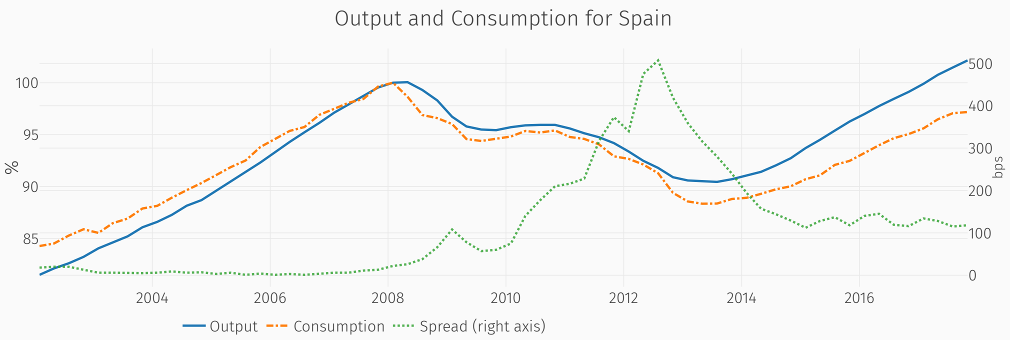


Spanish firms' self-reported limits to production

Source: Eurostat

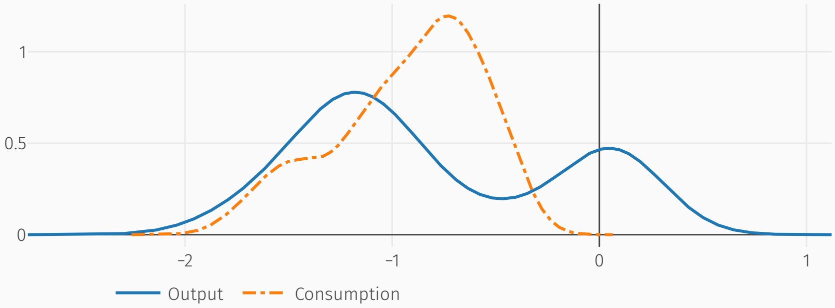
Nondurable Consumption

Back



Ergodic Distributions

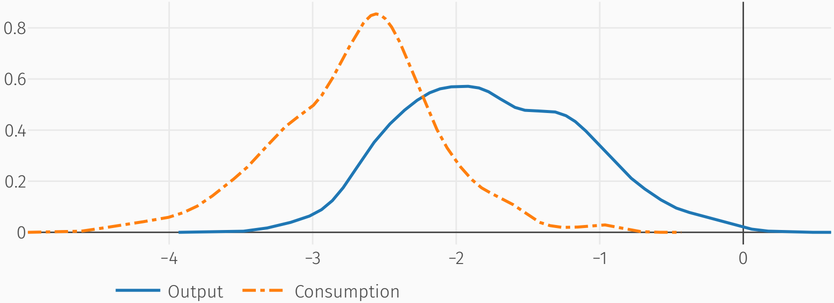
Back



Densities for Output and Consumption during Crises ($\pi \geq 15\%$)

Ergodic Distributions

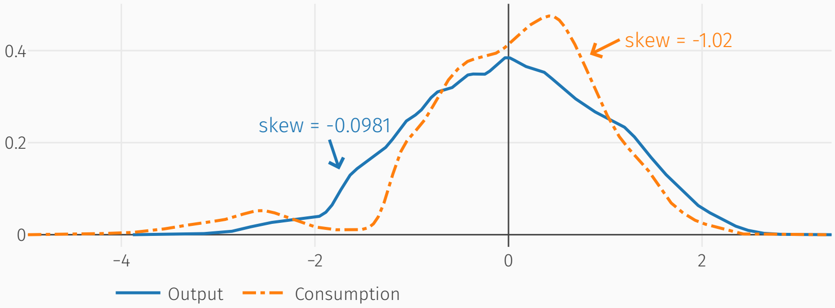
Back



Densities for Output and Consumption during Defaults

Ergodic Distributions

Back



Unconditional Ergodic Densities for Output and Consumption

Simulated Data – Default Episodes

Back

Red: Median, Shaded blue: [0.25, 0.75] percentiles, Dashed green: Mean

References

Anzoategui, D. (2017): "Sovereign Debt and the Effects of Fiscal Austerity," mimeo, NYU.

Arellano, C., Y. Bai, and G. Mihalache (2018): "Default risk, sectoral reallocation, and persistent recessions," *Journal of International Economics*, 112, 182–199.

Auclert, A. (2017): "Monetary Policy and the Redistribution Channel," Working Paper 23451, National Bureau of Economic Research.

Balke, N. (2017): "The Employment Cost of Sovereign Default," mimeo, UCL.

Bianchi, J., P. Ottonello, and I. Presno (2016): "Unemployment, Sovereign Debt, and Fiscal Policy in a Currency Union," 2016 Meeting Papers 459, Society for Economic Dynamics.

Bocola, L. (2016): "The Pass-Through of Sovereign Risk," *Journal of Political Economy*, 124, 879–926.

D'Erasmo, P. and E. G. Mendoza (2016): "Optimal Domestic (and External) Sovereign Default," Working Paper 22509, National Bureau of Economic Research.

Eggertsson, G. and P. Krugman (2012): "Debt, Deleveraging, and the Liquidity Trap: a Fisher-Minsky-Koo Approach," *Quarterly Journal of Economics*, 1469–1513.

Ferriere, A. (2016): "Sovereign default, inequality, and progressive taxation," Working paper, European University Insitute.

GENNAIOLI, N., A. MARTIN, AND S. ROSSI (2014): "Sovereign Default, Domestic Banks, and Financial Institutions," *Journal of Finance*, 69, 819–866.

HUIDROM, R., M. A. KOSE, J. J. LIM, AND F. L. OHNSORGE (2019): "Why do fiscal multipliers depend on fiscal Positions?" *Journal of Monetary Economics*.

KORINEK, A. AND A. SIMSEK (2016): "Liquidity Trap and Excessive Leverage," *American Economic Review*, 106, 699–738.

MALLUCCI, E. (2015): "Domestic Debt and Sovereign Defaults," International Finance Discussion Papers 1153, Board of Governors of the Federal Reserve System (U.S.).

MARTIN, P. AND T. PHILIPPON (2017): "Inspecting the Mechanism: Leverage and the Great Recession in the Eurozone," *American Economic Review*, 107, 1904–37.

MORELLI, J. M. AND F. ROLDÁN (2018): "Distributional Effects in Sovereign Debt Policy," mimeo, NYU.

NEUMEYER, P. A. AND F. PERRI (2005): "Business cycles in emerging economies: the role of interest rates," *Journal of Monetary Economics*, 52, 345–380.

PHILIPPON, T. AND F. ROLDÁN (2018): "On the Optimal Speed of Sovereign Deleveraging with Precautionary Savings," *IMF Economic Review*, 66, 375–413.