

# Aggregate Demand and Sovereign Debt Crises

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Francisco Roldán

New York University

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# MOTIVATION

- Sovereign debt crises associated with **deep** recessions [▶ More](#)

Output and Consumption for Spain



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

[▶ Detrended data](#)

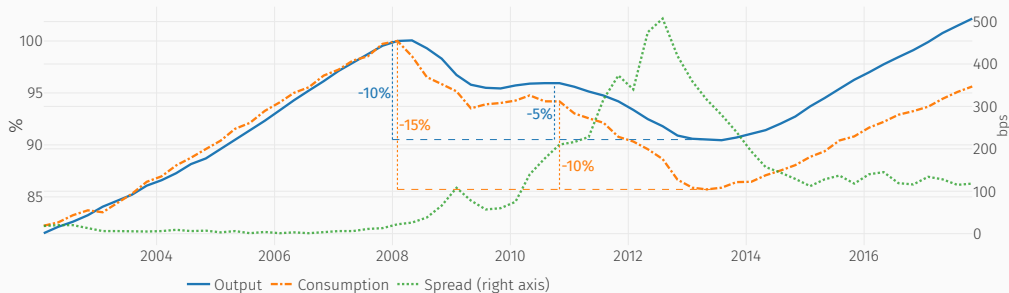
[▶ Trade balance](#)

[▶ Low demand?](#)

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  - $|\Delta C| > |\Delta Y| \implies$  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
- Sovereign debt literature assumes hand-to-mouth households or Law of One Price
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  - Consequences?
  - Substantial fraction of government debt held by residents [▶ Spanish data](#)

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- I propose a model of debt crises
  - Prominent role for household consumption/savings decision
    - Heterogeneous domestic savers can choose to be exposed to sovereign debt
  - Savings pattern in the crisis
  - **Feedback** loop between spreads and output
    - $\uparrow$  Spreads  $\implies$   $\downarrow$  Demand  $\implies$   $\downarrow$  Output
- Model
  - Expectations of outcomes in case of default
    - Aggregate income losses  $\longleftarrow$  TFP costs of default
    - Redistributive effects  $\longleftarrow$  Domestic debt holdings
  - Economy looks riskier when the default probability increases
    - Default risk **interacts** with precautionary behavior



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# MAIN FINDINGS

- Feedback effect explains significant portion of the crisis
  - Calibration numbers soon
- Highlight role of inequality, identity of debt holders
- New light on Aguiar-Gopinath facts [▶ More](#)
  - Amplification of negative shocks, demand-driven recessions
  - In downturns volatility of  $C >$  volatility of  $Y$

- **Sovereign risk affecting the supply side through finance**

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), D'Erasmus 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), ...

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

# EVIDENCE

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- 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)

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

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

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

	Dependent variable:			
	$\log Y_{jt}$ (1)	$\log C_{jt}$ (2)	$\log Y_{jt}$ (3)	$\log C_{jt}$ (4)
$\Delta Spread_{jt}$	-0.008*** (0.001)	-0.013*** (0.001)		
$\Delta Spread_{jt}$ (IV)			-0.006** (0.002)	-0.010*** (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. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

## DESCRIPTION OF MODEL

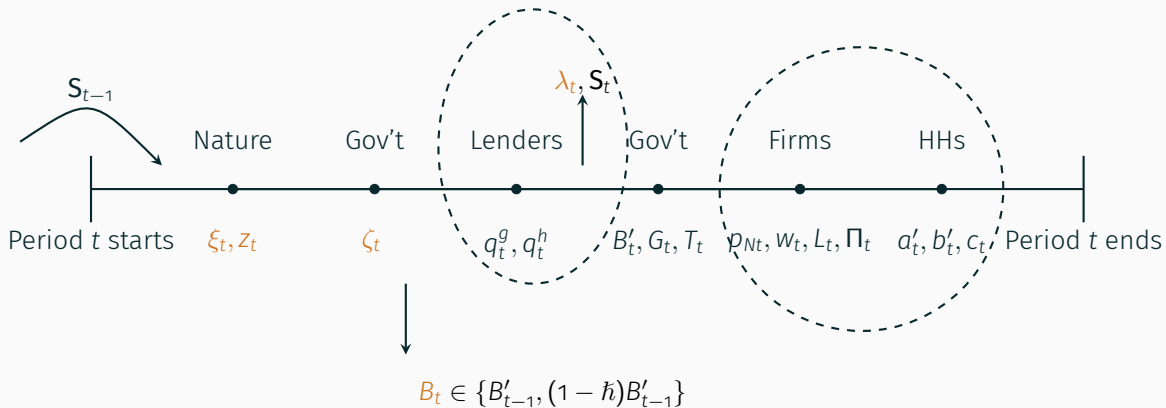
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## GENERAL DESCRIPTION

- 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



Decisions within a period  
Dashed ellipses encircle simultaneous decisions

At each  $t$ , the government

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

► Fiscal rules

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

→  $T_t$  summarizes a default / austerity tradeoff

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

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

$$q^h(\mathbf{S}) = \frac{1}{1 + r^*}$$

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

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

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

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

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

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

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

$$\ell(\mathbf{S}) = w(\mathbf{S})L(\mathbf{S})(1 - \tau) + \Pi(\mathbf{S})$$

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

$$a' \geq \bar{a}; \quad b' \geq 0$$

$$\mathbf{S}' = \Psi(\mathbf{S}, \xi', z', h')$$

$$\text{Exog LoMs for } (\epsilon, \xi, z); \text{ prob of } h' \text{ given } (\mathbf{S}, \xi', z')$$

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



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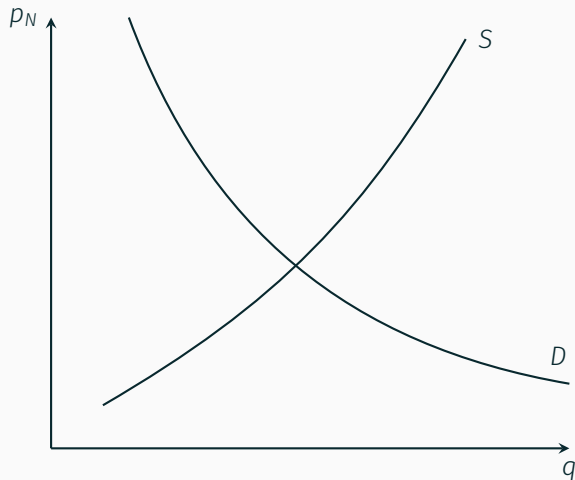
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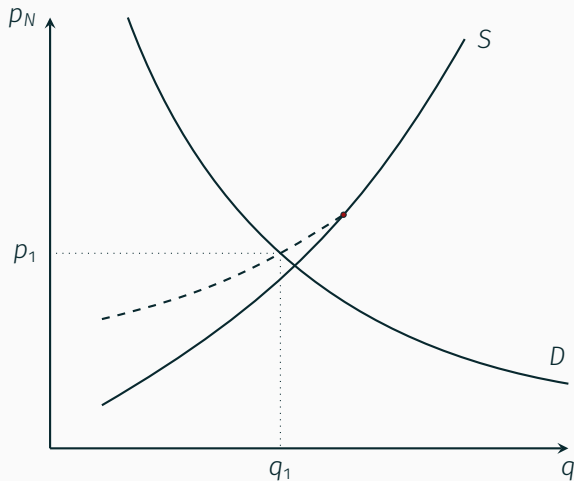


$$Y_N^d = C\varpi \left( \frac{p_N}{p_C} \right)^{-\eta} + \frac{\vartheta_N}{p_N} G$$

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

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

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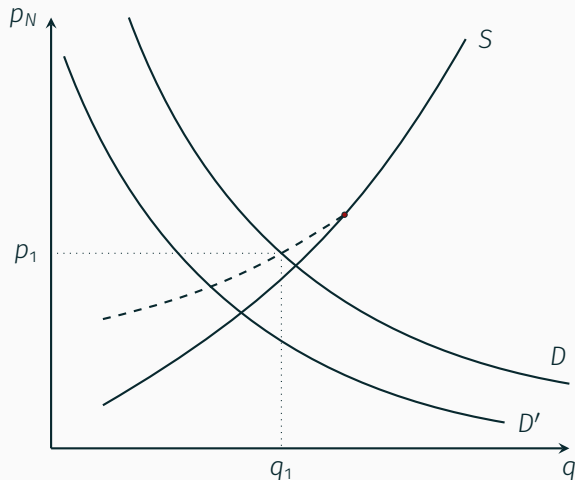


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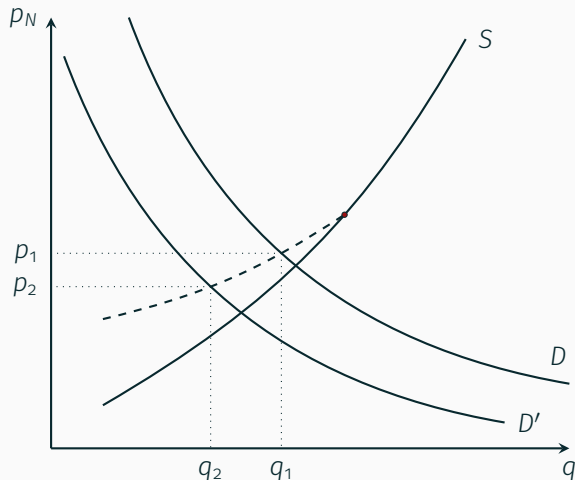
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$$\bullet C \downarrow \implies p_N \downarrow \implies w \downarrow$$

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

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

# THE GOVERNMENT'S OBJECTIVE

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

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

- In period  $t$ , observe  $S_{t-1}$  and  $(\xi_t, z_t)$
- Gov't understands  $S_t = \Psi(S_{t-1}, \xi_t, z_t, \zeta_t)$  ► Distribution
- Default iff

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

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

## Definition

Given fiscal rules  $B'(S)$ ,  $G(S)$ , an *equilibrium* consists of

► Algorithm

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

such that

- The policy functions solve the household's problem
- The laws of motion are consistent with the policy functions
- Firms maximize profits,  $w(S) \geq \bar{w}$ , markets clear
- The government's default policy maximizes  $\mathcal{W}(\Psi(S, \xi', z', \cdot))$

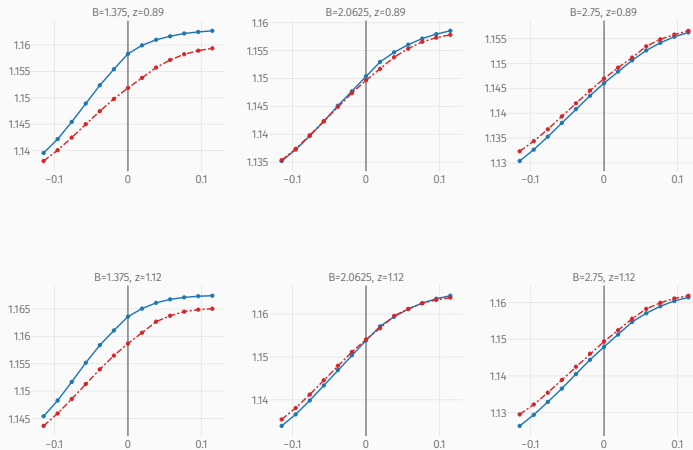
► Market Clearing



## MODEL RESULTS

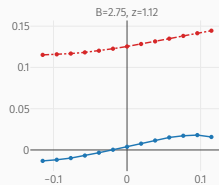
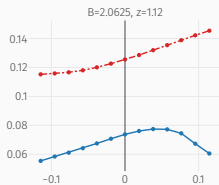
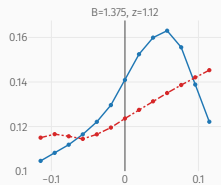
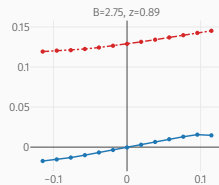
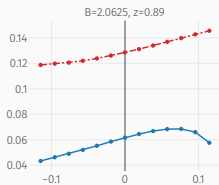
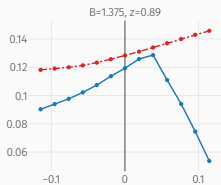
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# PRELIMINARY RESULTS



Anticipated objective function  
Blue: repayment, red: default

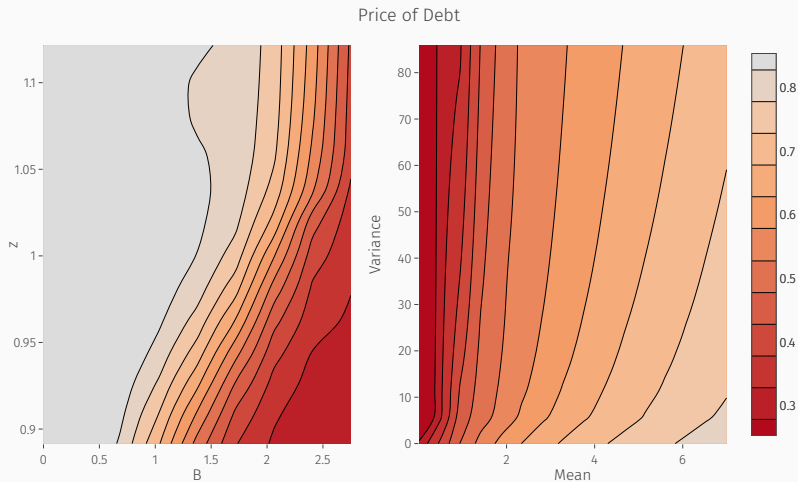
# PRELIMINARY RESULTS



Transfers

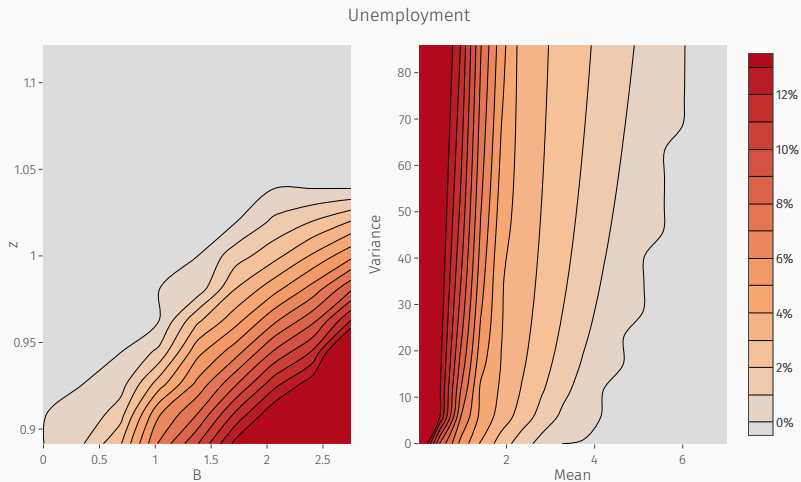
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# PRELIMINARY RESULTS



Model: Benchmark

# PRELIMINARY RESULTS



# SIMULATIONS

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Parameter	Value	Description	Source
$r^*$	4% ann.	Risk-free rate	Anzoategui (2017)
$\bar{h}$	50%	Haircut in case of default	Philippon and Roldán (2018)
$\Delta$	10%	TFP loss in case of default	Philippon and Roldán (2018)
$\varpi$	0.74	Share of nontraded in prod	Anzoategui (2017)
$\vartheta_N$	80%	Share of nontraded in G	Anzoategui (2017)
$\rho_\epsilon, \sigma_\epsilon$	(0.978, 0.022)	Idiosyncratic income	D'Erasmus and Mendoza (2016)
Internally calibrated			Target (Spain)
Discount rate of HHS	$1/\beta - 1$	4.5% ann.	Moments in Table 1
Risk aversion	$\gamma$	14.1	Moments in Table 1
Progressivity of tax schedule	$\tau$	19.3%	Moments in Table 1
Wage minimum	$\bar{w}$	1.15	Moments in Table 1
TFP process	$\rho_z, \sigma_z$	(0.892, 0.029)	Moments in Table 1
Mean risk premium	$\bar{\xi}$	1.4%	Moments in Table 1
Risk premium AR(1)	$\rho_\xi, \sigma_\xi$	(0.947, 0.002)	Moments in Table 1

Target	Model	Data
AR(1) coef $\log(Y_t)$	0.996	0.966
Std coef $\log(Y_t)$	0.0343	0.0129
AR(1) coef $\log(C_t)$	0.995	0.962
Std coef $\log(C_t)$	0.0207	0.0166
AR(1) coef spread	0.966	0.967
Std coef spread	0.161	0.103
Avg Debt-to-GDP	64.2%	64.6%
Std Debt-to-GDP	25.3%	23.5%
Avg unemployment	15.9%	15.9%
Std unemployment	7.59%	6.09%
Median dom holdings	79.6%	56.5%
Avg wealth-to-GDP	58%	94.5%

All data from Eurostat 2000Q1:2017Q4, except private consumption from OECD 2000Q1:2017Q4, domestic holdings from Banco de España, 2004Q1:2017Q4

Table 1: Model Fit

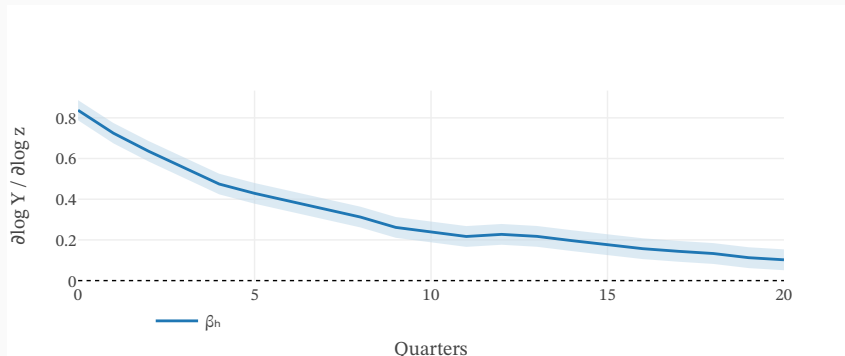


Target	Model	Data
AR(1) coef $\log(Y_t)$	0.996	0.966
Std coef $\log(Y_t)$	0.0343	0.0129
AR(1) coef $\log(C_t)$	0.995	0.962
Std coef $\log(C_t)$	0.0207	0.0166
AR(1) coef spread	0.966	0.967
Std coef spread	0.161	0.103
Avg Debt-to-GDP	64.2%	64.6%
Std Debt-to-GDP	25.3%	23.5%
Avg unemployment	15.9%	15.9%
Std unemployment	7.59%	6.09%
Median dom holdings	79.6%	56.5%
Avg wealth-to-GDP	58%	94.5%

All data from Eurostat 2000Q1:2017Q4, except private consumption from OECD 2000Q1:2017Q4, domestic holdings from Banco de España, 2004Q1:2017Q4

Table 1: Model Fit

# AMPLIFICATION OF TFP SHOCKS



Response of Output to a TFP shock

Shaded areas are 95% confidence intervals

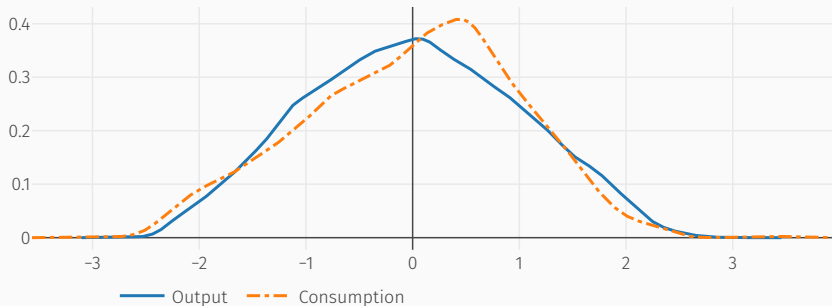
Fig 1 here

Figure 1: For large shocks

Fig 2 here

Figure 2: For indebted economies

# ERGODIC DISTRIBUTIONS



Ergodic Densities for Normalized Output and Consumption

# CRISES

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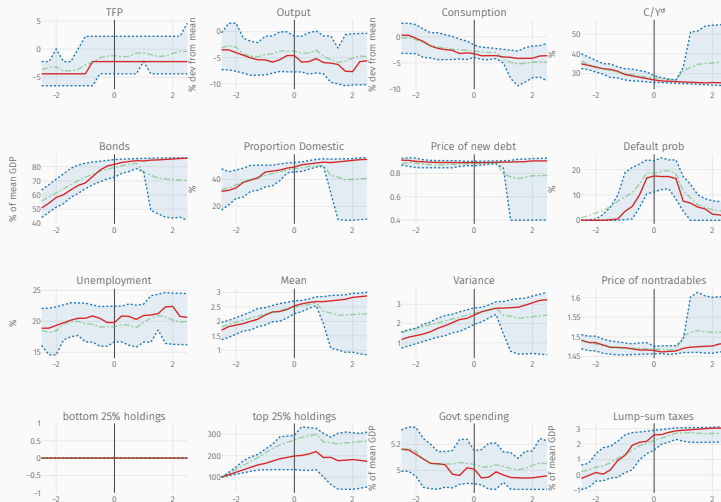
Simulate model economy for 2000 years

- Record all episodes of
  - i.* High spreads for 6 quarters
  - ii.* Default
- Take 2-year windows around each
  - Left with 131 defaults ( $\sim 6\%$  annual freq)
- Compute distribution of endogenous variables around them

# SIMULATED PATHS



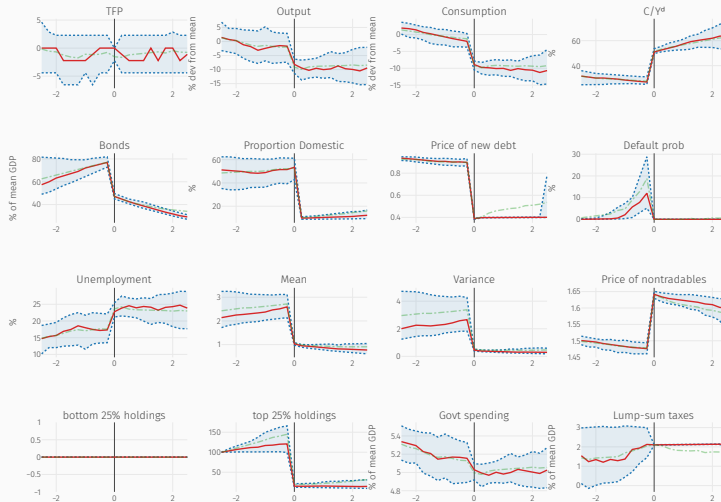
# SIMULATED DATA – HIGH SPREADS



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



# SIMULATED DATA – DEFAULT EPISODES



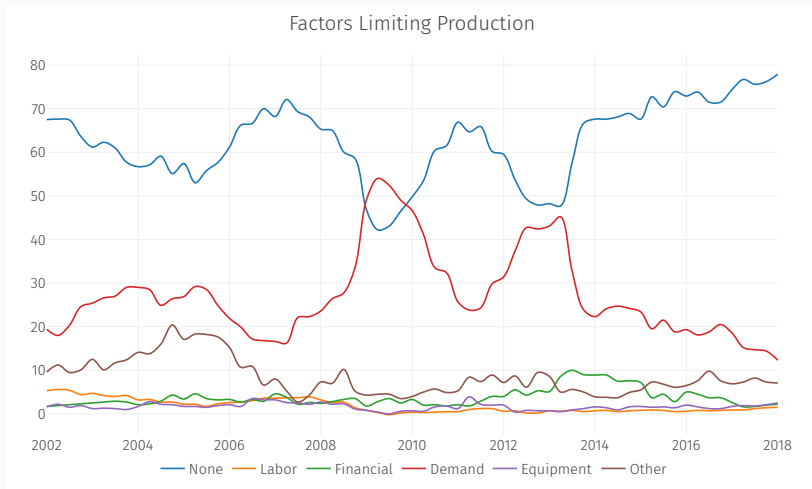
Red: Median, Shaded blue: [0.25, 0.75] percentiles, Dashed green: Mean

- **Calibrate** to match moments of Spanish economy
  - Standard: output, employment, spreads, net exports
  - New: distribution of exposures from Morelli and Roldán (2018) ▶ MR
- Compare episodes of high spreads in simulated data against
  - Same economy with no nominal rigidities
  - Same economy with **no risk**
    - Myopic domestic agents and foreigners who **perceive** no default risk
    - Myopic domestic agents only
  - No TFP costs of default ← shuts down aggregate income losses
  - No capital losses +  $\bar{h} = 0$  ← shuts down redistributive wealth effects
- Notions of **potential** output
- Difference is amplification through **extra** precautionary behavior
  - Different benchmarks emphasize different channels

## CONCLUDING REMARKS

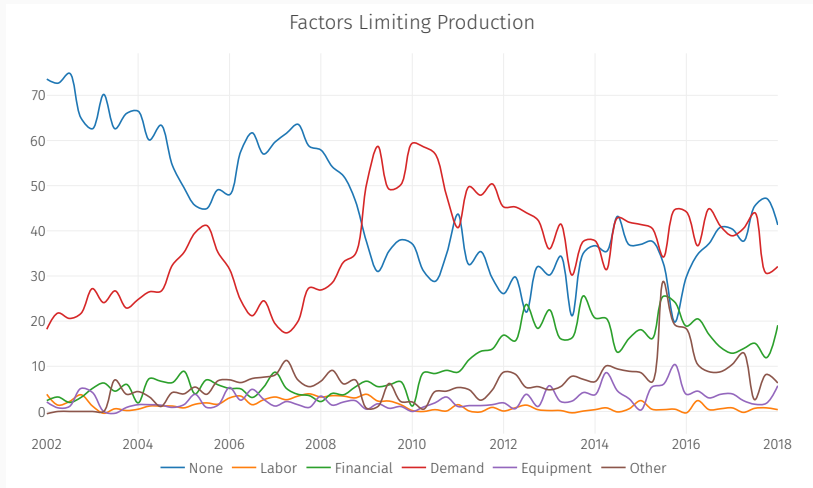
- Interested in interaction of
  - Default risk
  - Precautionary behavior
- + implications for amplification of shocks
- Potentially helps explain severity of Eurozone debt crisis
  - Exploit Spanish data for calibration of exposures
- Key:
  - Aggregate + redistributive wealth effects if default
  - Agents take precautions against those
  - Timing flips usual MPC / transfer argument
- All comments welcome!





Italian firms' self-reported limits to production

Source: Eurostat

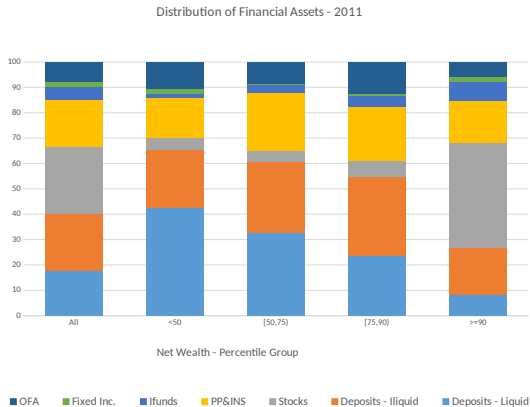


Greek firms' self-reported limits to production

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



# MEASURING EXPOSURES TO SOVEREIGN DEBT - DEPOSITS

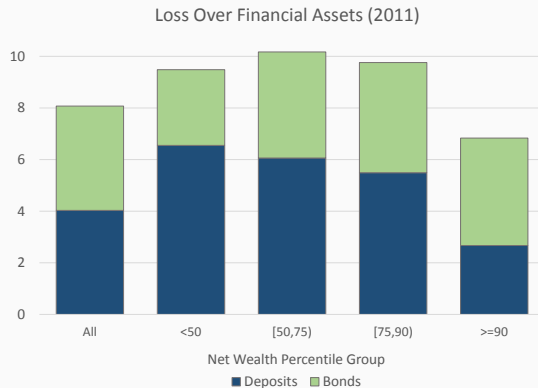
Work with different scenarios of loss on deposits:

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

**Table 2:** 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

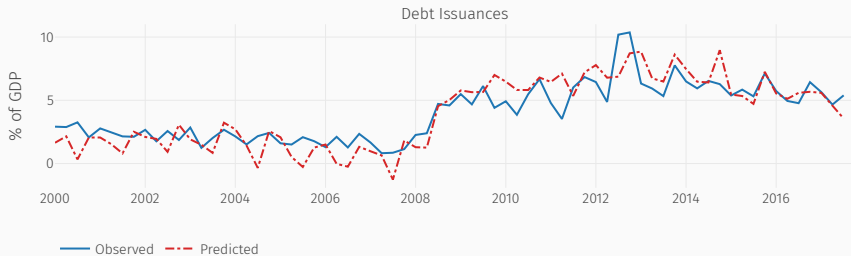
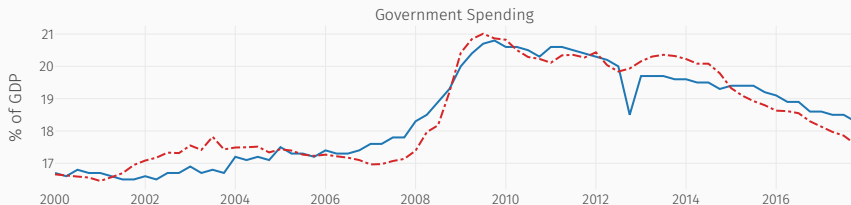
- Companion paper: dom exp to Spanish sovereign risk [▶ More](#)
- Pension funds, mutual funds, insurance – perfect passthrough
- Deposits – more complicated
  - Philippon and Salord (2017): bank resolutions in Cyprus [▶ Details](#)



	$G_t/Y_t$		$(B'_t - (1 - \rho)B_t) / Y_t$	
	(1)	(2)	(3)	(4)
Unemployment <sub>t</sub>	0.031 (0.039)	0.073*** (0.015)	0.334** (0.158)	0.346*** (0.059)
Unemployment <sub>t</sub> <sup>2</sup>	0.002 (0.001)		0.0001 (0.006)	
$B_t/Y_t$	0.010* (0.005)	-0.017*** (0.002)	-0.010 (0.020)	0.009 (0.007)
$(B_t/Y_t)^2$	-0.0002*** (0.00004)		0.0001 (0.0001)	
Net Exports <sub>t</sub>	0.009 (0.019)	0.007 (0.012)	0.046 (0.075)	0.019 (0.046)
Net Exports <sub>t</sub> <sup>2</sup>	-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)

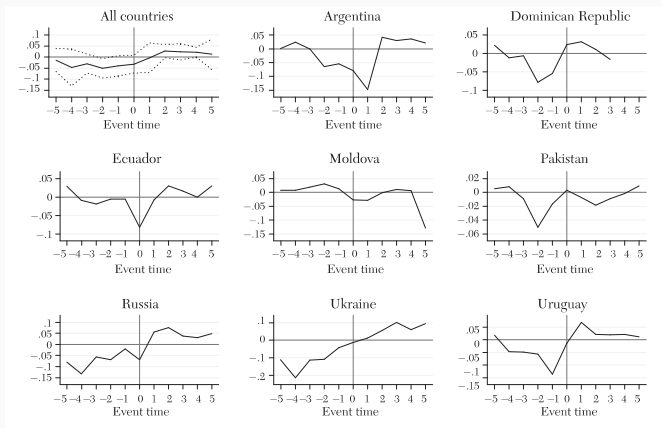
[◀ BACK](#)

# EVOLUTION OF THE DISTRIBUTION

The **law of motion** for  $\lambda$

- Policy functions  $\phi_a, \phi_b$  at  $\mathbf{S}_t$  determine assets at  $t + 1$
- After seeing  $z_{t+1}$ , the government decides **repayment**
- At  $\mathbf{S}_{t+1}$ , relationship between  $q^g(\mathbf{S}_{t+1})$ ,  $R_b(\mathbf{S}_{t+1})$ ,  $\mu_{t+1}$ ,  $\sigma_{t+1}$

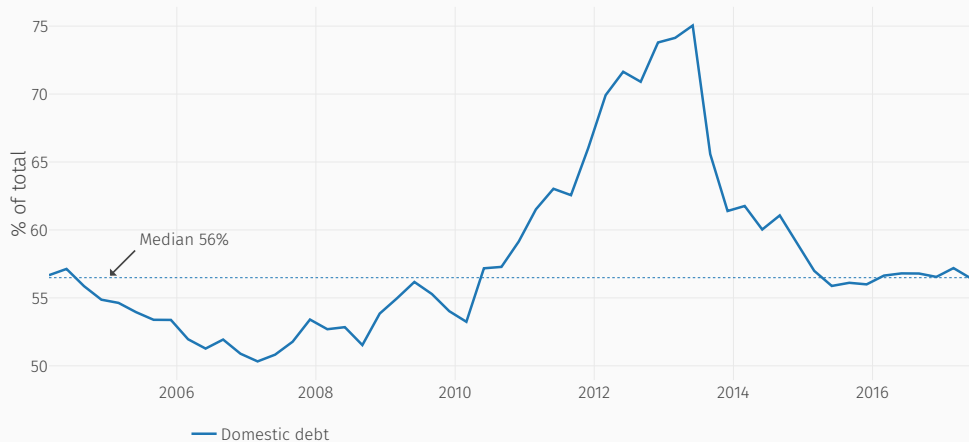
$$\begin{aligned}R_b(\mathbf{S}_{t+1}) &= \mathbb{I}_{(\zeta_{t+1}=1)}\kappa + (1 - \rho)q^g(\mathbf{S}_{t+1}) \\ \int \omega d\lambda_{t+1} &= \int \phi_a(\mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{S}_t) d\lambda_t \\ \int \omega^2 d\lambda_{t+1} &= \int (\phi_a(\mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{S}_t))^2 d\lambda_t\end{aligned}$$



Defaults and output growth

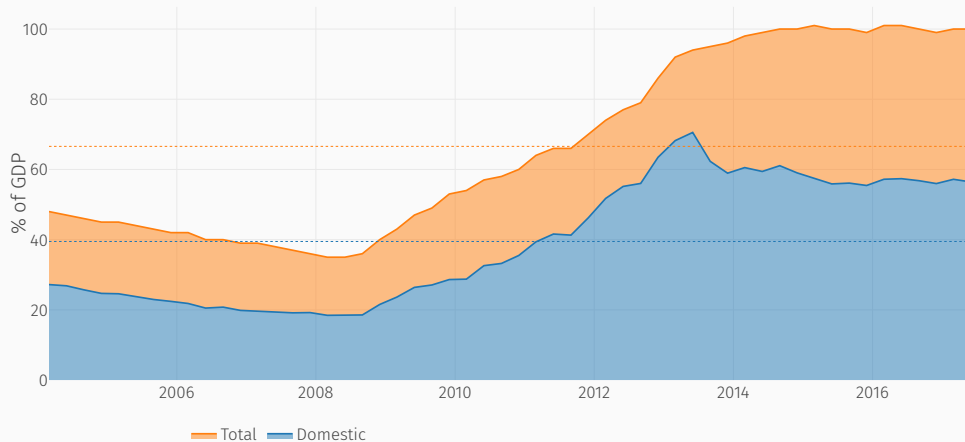
Source: Panizza, Sturzenegger, and Zettelmeyer (2009)

Share of Domestic Debt



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

## Spanish Government Debt



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



# GENERAL SDF OF FOREIGNERS

- If risk-averse foreigners

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

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

- Reduces to risk-neutral if

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

# SOLUTION METHOD

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

	Unemployment <sub>jt</sub>			Saving rate <sub>jt</sub>		
	(1)	(2)	(3)	(4)	(5)	(6)
Spread <sub>jt</sub>	1.381*** (0.064)			0.461*** (0.097)		
Spread <sub>jt</sub> (IV)		2.372*** (0.826)	1.951** (0.896)		1.634 (1.186)	2.048 (1.515)
Spread Non-fin <sub>jt</sub>		−0.172 (0.297)	−0.450 (0.306)		0.654 (0.628)	0.832 (0.626)
Spread Fin <sub>jt</sub>		−0.364 (0.530)	0.076 (0.601)		−0.265 (0.666)	−0.595 (0.901)
$B_{jt}/Y_{jt}$			0.040*** (0.012)			−0.035 (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 <sup>2</sup>	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

- Three markets need to clear

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

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

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

where net foreign inflows are

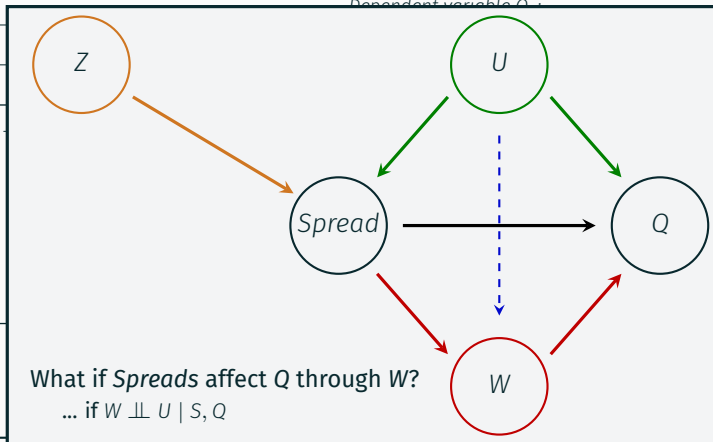
$$\mathbf{NFI}_t = \int (\omega - q_t^h \phi_a - q_t^g \phi_b) d\lambda_t - \kappa B_{t-1} + q_t^g (B_t - (1 - \rho) B_{t-1})$$

	Dependent variable $Q_{jt}$ :							
	$\log Y_{jt}$				$\log C_{jt}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Spread}_{jt}$	$-0.011^{***}$ (0.003)				$-0.011^{***}$ (0.002)			
$\text{Spread}_{jt} \text{ (IV)}$		$-0.048^{**}$ (0.019)	$-0.031$ (0.023)	$-0.031$ (0.024)		$-0.088^{***}$ (0.022)	$-0.035^{**}$ (0.017)	$-0.035^{**}$ (0.016)
$R_{jt}^h$			$0.054^{***}$ (0.010)	$0.049^{***}$ (0.011)			$0.004$ (0.007)	$-0.009$ (0.007)
$R_{jt}^s$				$0.013$ (0.046)				$0.036$ (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

Dependent variable  $Q_{jt}$



$Spread_{jt}$

$Spread_{jt}$  (IV)

$R^h_{jt}$

$R^S_{jt}$

Model

Country + Time FE

Observations

Adj.  $R^2$

(7)

(8)

0.035\*\*  
(0.017)

−0.035\*\*  
(0.016)

0.004  
(0.007)

−0.009  
(0.007)

0.036  
(0.031)

IV

✓

540

0.999

IV

✓

540

0.999

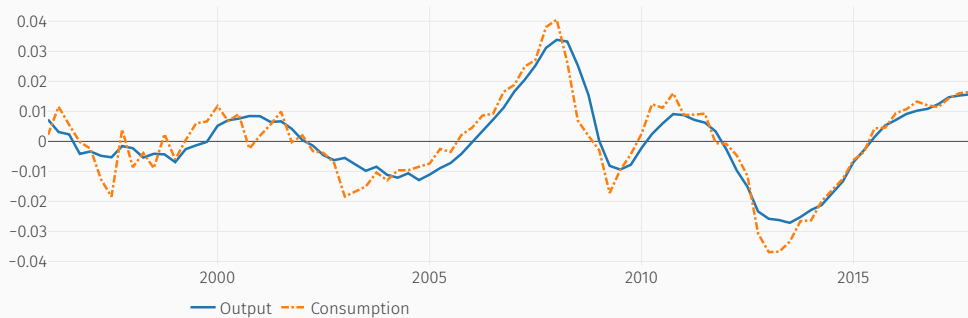
Standard errors in parentheses. \*\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

ECB borrowing rates for AUT, BEL, DEU, ESP, FRA, IRL, ITA, NLD, PRT. 2003Q1 – 2017Q4

	$\sigma(C)$	$\sigma(Y)$	$\sigma(C)/\sigma(Y)$	$\sigma(C)/\sigma(Y)$ (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 %.

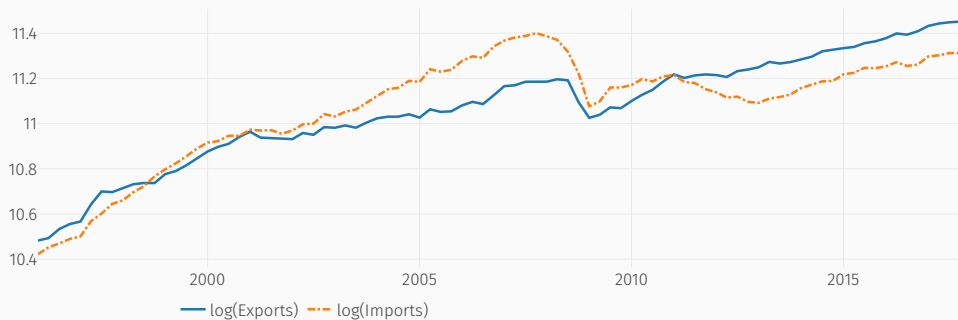
Filtered Spanish output and consumption



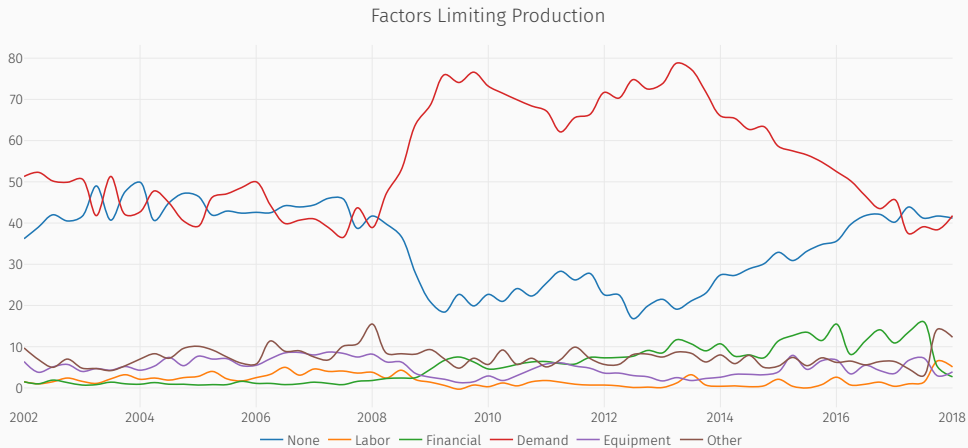
Spain in the 2000s



Trade balance for Spain

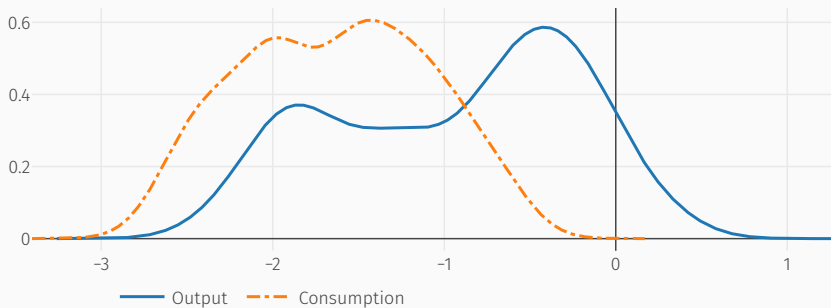


Spain in the 2000s

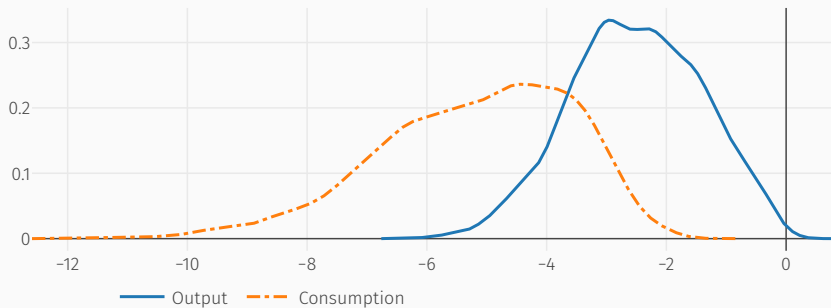


Spanish firms' self-reported limits to production

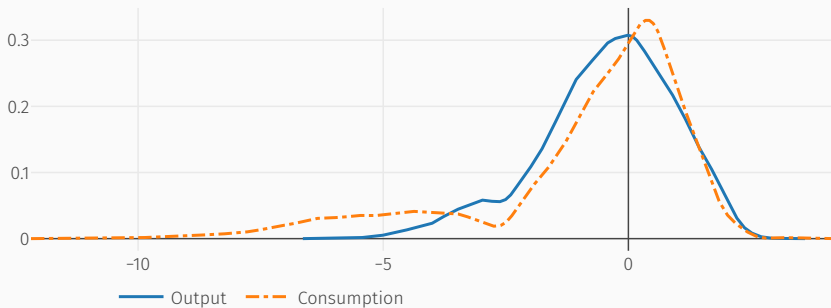
Source: Eurostat



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



Densities for Output and Consumption during Defaults



Unconditional Ergodic Densities for Output and Consumption

## REFERENCES

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- 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 Institute.





