

Aggregate Demand and Sovereign Debt Crises

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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](#)

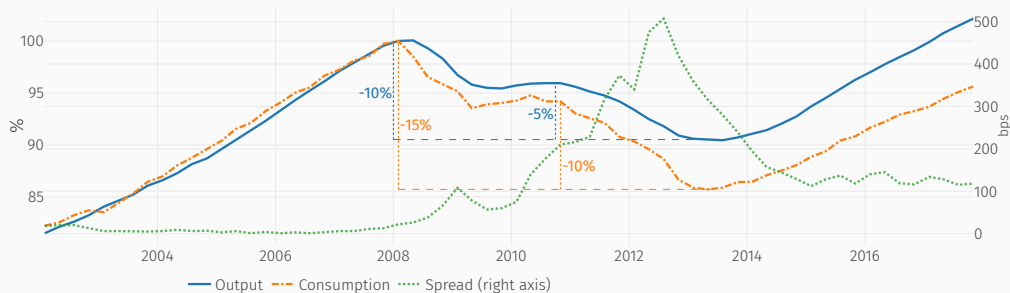
[▶ Low demand?](#)

[▶ Nondurable consumption](#)

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- 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
- Sovereign debt literature assumes hand-to-mouth households or 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](#)

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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

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)

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

- 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

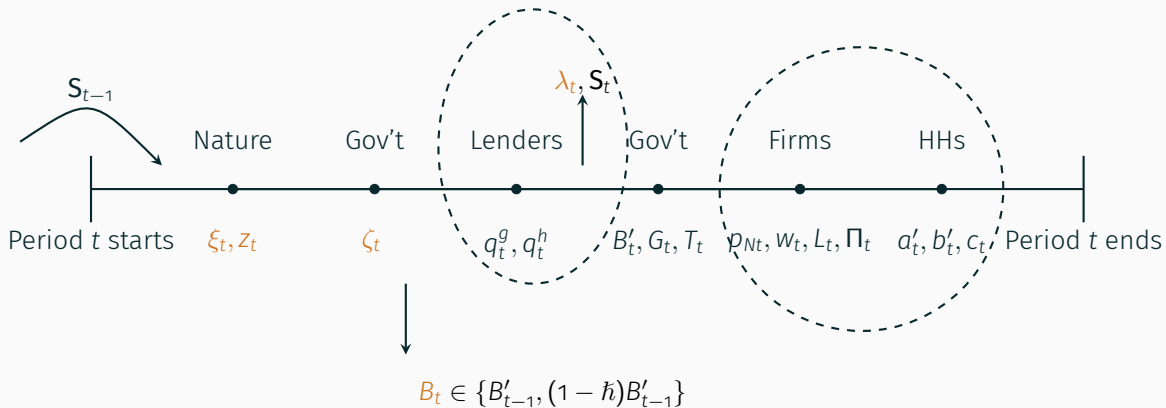
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

DESCRIPTION OF MODEL

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
 - $\text{cov}(R_{\mathbf{S}, \mathbf{S}'}, \text{sdf}' | \mathbf{S}) \downarrow \leftarrow$ 'Savings technology' effect

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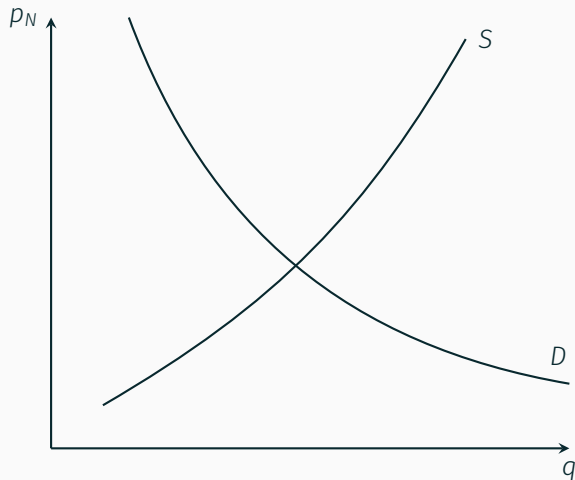
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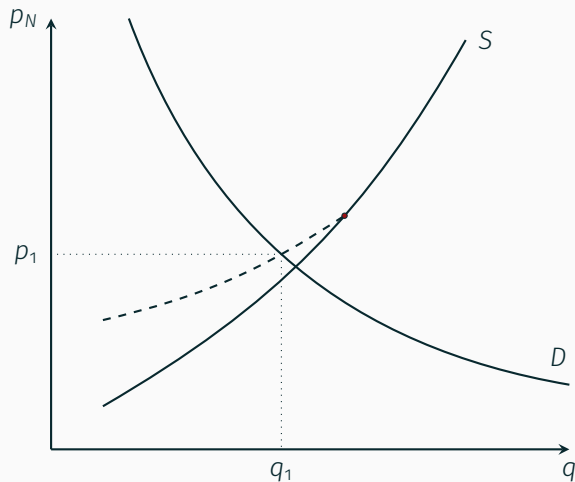


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$$Y_N^s = L_N^{\alpha_N} (1 - \mathbb{1}_{(\zeta \neq 1)} \Delta)$$

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

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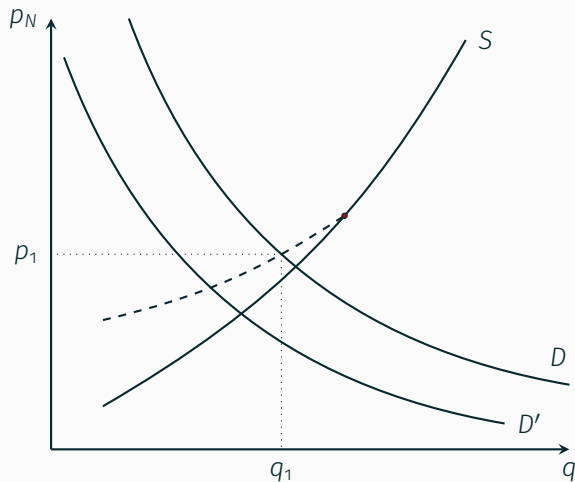


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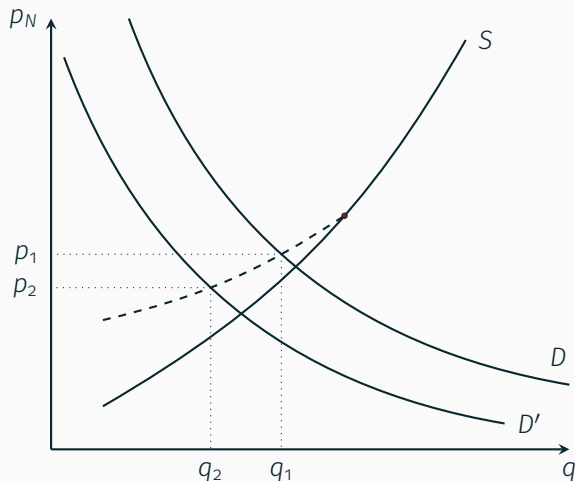
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- $C \downarrow \implies p_N \downarrow \implies w \downarrow$
- Wage rigidity creates price stickiness

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

EQUILIBRIUM CONCEPT

Definition

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

► Algorithm

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

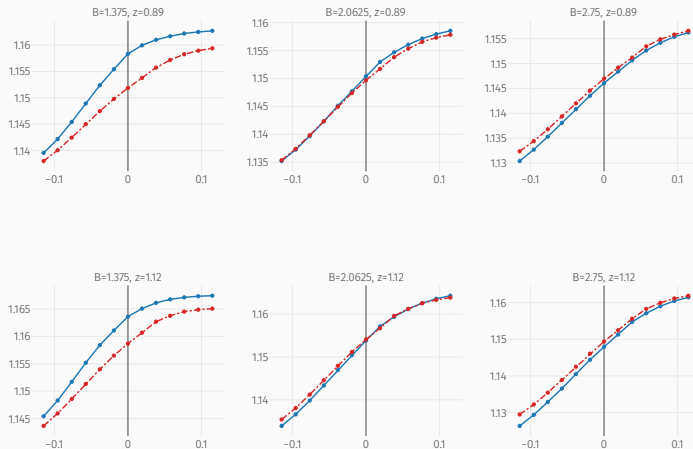
such that

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

► Market Clearing

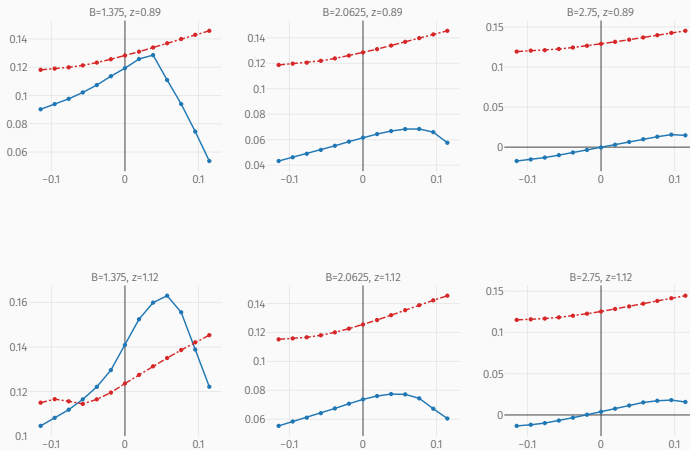
MODEL RESULTS

PRELIMINARY RESULTS



Anticipated objective function
Blue: repayment, red: default

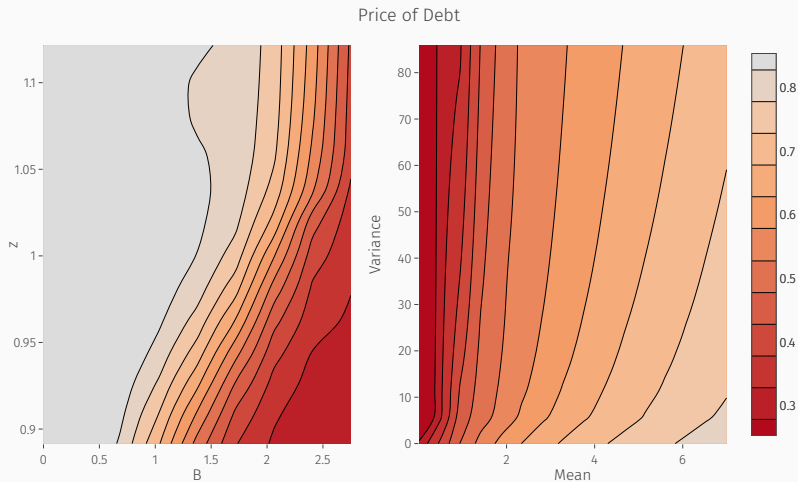
PRELIMINARY RESULTS



Transfers

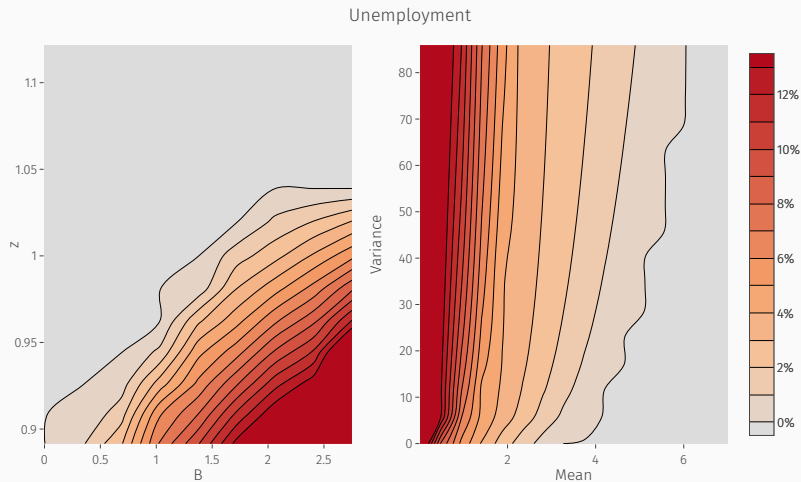
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PRELIMINARY RESULTS



Model: Benchmark

PRELIMINARY RESULTS



Model: Benchmark

SIMULATIONS

CALIBRATION

Parameter	Value	Description	Source
r^*	4% ann.	Risk-free rate	Anzoategui (2017)
\bar{h}	50%	Haircut in case of default	Philippon and Roldán (2018)
Δ	10%	TFP loss in case of default	Philippon and Roldán (2018)
ϖ	0.74	Share of nontraded in prod	Anzoategui (2017)
ϑ_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	γ	14.1	Moments in Table 1
Progressivity of tax schedule	τ	19.3%	Moments in Table 1
Wage minimum	\bar{w}	1.15	Moments in Table 1
TFP process	ρ_z, σ_z	(0.892, 0.029)	Moments in Table 1
Mean risk premium	$\bar{\xi}$	1.4%	Moments in Table 1
Risk premium AR(1)	ρ_ξ, σ_ξ	(0.947, 0.002)	Moments in Table 1

CALIBRATION (CONT'D)

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

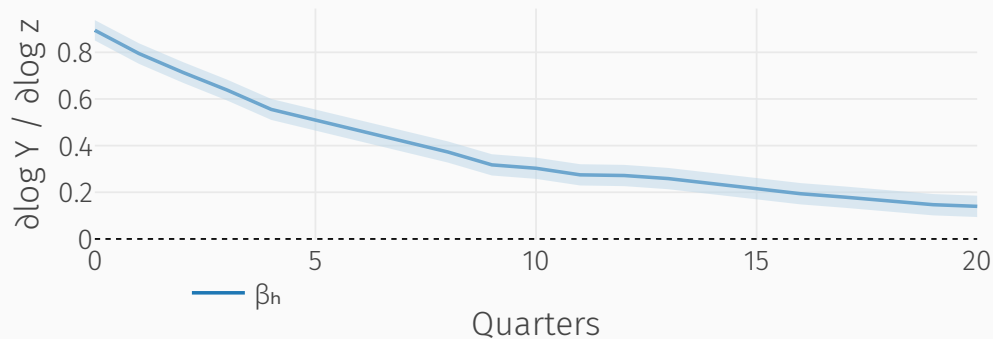
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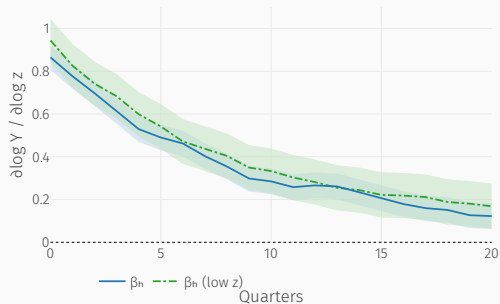
AMPLIFICATION OF TFP SHOCKS



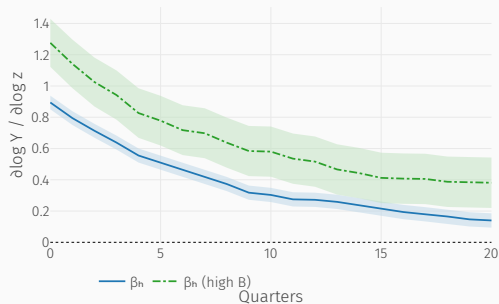
Response of Output to a TFP shock

95% confidence intervals shaded

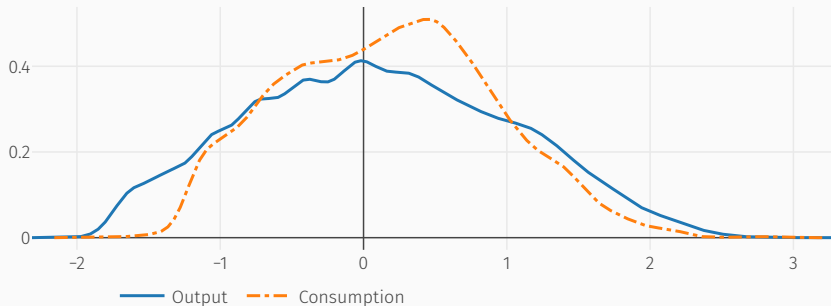
AMPLIFICATION OF TFP SHOCKS (CONT'D)



For large shocks



For indebted economies



Ergodic Densities for Normalized Output and Consumption

CRISES

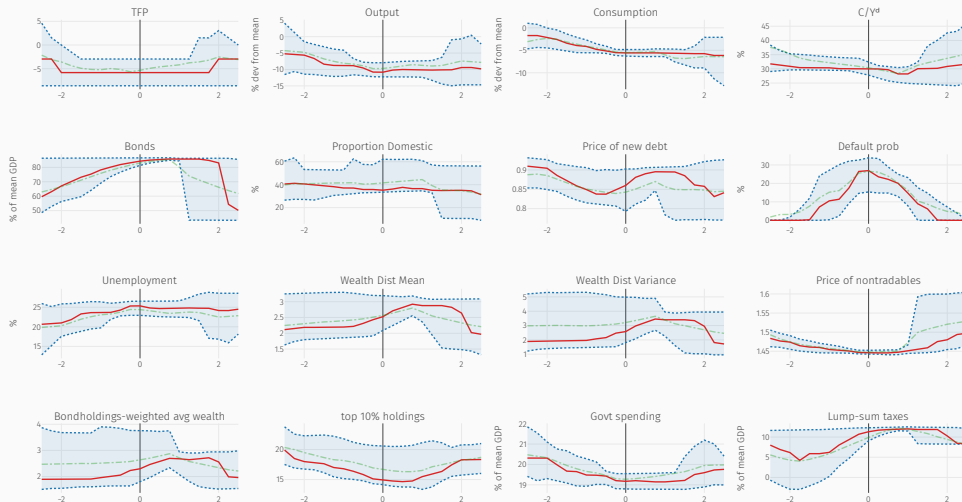
Simulate model economy for 2000 years

- 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

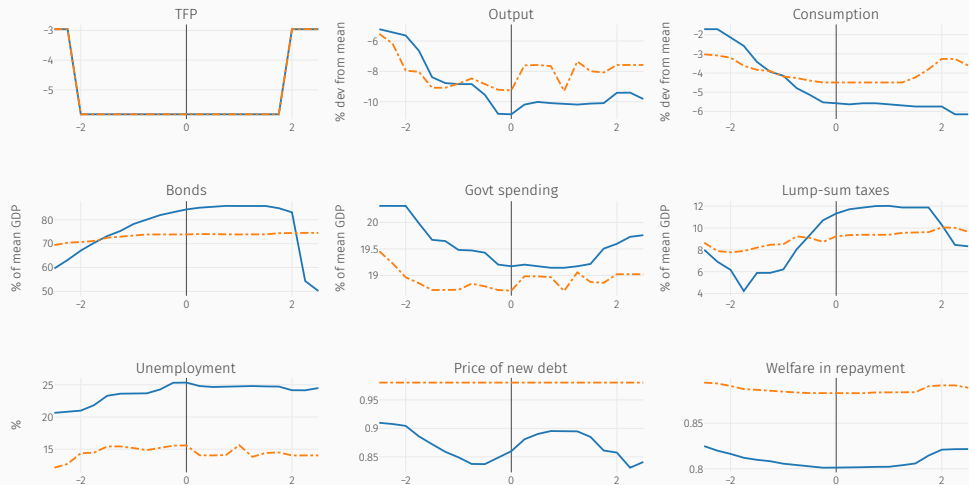


SIMULATED DATA – HIGH SPREADS



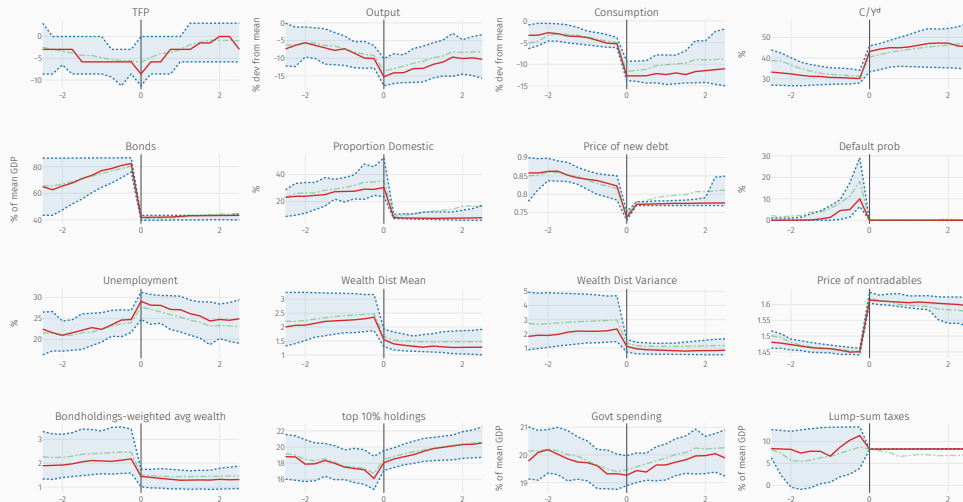
Red: Median, Shaded blue: [0.25, 0.75] percentiles, Dashed green: Mean

SIMULATED DATA – CRISES



Blue: Benchmark, Dashed orange: No default

SIMULATED DATA – DEFAULT EPISODES



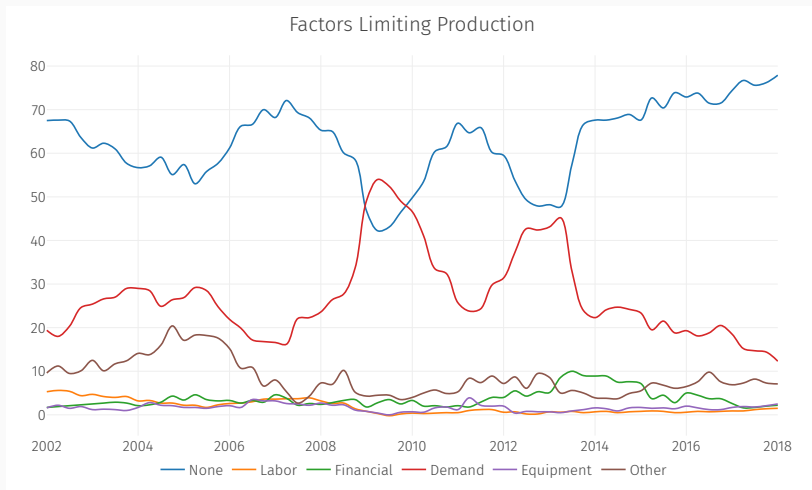
Red: Median, Shaded blue: [0.25, 0.75] percentiles, Dashed green: Mean

STILL MISSING

- **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

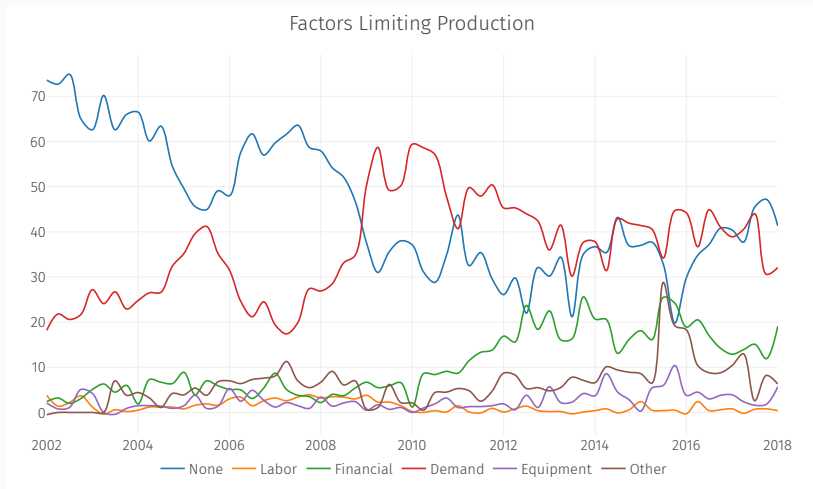
CONCLUDING REMARKS

- 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

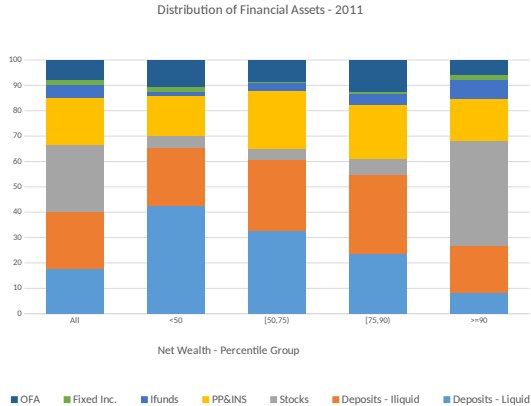


Greek firms' self-reported limits to production

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

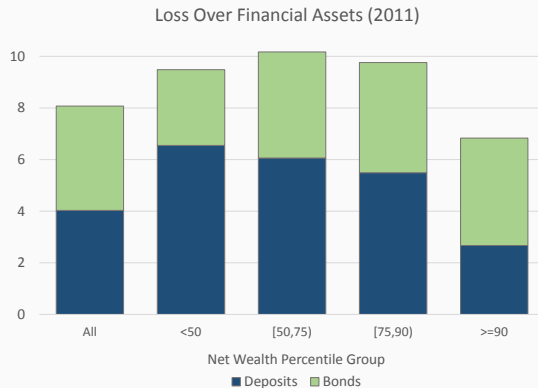
Work with different scenarios of loss on deposits:

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

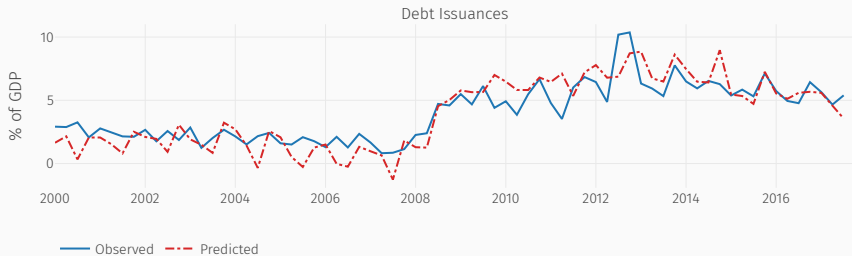
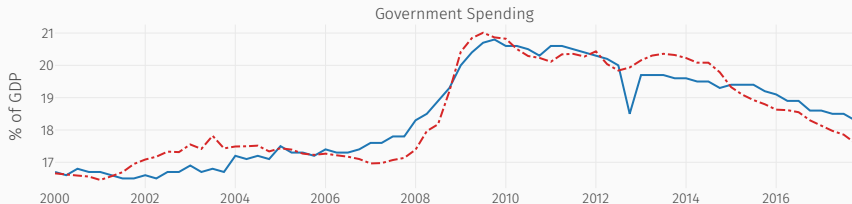
- Companion paper: dom exp to Spanish sovereign risk [▶ More](#)
- Pension funds, mutual funds, insurance – perfect passthrough
- Deposits – more complicated
 - Philippon and Salord (2017): bank resolutions in Cyprus [▶ Details](#)



	G_t/Y_t		$(B'_t - (1 - \rho)B_t) / Y_t$	
	(1)	(2)	(3)	(4)
Unemployment _t	0.031 (0.039)	0.073*** (0.015)	0.334** (0.158)	0.346*** (0.059)
Unemployment _t ²	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 _t	0.009 (0.019)	0.007 (0.012)	0.046 (0.075)	0.019 (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

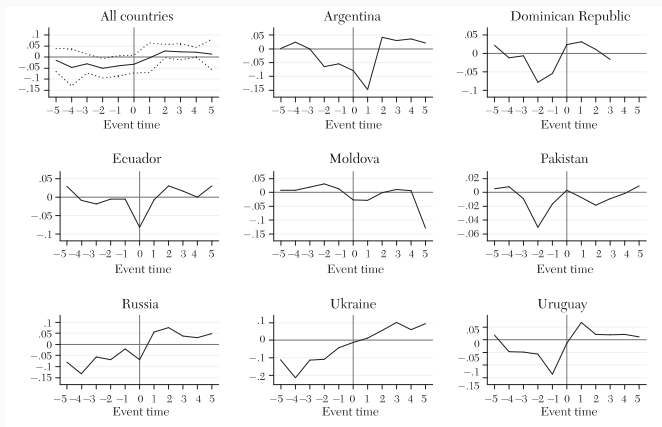
The **law of motion** for λ

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

$$R_b(\mathbf{S}_{t+1}) = \mathbb{I}_{(\zeta_{t+1}=1)}\kappa + (1 - \rho)q^g(\mathbf{S}_{t+1})$$

$$\int \omega d\lambda_{t+1} = \int \phi_a(\mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{S}_t) d\lambda_t$$

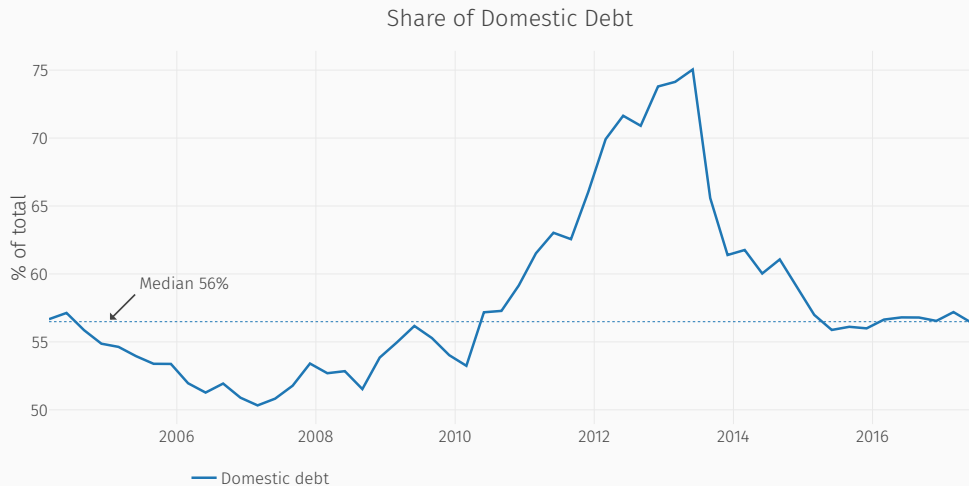
$$\int \omega^2 d\lambda_{t+1} = \int (\phi_a(\mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{S}_t))^2 d\lambda_t$$



Defaults and output growth

Source: Panizza, Sturzenegger, and Zettelmeyer (2009)

SHARE OF DOMESTIC DEBT

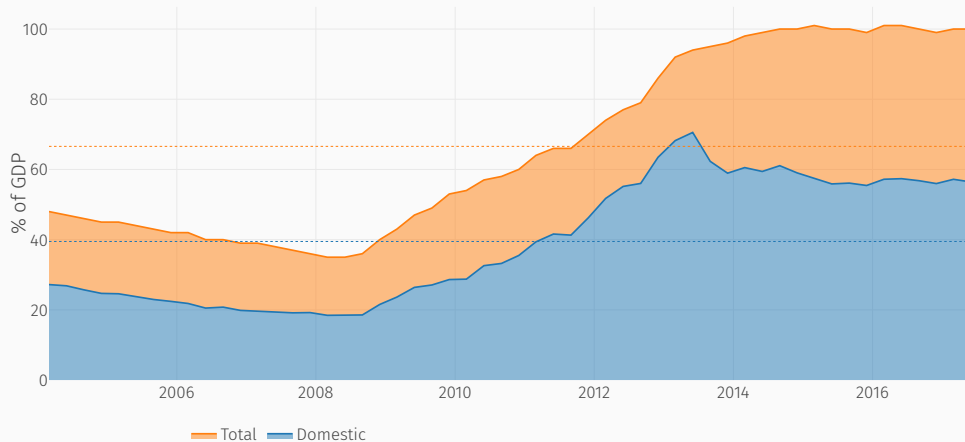
[◀ BACK](#)

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

SHARE OF DOMESTIC DEBT

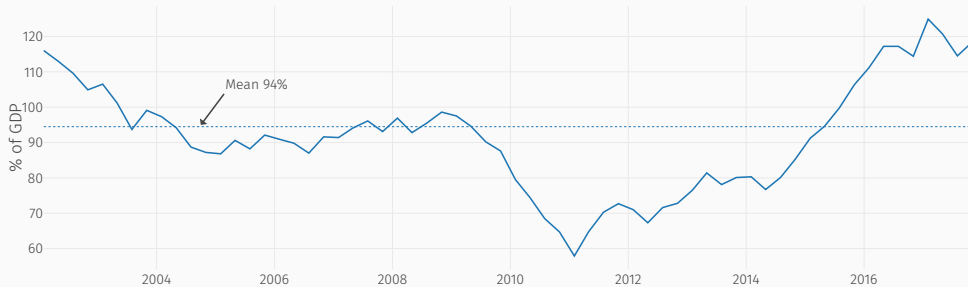
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Spanish Government Debt



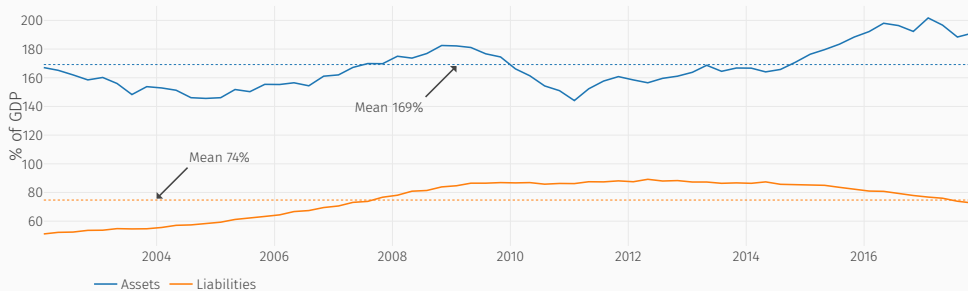
Source: Morelli and Roldán (2018) on Banco de España
Dotted lines are sample averages

Net Worth of Spanish Households



Source: Eurostat
Dotted lines are sample averages

Net Worth of Spanish Households



Source: Eurostat
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, Π, 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 _{jt}			Saving rate _{jt}		
	(1)	(2)	(3)	(4)	(5)	(6)
Spread _{jt}	1.381*** (0.064)			0.461*** (0.097)		
Spread _{jt} (IV)		2.372*** (0.826)	1.951** (0.896)		1.634 (1.186)	2.048 (1.515)
Spread Non-fin _{jt}		-0.172 (0.297)	-0.450 (0.306)		0.654 (0.628)	0.832 (0.626)
Spread Fin _{jt}		-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 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

- 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

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

	<i>Dependent variable Q_{jt}:</i>							
	<i>log Y_{jt}</i>				<i>log C_{jt}</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Spread_{jt}	-0.011^{***} (0.003)				-0.011^{***} (0.002)			
Spread_{jt} (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}

					(7)	(8)
$Spread_{jt}$						
$Spread_{jt} \text{ (IV)}$					0.035** (0.017)	-0.035** (0.016)
R_{jt}^h					0.004 (0.007)	-0.009 (0.007)
R_{jt}^s						0.036 (0.031)
Model					IV	IV
Country + Time FE					✓	✓
Observations					540	540
Adj. R^2					0.999	0.999

What if *Spreads* affect Q through W ?

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

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

THE CYCLE IS THE TREND

[◀ BACK TO MOTIVATION](#)[◀ BACK TO EVIDENCE](#)

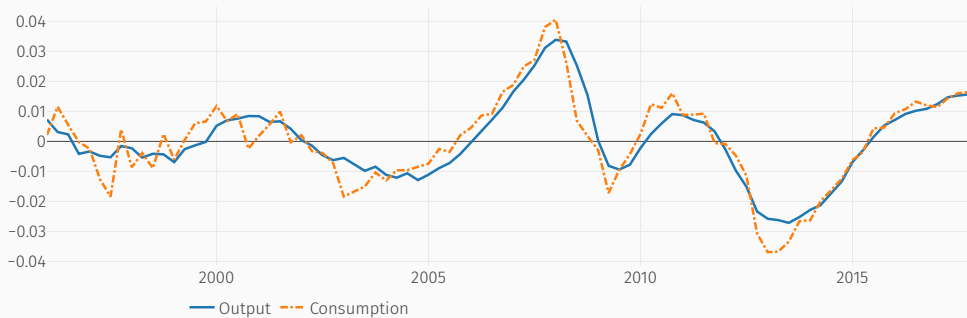
	$\sigma(C)$	$\sigma(Y)$	$\sigma(C)/\sigma(Y)$	$\sigma(C)/\sigma(Y)$ (AG)
Austria	0.716	0.782	0.916	0.870
Belgium	0.556	0.795	0.700	0.810
Denmark	1.047	1.178	0.889	1.190
Finland	1.278	1.957	0.653	0.940
France	0.780	0.773	1.009	—
Germany	0.692	0.867	0.799	—
Ireland	3.140	3.680	0.853	—
Italy	1.165	0.978	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

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Filtered Spanish output and consumption

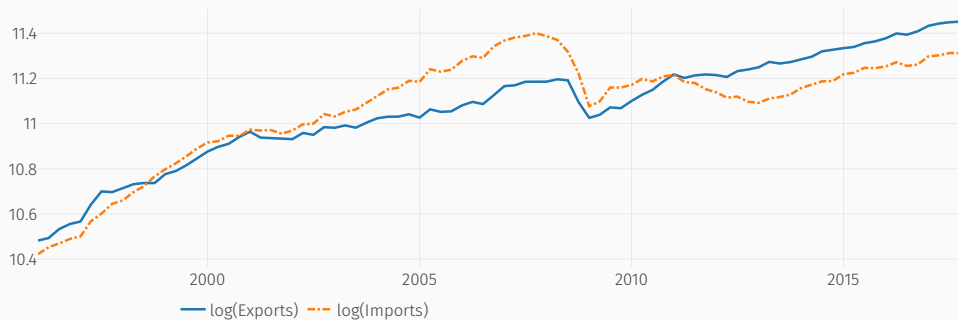


Spain in the 2000s

SPAIN IN THE EUROZONE CRISIS

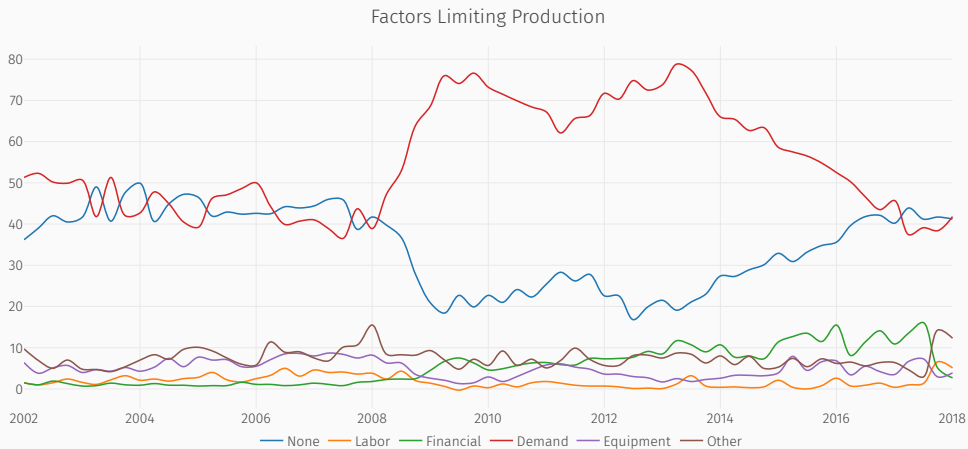
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Trade balance for Spain



Spain in the 2000s

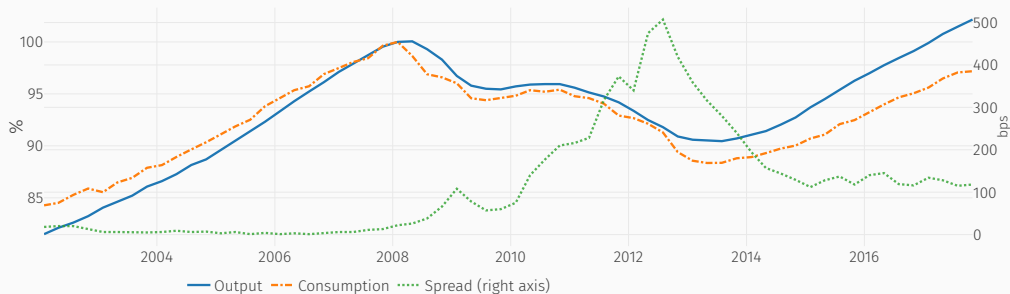
LOW DEMAND?

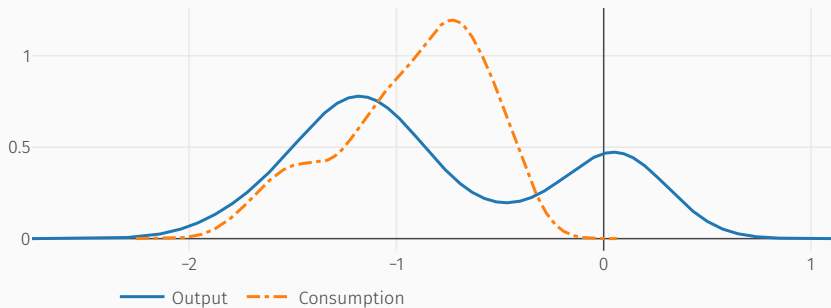
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Spanish firms' self-reported limits to production

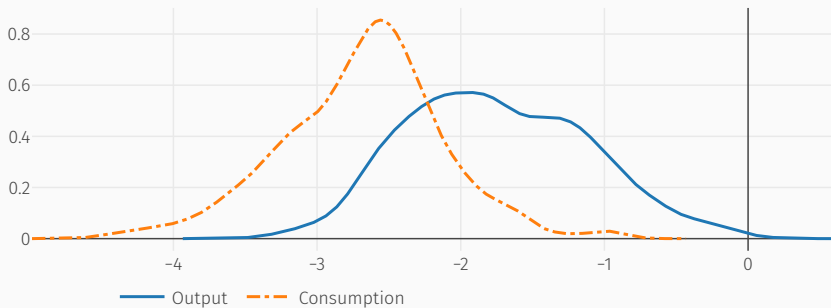
Source: Eurostat

Output and Consumption for Spain

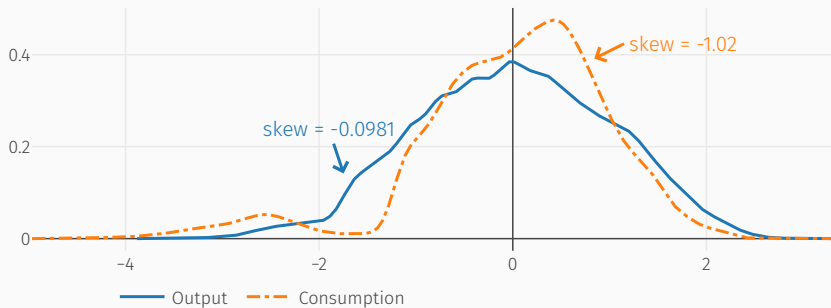




Densities for Output and Consumption during Crises ($\pi \geq 15\%$)



Densities for Output and Consumption during Defaults



Unconditional Ergodic Densities for Output and Consumption

REFERENCES

- 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.

- GENNAIOLI, N., A. MARTIN, AND S. ROSSI (2014): "Sovereign Default, Domestic Banks, and Financial Institutions," *Journal of Finance*, 69, 819–866.
- 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.
- PHILIPPON, T. AND F. ROLDÁN (2018): "On the Optimal Speed of Sovereign Deleveraging with Precautionary Savings," *IMF Economic Review*, 66, 375–413.
- PÉREZ, D. (2016): "Sovereign Debt, Domestic Banks and the Provision of Public Liquidity," mimeo, NYU.
- ROMEI, F. (2015): "Need for (the Right) Speed: the Timing and Composition of Public Debt Deleveraging," Economics Working Papers MWP2015/11, European University Institute.

