Aggregate Demand and Sovereign Debt Crises*

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Abstract

Sovereign debt crises coincide with pronounced recessions. In the conventional view, poor economic conditions increase default incentives and bond spreads. I provide evidence suggesting that the reaction of consumption demand creates feedback from sovereign spreads to output even while the government is in good standing with creditors. Because they ignore the savings behavior of private agents, existing models cannot capture this empirical feature of crises. I study the implications of this feedback mechanism in a model where the government of a small open economy borrows from foreign lenders but some of the debt is held by heterogeneous domestic savers. Because of this heterogeneity in wealth, potential sovereign defaults carry redistributive effects besides aggregate income losses. Both effects introduce risk in private agents' expectations after bad news for repayment. Default risk then exacerbates the precautionary motive of households and depresses aggregate spending. In a calibration to Spain in the 2000s, I find that between 20% and 40% of the output contraction is attributable to default risk. More generally, default risk exacerbates volatility in consumption, creating large welfare losses even if default does not materialize.

JEL Classification E2, F3, G2

Keywords Debt crises, sovereign debt, default, precautionary motives, aggregate demand

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Introduction

Sovereign debt crises coincide with large output contractions. For the case of Spain during the Eurozone crisis, output fell by about 10% of its 2008 peak. Consumption dropped more than output, by up to 15% of the pre-crisis maximum. The resulting increase in the aggregate saving rate was not a particular feature of the Spanish experience. Indeed, the sovereign debt literature typically targets a high relative volatility of consumption. In a more formal instrumental variables approach on country-level data from the Eurozone crisis, I show that increases in sovereign spreads caused drops in output and even larger drops in consumption.

The literature on sovereign debt largely assumes either households that are effectively in financial autarky or one-sector small open economy models in which domestic demand is irrelevant as all production can be exported. As a result, it cannot account for the role of households' savings decisions in the unfolding of the crisis. In the canonical model, output and spreads and correlated because recessions increase default incentives. The presence of sovereign risk does not affect the economy unless a default actually happens.

In this paper I propose a model of sovereign debt that rationalizes the large output and consumption drops in response to sovereign risk. The model The main mechanism driving it is that default risk boosts the precautionary motive of households. When economic conditions worsen and sovereign default becomes more likely, households also anticipate the negative outcomes that would accompany one. Their individually optimal reaction is to cut consumption in favor of higher savings, leading to low aggregate demand. The model then predicts a vicious cycle of high spreads causing demand shortages and output contractions causing further increases in debt and spreads. This vicious cycle amplifies underlying shocks to create deep recessions when sovereign risk appears, exacerbating the volatility of consumption relative to output even if a default does not actually take place. I calibrate the model to Spain's debt crisis and use it to quantify the importance of this amplification mechanism.

The model links a high relative volatility of consumption relative to output to the presence of sovereign risk. Canonical models of sovereign risk share this feature on the surface: in standard models, the real interest rate is countercyclical, which should imply lower consumption during crises. However, in reality the rate that is countercyclical is the government's borrowing rate, not necessarily the one faced by households. While private borrowing rates are correlated with the rate on government securities, this is typically not true of saving rates. In the 2000s, Spanish households held about 94% of GDP in net worth (Figure 26), which suggests that they were facing more the latter than the former.

I consider a small open economy in which heterogeneous households can choose to be exposed to defaultable government debt. In it, defaults both depress income and redistribute wealth to and within the domestic economy. Aggregate income losses are the result of drops in TFP of the kind emphasized in the literature. My setup with endogenous distributions of wealth and exposures to sovereign debt shapes the potential redistribution, along with the (fixed, exogenous) distribution of the tax burden. Downward nominal wage rigidity then enables the transmission of low aggregate demand to output contractions.

Non-Ricardian features are central to my analysis. In the model, Ricardian equivalence fails because of incomplete markets and borrowing constraints. A potential default would redistribute from agents who are exposed to sovereign risk to agents who are not. When the default probability increases, however, those who stand to gain do not increase their consumption. This happens because these agents are poorer and close to their borrowing limit, so future potential transfers do not enter their relevant measure of permanent income. Indeed, these agents have low marginal propensities to consume (MPCs) out of future income for the same reason that they have high MPCs out of current income.

Another, direct effect goes through the government's borrowing costs, which other studies have emphasized. In a crisis, conditional on no default, the present value of surpluses increases as more resources are needed to service the debt. This means that high spreads transfer from taxpayers to bondholders while a default does not happen, which tends to hurt aggregate spending even more.

The same non-Ricardian features allow for a clean separation of the debts and assets of the government and the private sector. In canonical models of sovereign default, allowing households to borrow and save risk-free unravels the equilibrium. The reason is simple: if the government has access to lump-sum taxes and the representative household can commit to repay loans, then the government can use its tax policy to effectively have the household borrow on its behalf at the risk-free rate. This has led researchers to study models in which the private sector's ability to borrow and save is constrained. An alternative assumption is to constrain the tax instruments at the government's disposal. In my model, even though the government can collect lump-sum taxes, it cannot make those taxes agent-specific. This provides a natural constraint on the government's ability to sidestep its lack of commitment.

A common argument during debt crises is that a lack of 'confidence' makes aggregate demand fall short of levels consistent with full employment. This paper addresses these arguments by making the lack of confidence a rational, although inefficient, response to the evolution of fundamentals in the economy. Furthermore, the amplification I emphasize helps explain why emerging economies exhibit high volatility of consumption relative to output 'as if' they were subject to trend shocks (Aguiar and Gopinath, 2007).

In a calibration exercise to Spain, I find that between 20% and 40% of the contraction of output during crises can be directly attributed to the presence of sovereign risk. Moreover, almost all of the volatility in aggregate consumption is caused by sovereign risk. This is true even conditioning on no default in the benchmark, as much of the volatility comes from the anticipation effects and the large movements in demand that these create. This extra volatility is extremely costly for the economy: on average, households would give up as much as 10% of permanent consumption to make defaults impossible.

The calibrated model allows to quantify the amplification of shocks. It does so by generating different notions of ‘potential’ output, which can be compared to actual output in the crisis. A natural comparison point is the same model solved without default risk: it measures how much output would have fallen only because of the benchmark model’s underlying shocks. The other comparison models I consider are ones in which the government’s policy for default is kept the same, but either the TFP costs of default are removed or the redistribution is shut down by forbidding agents in the economy from holding sovereign debt in the first place.

An interesting aspect is that the anticipation of both income losses and redistribution interact to create volatility in aggregate consumption and output. While a version of the model without redistributive effects produces marginal changes in the volatilities, the version without income losses cannot remove all of the volatility created by sovereign risk.

Discussion of the Literature This paper relates to several strands of literature. I build on canonical models of sovereign debt (Eaton and Gersovitz, 1982; Arellano, 2008) by considering a benevolent government borrowing without commitment from international creditors. Recent papers have emphasized internal costs of sovereign default. Mendoza and Yue (2012) assume that domestic firms lose access to some imported inputs after a default, which reduces aggregate productivity. Dovis (2018) rationalizes these costs of defaults as a descentralization of the optimal contract between the country and its lenders subject to lack of commitment and information frictions. From these papers I take the shape and size of default costs, which are exogenous in my model.

Others such as Gennaioli et al. (2014), Pérez (2016), and Mallucci (2015) argue that the presence of domestic debt creates default costs through the disruption of financial intermediation. These papers assume households are able to save and provide deposits to the financial sector. However, because they use one-sector models in which the law of one price holds, they effectively abstract from the aggregate demand effects I emphasize.

I build on models in which nominal rigidities in wage setting combined with an exchange rate peg create an aggregate demand externality (Schmitt-Grohé and Uribe, 2016, and a large literature). Anzoategui (2020) combines wage rigidities and default risk to estimate what would have happened to Spain had it not imposed austerity measures in the crisis. The tradeoff emphasized in that paper is that austerity depresses aggregate demand but endogenously decreases the probability of a debt crisis. Bianchi, Ottonello, and Presno (2016) also think about fiscal multipliers in the presence of sovereign risk and they characterize the optimal policy in the presence of wage rigidities, where the government can affect the real exchange rate via the relative demand for traded and nontraded goods. Both papers abstract from the precautionary effects that are at the core of my argument by assuming that domestic households are unable to save.

In a similar line, Arellano et al. (2018b) consider a New Keynesian small open economy model where the government chooses its fiscal and default policy. They focus on the optimal fiscal policy without commitment when the Central Bank follows a Taylor rule, the currency floats freely and the economy undergoes a real devaluation at the time of default. These differences in assumptions change the conclusions in interesting and complementary ways.

Three other studies explicitly think about anticipation effects from sovereign risk: Bocola (2016), Arellano et al. (2018a), and Balke (2017). In the first paper, when the probability of default is high, banks attach a higher value to safe assets. They lose appetite for risk and charge firms a higher interest rate. Investment drops which depresses growth in a complementary way to the one explored here. Because it works through the supply side of the economy, this mechanism cannot by itself account for the savings pattern of households in the crisis. Moreover, this mechanism requires that banks be unable to raise equity, which is correct in the short run but less likely as time passes. In contrast, I take the opposite stand that the financial sector acts as a veil for the nonfinancial private sector. This also highlights inequality within the private sector as a driver of the output response to sovereign risk.

Arellano et al. (2018a) assume the correlation between private borrowing costs and sovereign spreads and think about the consequences for investment. In a centralized economy, they find that negative TFP shocks that endogenously increase sovereign risk also induce lower investment, and that the fall is concentrated in the nontradable sector. The reason is that, even if the planner wants to invest less because returns are low, it tries to tilt investment towards traded goods, which are needed to service the debt. The authors show that the allocation can be descentralized using a rich enough taxation scheme. In two-digit sectoral data for Spain in the 2011 crisis, they find that investment did fall by more in sectors that rank lower in a measure of tradedness. In Balke (2017), the same public-private correlation in borrowing costs constrains firms' ability to obtain working capital loans, which depresses vacancy posting and job creation.

Philippon and Roldán (2018) describe in a related but more stylized setting the possibility of expansionary austerity. There, austerity can ease the fears of unconstrained 'savers' and boost aggregate demand. In a calibration to the Eurozone, the direct contractionary impact negates expansionary austerity. They then focus on the optimal design of the sovereign deleveraging plan. Romei (2015) considers the distributional impact of different speeds of fiscal consolidation in the absence of aggregate demand effects. In a flexible-price model, Cuadra, Sánchez, and Sapriza (2010) argue that governments constrained by their own lack of commitment to future actions find it optimal to follow procyclical fiscal policies.

Part of how sovereign risk affects demand is because of redistribution. In this sense, I build on models such as Eggertsson and Krugman (2012), Auclert (2017), or Korinek and Simsek (2016), where shocks contract demand because they redistribute from high-MPC to low-MPC agents. This paper features this idea prominently, except that the timing of transfers reverses the identities of low- and high-MPC agents.

I also relate to studies in which sovereign debt policy responds to distributional concerns, as has been emphasized since Woodford (1990) and Aiyagari and McGrattan (1998). The distributional focus here is on the distribution of MPCs, but distributional concerns will also feature in the government's objective function. D'Erasmo and Mendoza (2016) build a heterogeneous-agents model of sovereign default and find that levels of debt like those of present day Spain suggest a government with a bias towards favoring its creditors. Ferriere (2016) and Ferriere and Navarro (2017) argue for a positive link between progressive taxation on the one hand and incentives to repay sovereign debt and fiscal multipliers on the other. Guembel and Sussman (2009) and Andreasen et al. (2011) study political economy considerations in sovereign debt policy, while Dovis et al. (2016) find that, in an overlapping-generations economy, the tension between the ex-ante desire to promote savings and the ex-post temptation to redistribute by taxing capital can lead to 'populist cycles' of austerity and external debt-financed expansions.

Layout The remainder of the paper is organized as follows. Section 2 presents some motivating evidence. Section 3 describes the model while Section 4 defines the equilibrium and provides some intuition on the inner workings of the model. Section 5 discusses the calibration and Section 6 summarizes results from the model solution. Section 7 analyzes simulated data from the calibrated model, while Section 8 focuses on crises. Finally, Section 9 concludes.

2. Motivating Evidence

Figure 1 plots total GDP and households' consumption for Spain in the 2000s. To show each series in as raw a form as possible, I plot them relative to the value at the start of 2008. Output and consumption strongly contract during the crisis years. Moreover, consumption contracts more than output as the crisis unfolds. Figures 29 and 30 in the Appendix reinforce this point by showing that the same pattern appears in HP-detrended data and that it corresponds to an increase in the trade balance. Peak to trough, the declines in output and consumption are of about 10% and 15%. These numbers can be misleading as they include the effect of the Global Financial Crisis and the Spanish housing bust. Comparing the trough of the crisis to early 2011 to isolate the effect of sovereign risk as much as possible, the output and consumption contractions are of the order of 5% and 10%.

Table 6 in the Appendix replicates the volatility calculations from Aguiar and Gopinath (2007) using the Eurozone crisis data. For Spain and Portugal (and the Netherlands), the volatility of consumption is greater than the volatility of consumption, and the ratio of those volatilities is larger now than it was in Aguiar and Gopinath's data from the late 20th century. On the other hand, for countries that were mostly unscathed by the crisis (such as Austria, Belgium, Denmark, and Finland), the relative volatility of consumption remains low.

The case of Spain in the Eurozone crisis is of particular interest, as a default did not actually happen even though full repayment of government was uncertain during the period: Figure 1 reveals that a 10-

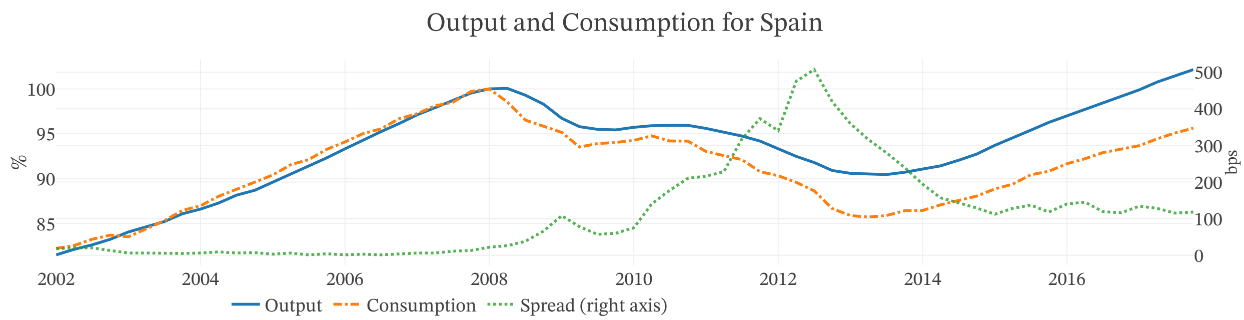


Figure 1: Spanish Output and Consumption in the 2000s

year Spanish government bond paid a significant interest rate spread over a comparable German Bund. Figure 25 shows that measures of slack in the Spanish economy increase significantly during the crisis in what looks like two phases, consistent with the private deleveraging followed by sudden stop interpretation of Martin and Philippon (2017). The two phases are also noticeable as two separate instances of output contraction in Figure 1.

Finally, Figure 2 contains results from a Eurostat survey of Spanish firms who are asked about the reasons why they produce what they do and not more. For the proportion of firms reporting 'demand' as their main limiting factor, the same bimodal shape emerges, with slightly more firms reporting financial constraints in the sudden-stop phase. At the very least, the picture is suggestive that aggregate demand was low in the crisis when spreads were highest.

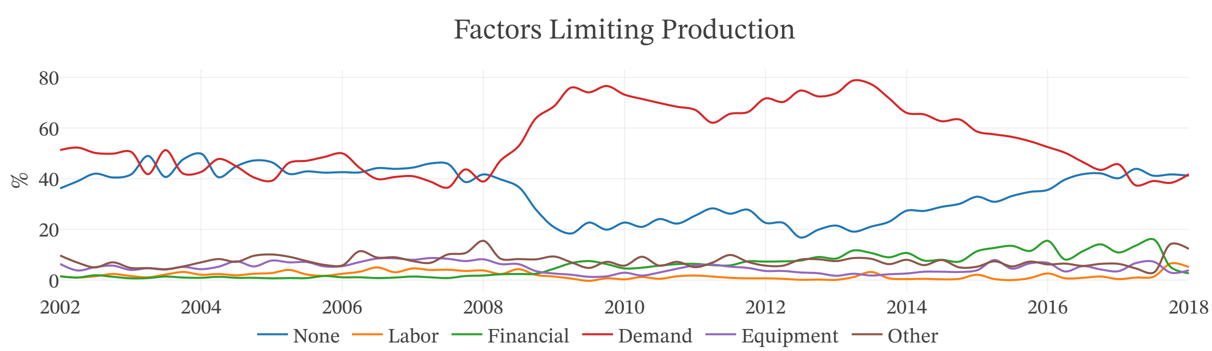


Figure 2: Spanish Firms' Self-reported Limits to Production

Source: Eurostat

2.1 *Feedback*

The open-economy macroeconomics literature has thought about different ways in which sovereign spreads hurt the economy (see Neumeyer and Perri, 2005, among others). I contribute evidence based on quarterly data for 11 European countries. Appendix C details the data sources. I am interested in estimating an equation like

$$Q_{jt} = \beta \Delta Spread_{jt} + \gamma X_{jt} + \mu_j + \delta_t + \epsilon_{jt} \tag{1}$$

for the sovereign debt crisis period of 2010Q1:2013Q1, for $Q_{jt} = \log Y_{jt}, \log C_{jt}$, where the X_{jt}'s are controls and μ_j and δ_t are time and country fixed effects. Clearly, shocks that tend to make output or consumption drop also increase the spreads by more. This is, spreads are endogenous in equation (1), so some kind of exogenous variation is needed to estimate the causal effect.

I construct an instrument following Martin and Philippon (2017). I start by estimating the following auxiliary regression

$$\Delta Spread_{jt} = \underbrace{\phi B_{j0} + \delta_t}_{Z_{jt}} + \eta_{jt} \tag{2}$$

where the increase in spreads of country j in quarter t is predicted using time fixed-effects δ_t and the debt-to-GDP ratio B_{j0} measured in the first quarter of 2008. I run this regression including all countries during the sovereign debt crisis period. The fitted values $\hat{Z}_{jt}$ are then used as instruments for the spreads in equation (1).

A negative coefficient in this IV estimation of (1) reflects that countries that saw their spreads increase more because of their earlier fiscal situation saw bigger output or consumption contractions in the crisis. Table 1 summarizes the estimation of equation (1)

	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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 1: Feedback of Spreads and Macro Outcomes

Columns (3) and (4) report the benchmark IV estimates (the first two columns provide OLS estimates for comparison). An increase of 100bps in government spreads is associated with falls in output and consumption of about half and one percentage points, respectively. These effects are not only large but also somewhat puzzling: the response of consumption is significantly larger, which seems at odds with consumption smoothing in advanced economies where the private sector manages considerable net worth.

3. Model

I consider a small open economy populated by a continuum of heterogeneous households and firms that produce tradable and nontradable goods. A government runs an exogenous, estimated fiscal rule for spending and debt issuance, but chooses default or repayment with discretion. The key ingredients of the economy are an endogenous distribution of wealth that interacts with default risk and wage rigidities. There are incomplete markets and only two assets are traded: a one-period, risk-free private security and a long-term, non-contingent, defaultable government bond.

3.1 Households

There is a continuum of heterogeneous households who differ in the realization of an insurable idiosyncratic shock to their 'effective' labor supply, ϵ, as well as in their asset holdings. Let a and b denote holdings of the risk-free asset and of government debt, respectively. Households are limited in their ability to hold negative positions in these assets: it is impossible to short the government, and there is an ad-hoc lower bound $\bar{a}$ on the risk-free asset. Respecting these restrictions, both assets trade at prices q^h and q^g.

Households value the consumption of traded and nontraded goods according to a CES aggregator

$$c = \left[\varpi^{\frac{1}{\eta}} c_N^{\frac{\eta-1}{\eta}} + (1-\varpi)^{\frac{1}{\eta}} c_T^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

where η is the elasticity of substition among the two goods. I assume an inelastic labor supply. Households have Epstein-Zin preferences over streams of consumption represented by the value function

$$v_t = \left((1-\beta) c_t^{\frac{\psi-1}{\psi}} + \beta \mathbb{E}_t \left[{v_{t+1}}^{1-\gamma} \right]^{\frac{\psi-1}{\psi(1-\gamma)}} \right)^{\frac{\psi}{\psi-1}}$$

where β is the discount factor, γ is the coefficient of risk-aversion and ψ is the inverse elasticity of intertemporal substitution.

In period t, households observe the aggregate state of the economy $\mathrm{S}_t = (B_t, \lambda_t, \xi_t, \zeta_t, z_t)$, comprised of total government debt outstanding B_t, the current distribution of households over their idiosyncratic states λ_t, the current value of a shock to sovereign spreads ξ_t, the current state of the country in international credit markets ζ_t, and the current level of a productivity shock z_t. In equilibrium, this information is enough to recover the relative price of nontraded goods $p_N(\mathrm{S}_t)$ and the current wage rate $w(\mathrm{S}_t)$, as well as the price of government debt $q^g(S_t)$, lump-sum taxes $T(S_t)$, firms' profits $\Pi(S_t)$, and the price of consumption (CPI)

$$p_C = p_C(p_N) = \left[\varpi p_N^{1-\eta} + (1-\varpi)\right]^{\frac{1}{1-\eta}}$$

where the price of traded goods is normalized to $p_T = 1$.

Government debt is a long-term asset which promises a geometrically-decaying coupon payment denominated in the traded good, as in Leland (1998) and Chatterjee and Eyigungor (2012). While the government is not in default, holders of debt purchased t periods ago receive $\kappa(1-\rho)^{t-1}$. This standard setup makes one unit of debt issued j periods ago a perfect substitute of $1-\rho$ units of debt issued $j-1$ periods ago. When the government defaults, a haircut $\hbar$ is applied to all outstanding debt and coupon payments are suspended until the government regains market access.

The household's idiosyncratic states are the current level of its labor productivity ϵ as well as the total value of its asset portfolio $\omega_t = a'_{t-1} + R^b_{t-1,t} b'_{t-1}$. I adopt the convention that the risk-free asset pays one unit of the traded good while the government bond yields $R^b_{t-1,t}$. Let $\mathbf{s} = (\omega, \epsilon)$ denote the idiosyncratic state vector. Individual labor productivity follows an AR(1) process in logs so $\log \epsilon_{t+1} = \rho_\epsilon \log \epsilon_t + \sigma_\epsilon \nu^\epsilon_{t+1}$, where $\nu^\epsilon_t \overset{\text{iid}}{\sim} \mathcal{N}(0,1)$.

Because of nominal rigidities (see below), there can be rationing in the labor market when labor demand falls short of supply. In that case, I assume that households are rationed proportionally so that everyone works the same amount of hours. These assumptions mean that a household with current shock ϵ receives (pre-tax) labor income equal to $y^L(\mathbf{s}, S) = w(S)L(S)\epsilon$ at wage w and employment L in state S, of which a fraction τ is paid to the government as labor income taxes.

Households also receive income from ownership of the firms. I assume that this income is rebated lump-sum in proportion to the current value of the shock ϵ. Because the integral of ϵ is normalized to 1, households receive income $y^\Pi(\mathbf{s}, S) = \Pi(S)\epsilon$.

The household's problem (3) summarizes the discussion above.

$$v(\omega, \epsilon, S) = \max_{a',b',c} \left((1-\beta) c^{\frac{\psi-1}{\psi}} + \beta \mathbb{E}\left[\left(v(a' + R_b(S, S')b', \epsilon', S') \right)^{1-\gamma} | \omega, \epsilon, S \right]^{\frac{\psi-1}{\psi(1-\gamma)}} \right)^{\frac{\psi}{\psi-1}} \tag{3}$$

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

This problem is affected by the presence of sovereign risk in at least three distinct ways. An increase in default risk depresses expected future income, generates capital losses through movements in realized

R_b, and worsens the savings technology by making expected R_b more negatively correlated with future income. Section 4.4 discusses these effects in detail.

The solution to the household's problem consists of policy function $\phi_a, \phi_b, \phi_c : \boldsymbol{s} \times \mathcal{S} \to \mathbb{R}$. It is important to notice that the value function $v(\mathbf{s}, \mathrm{S})$ describes a household *after* the government's default decision.

3.2 *Relative prices and the real exchange rate*

I now turn to the determination of the relative price of the nontraded good (the real exchange rate). Because of the homotheticity of CES demand, each household consumes both goods in the same proportions. The first-order condition for the composition of consumption, summing over all agents, then reads

$$p_N(\mathrm{S}) = \frac{\varpi^{1/\eta}}{1 - \varpi^{1/\eta}} \left(\frac{C_T(\mathrm{S})}{C_N(\mathrm{S})} \right)^{\frac{1}{\eta}} \tag{4}$$

3.3 *Firms*

There are two types of firms that produce traded and nontraded goods. Their technologies are concave in labor and are given by

$$Y_{Nt} = f_N(z_t, \zeta_t) L_{Nt}^{\alpha_N} \tag{5}$$

$$Y_{Tt} = f_T(z_t, \zeta_t) L_{Tt}^{\alpha_T} \tag{6}$$

The functions f_i for $i \in \{N, T\}$ describe productivity in both sectors. TFP depends on the productivity shock z_t and is reduced when the economy is in default. As a benchmark, I consider the case where the shock z_t only affects the production of traded goods

$$f_N(z, \zeta) = 1 - \Delta 1_{(\zeta \neq 1)}$$
$$f_T(z, \zeta) = z \left(1 - \Delta 1_{(\zeta \neq 1)}\right)$$

where Δ is the output cost of default and $\zeta = 1$ denotes good standing in international markets.

In equilibrium, firms in both sectors must pay the same wage. However, because of nominal rigidities, the wage w_t cannot fall below $\bar{w}$, as in Bianchi, Ottonello, and Presno (2016). When the constraint does not bind, the economy operates at full employment; otherwise, workers are rationed. I discuss this way of introducing nominal rigidities in more detail in Section 4.5.

3.4 *Fiscal policy*

The government's policy determines three actions: whether to repay its current debt obligations in full, how much new debt to issue, and the level of lump-sum transfers it gives to households.

The government's policy consists of repayment and issuance strategies $h'(\mathrm{S}, \xi', z'), B'(\mathrm{S})$. The issuance strategy simply states how much new debt the government is issuing. On the other hand, the repayment strategy maps an aggregate state in t and a realization of shocks in $t+1$ into a probability of repayment.

When the government is in default (denoted by $\zeta = 0$), coupon payments are interrupted. Holders of the debt can still trade it in the secondary market. Defaulted debt is still valuable as the government recovers access to markets with constant probability θ each period. While in default, new debt cannot be issued (even if it would command a positive price), which restricts $B'(\mathrm{S}_t) = B(\mathrm{S}_t)$ in default states.

The government's budget constraint (7) equates resources from (net) debt issuance and labor income taxes to expenditures given by coupon payments, government spending, and lump-sum transfers

$$\underbrace{q^g(\mathrm{S}_t)}_{\textit{debt price}} \underbrace{\left(B'(\mathrm{S}_t) - (1-\rho)B(\mathrm{S}_t)\right)}_{\textit{new debt issued}} + \underbrace{\tau w(\mathrm{S}_t)L(\mathrm{S}_t)}_{\textit{income tax}} = \underbrace{\kappa 1_{(\zeta=1)}B(\mathrm{S}_t)}_{\textit{coupon}} + \underbrace{g(\mathrm{S}_t)}_{\textit{spending}} - \underbrace{T(\mathrm{S}_t)}_{\textit{lump-sum}} \tag{7}$$

This budget constraint means that, given $q^g(\mathrm{S}_t)$, the government's choice of transfers $T(\mathrm{S}_t)$ can be obtained as a residual from its issuance policy.

I assume that the government follows exogenous fiscal rules to determine consumption g_t and debt issuances B'_t. These are allowed to be a function of the whole state vector, and I estimate them to match observed correlations with key business cycles statistics (see Section 5). Finally, I assume that the government spends a constant fraction ϑ_N of its expenditures on the nontraded good.

3.4.1 *Defaults and the evolution of debt*

The repayment strategy of the government $h'(\mathrm{S}_t, \xi_{t+1}, z_{t+1})$ specifies a repayment probability in each state of the following period. The government makes its default choice in period $t+1$ having observed the exogenous states (ξ_{t+1}, z_{t+1}) and understanding which aggregate states S_{t+1} result from repayment and from default. The government also receives an *iid* preference shock ξ^{def} orthogonal to all other variables, which plays the role of smoothing out the policy for numerical tractability.

If there is a default in period $t+1$, a haircut of $\hbar$ applies to the debt of the government. This means that $B(\mathrm{S}_{t+1}) = (1-\hbar)B'(\mathrm{S}_t)$, whereas $B(\mathrm{S}_{t+1}) = B'(\mathrm{S}_t)$ otherwise. When in default, there is a constant probability θ of reentering financial markets.

The budget constraint (7) is designed to capture a particular tradeoff. When resources from tax collections and debt issuance are low (for instance, when spreads are high), the government chooses between default or low lump-sum transfers. In this context, one could interpret the second option as a regressive austerity plan.

3.5 Monetary policy

The small open economy defends a pegged exchange rate. Everywhere in the model, this assumption amounts to a normalization of the (constant) price of nontraded goods $p_T \equiv 1$. Importantly, I assume that the economy does not abandon the peg upon default, as Na, Schmitt-Grohé, Uribe, and Yue (2018) argue is a relevant case.

Relaxing my assumption to have devaluations accompany defaults would not be innocuous. It would certainly reduce the aggregate income losses from default by allowing real wages to fall. On the other hand, it would create wealth effects from the currency of denomination of contracts and assets that households own. The first consequence can be captured in this model by making the bound on wages depend on the default state ζ. However, addressing the second, probably more interesting consequence requires a rich model of currency choice and is beyond the scope of this paper.

3.6 Foreign borrowing and the external sector

I assume a large quantity of foreigners who have access to funds at a fixed international risk-free rate $r^\star$. Immediately, this implies that

$$q^h(S) = \frac{1}{1+r^\star} \tag{8}$$

Furthermore, if foreigners hold the government's debt in state S, then by no arbitrage it has to be the case that

$$q^g(S) = \frac{1}{1+r^\star}\mathbb{E}\left[\underbrace{1_{(\zeta'=1)}\left(1-\xi'\right)\kappa}_{\text{coupon}} + \underbrace{\left(1-\rho 1_{(\zeta'=1)}\right)}_{\text{depreciation}}\underbrace{\left(1-\hbar 1_{(\zeta=1\cap\zeta'\neq 1)}\right)}_{\text{potential haircut}}\underbrace{q^g(S')}_{\text{resale price}} \;\middle|\; S\right] \tag{9}$$

which reflects that debt is a claim to coupon payments while there is no default, that a default entails the haircut $\hbar$, and that the unmatured fraction $(1-\rho)$ of the bond can be resold in secondary markets. With respect to the coupon payments, I assume that foreigners price debt as if the coupon payment was $(1-\xi')\kappa$ where the stochastic process for ξ is constrained to remain within the interval $(0,1)$. This assumption artificially depresses the price of government debt in order to match the home bias in holdings (see Section 4.3 for a discussion).

If the government was already in default at state S_t, equation (9) specializes to

$$q^g(S \mid \zeta \neq 1) = \frac{1}{1+r^\star}\left(\theta\mathbb{E}\left[1-\xi' \mid S\right]\kappa + (1-\rho\theta)\,\mathbb{E}\left[q^g(S') \mid S\right]\right)$$

as the government reenters international markets with constant hazard θ and it cannot default again while in the default state.

Equation (9) only holds when foreigners hold some of the debt. I assume that, as in the data, domestic demand for government debt always falls short of the total amount outstanding. I then check in simulation that this is the case.

When the small open economy is indebted with the rest of world, its consolidated intertemporal budget constraint states that the value of debt obligations must equal the expected discounted value of trade surpluses. If A denotes the total amount of risk-free debt and A^f, A^h that in hands of foreigners and domestic agents, respectively, and the same convention applies to government debt B, net foreign inflows are given by

$$\mathtt{NFI}_t = \underbrace{q_t^h A_{t+1}^f + q_t^g \left(B_t'^f - (1-\rho)B_t^f\right)}_{\text{Capital inflows}} - \underbrace{\left(\kappa B_t^f + A_t^f\right)}_{\text{Capital outflows}} \tag{10}$$

where resources flow into the small open economy when domestic agents borrow from foreigners and when foreigners purchase debt. On the other hand, resources flow out when the government makes coupon payments to foreigners and when domestic agents repays their debts.

Because the distribution λ does not distinguish holdings of both assets separately, neither A_t nor its components are a function of the state variables $\mathbf{S}_t$. However, some manipulation allows to recast (10) in terms of flows as

$$\begin{aligned}\mathtt{NFI}_t &= q_t^g B_t'^f - \left(A_t^f + (\kappa + (1-\rho)q_t^g)B_t^f\right) + q_t^h A_{t+1}^f \\ &= \int \left(\omega - q_t^h \phi_a - q_t^g \phi_b\right) d\lambda_t - \kappa B_t + q_t^g (B_t' - (1-\rho)B_t)\end{aligned}$$

where government debt held by foreigners equals $B_t'^f = B_t' - \int \phi_b d\lambda_t$, private debt held by foreigners equals $A_{t+1}^f = -\int \phi_a d\lambda_t$, and $\int \omega d\lambda_t = A_t^h + (\kappa + (1-\rho)q_t^g)B_t^h$.

Finally, market clearing requires that

$$Y_{Nt} = C_{Nt} + \frac{\vartheta_N}{p_{Nt}} G_t \qquad \text{and} \qquad Y_{Tt} + \mathtt{NFI}_t = C_{Tt} + (1-\vartheta_N)G_t \tag{11}$$

as net foreign inflows must equal the trade deficit.

3.7 *Timing*

Figure 3 summarizes the unfolding of events within a period. The past state is carried from the previous period. Then nature chooses the current level of TFP and risk premia. Observing these, the government decides its repayment if it is not in default already. If the country was already in default, then nature chooses whether there is reentry to financial markets. Only then do foreign lenders set asset prices. At this point the distribution of wealth across households is determined. The government then implements its issuance and transfer policies. Finally, firms choose employment and prices, the households make their consumption and savings choices, and the period ends.

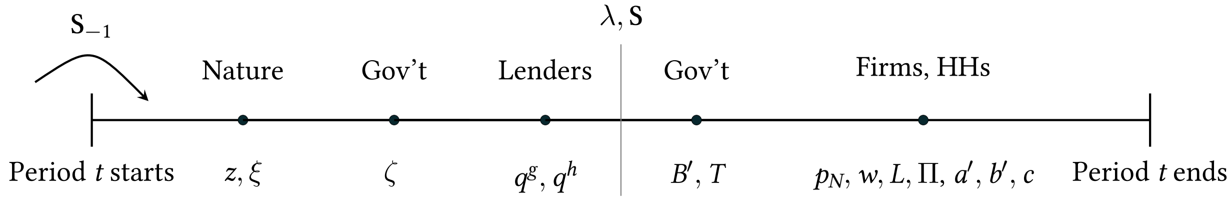


Figure 3: Timeline

3.8 *Evolution of the distribution*

Before defining the equilibrium, I discuss a particular assumption that allows me to solve the model parsimoniously. In the exposition above, the state vector S contains the whole distribution of agents across their idiosyncratic states, which is an infinitely-dimensional object. As is usual in heterogeneous-agents models, I proceed by solving for a bounded rationality equilibrium where agents only have limited knowledge of the distribution λ.

Specifically, I assume that agents believe the distribution of wealth and individual labor productivity to be jointly lognormal with

$$\begin{pmatrix} \omega_t \\ \epsilon_t \end{pmatrix} \sim \log \mathcal{N}\left(\begin{bmatrix} \mu_t \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_t & \rho_t \\ \rho_t & \sigma_\epsilon \end{bmatrix} \right) \tag{12}$$

where as of this writing, I further assume that $\rho_t = 0$. μ_t and σ_t, however, vary over time and become state variables.

This assumption allows me to summarize λ_t with $(\mu_t, \sigma_t, \rho_t)$. As for the law of motion of the distribution, the household's policy functions need not imply that λ_{t+1} is exactly lognormal even if λ_t is. This is the key place where the approximation is taken, as I assume laws of motion for the distribution parameters.

Two approximations happen at once. The first is that I only solve for the equilibrium on a subset (the lognormal distributions) of the infinite dimensional space of all possible distributions. Bounded rationality really happens along the second approximation: whenever the policy functions imply a distribution that is not lognormal for the following period, I project it back onto the (μ, σ, ρ) space by making all agents in the model expect a lognormal distribution with the same mean and variance than the one implied by the policies.

These approximations allow me to solve for the equilibrium of the model without the usual simulation step. Instead, I check in simulation that the agents' forecasting rule accurately predicts the dynamics of relevant variables.

Given all functions of the state (including the households' policy functions) and the current distribution, substituting λ_t for the corresponding lognormal in (13) yields a system for the joint evolution of the parameters of the distribution as well as the price of debt (which depends on the future distribution through the government's default incentives)

$$\begin{cases} R_b(\mathbf{S}_{t+1}) & = & 1_{(\zeta_{t+1}=1)}\kappa + (1-\rho)q^g(\mathbf{S}_{t+1}) \\ \int \omega d\lambda_{t+1} & = & \int \phi_a(\mathbf{s}_t, \mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{s}_t, \mathbf{S}_t) d\lambda_t \\ \int \omega^2 d\lambda_{t+1} & = & \int \left[\phi_a(\mathbf{s}_t, \mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{s}_t, \mathbf{S}_t)\right]^2 d\lambda_t \\ \int \omega\epsilon d\lambda_{t+1} & = & \int \left[\phi_a(\mathbf{s}_t, \mathbf{S}_t) + R_b(\mathbf{S}_{t+1})\phi_b(\mathbf{s}_t, \mathbf{S}_t)\right] \epsilon' f(\epsilon_t, \epsilon') d\lambda_t \end{cases} \tag{13}$$

4. Equilibrium

4.1 Competitive equilibrium

Definition Given government policies $h'(\mathbf{S}, \xi', z')$, $B'(\mathbf{S})$, $and g(\mathbf{S})$, a *competitive equilibrium* consists of value and policy functions $\{v, \phi_a, \phi_b, \phi_c\}(\mathbf{s}, \mathbf{S})$, aggregates $L_T(\mathbf{S})$, $L_N(\mathbf{S})$, $\Pi(\mathbf{S})$, $Y_N(\mathbf{S})$, $Y_T(\mathbf{S})$, prices $p_C(\mathbf{S})$, $p_N(\mathbf{S})$, $w(\mathbf{S})$, $q^g(\mathbf{S})$, $q^h(\mathbf{S})$, taxes $T(\mathbf{S})$ and laws of motion for the distribution parameters $\{\mu', \sigma'\}(\mathbf{S}, \xi', z', \zeta')$ such that

- The policy functions solve the household's problem (3) given prices, aggregates, and the law of motion for the distribution.
- The relative price of nontraded goods $p_N(\mathbf{S})$ satisfies the intratemporal first-order condition (4).
- The aggregates $L_T(\mathbf{S}), L_N(\mathbf{S})$ maximize the firms profits given prices $w(\mathbf{S}), p_N(\mathbf{S})$ and the quantities produced $Y_N(\mathbf{S}), Y_T(\mathbf{S})$ satisfy the production functions (5, 6).
- The lump-sum taxes $T(\mathbf{S})$ satisfy the government's budget constraint (7).
- Asset prices $q^h(\mathbf{S})$ and $q^g(\mathbf{S})$ satisfy the no-arbitrage conditions (8, 9).
- Market clearing
  1. in traded and nontraded goods (11).
  2. in labor: either $w(\mathbf{S}) = \bar{w}$ or $L_T(\mathbf{S}) + L_N(\mathbf{S}) = \int \epsilon d\lambda_{\mathbf{S}}$.
- The laws of motion for the distribution parameters satisfy the consistency requirement (13).

4.2 The government's strategy

The government's objective is to maximize current welfare in the economy. I assume that it places equal weights on every agent. Without commitment, the government maximizes

$$\mathcal{W}(\mathrm{S}, h') = \int v(\mathbf{s}, \mathrm{S}) d\lambda_{\mathrm{S}}(\mathbf{s}) + 1_{(\zeta=1)} \sigma_g \xi^{def} \tag{14}$$

where $\xi^{def} \overset{iid}{\sim} \mathcal{N}(0,1)$ is a preference shock that serves the numerical purpose of smoothing the default policy. The government is subject to equilibrium conditions and its budget constraint, where the notation λ_{S} emphasizes that the distribution is a part of the state S. Importantly, the value function and the distribution correspond to the competitive equilibrium that results under the policy h'.

A policy h' for repayment is a part of an *equilibrium* if, at each (S, z'), the probability of repayment satisfies

$$h'(\mathrm{S}, z') = \mathbb{P}\left(\sigma_g \xi^{def} \leq \underbrace{\mathcal{W}\left(\Psi(\mathrm{S}, \xi', z', \zeta' = 1), h'\right)}_{\textit{value under repayment}} - \underbrace{\mathcal{W}\left(\Psi(\mathrm{S}, \xi', z', \zeta' \neq 1, h')\right)}_{\textit{value under default}}\right) \tag{15}$$

where $\Psi(\mathrm{S}, \xi', z', \zeta') = \mathrm{S}'$ is the state that ensues when (ξ', z') are realized after S and the government chooses a default state ζ'. Equation (15) makes it clear that, after observing the realization of ξ' and z', the government understands which state S' results if it decides to default or to repay. This includes the level of debt remaining to be paid as well as the distribution induced in each case.

Condition (15) is a rational-expectations restriction: the policy that households, foreigners, and the current government expect of future governments, h', must coincide with the policy that the government would choose if allowed a deviation that did not alter future expectations. In other words, condition (15) insists that the policy h' be part of a Nash equilibrium. The restriction that all policies depend only on the current state S (and not on the whole history of play) further refines the solution concept to that of recursive equilibrium.

Section A.2 in the Appendix describes the computation of a solution in detail.

4.3 Euler equations and coupon payments

The Euler equation (16) determines a household's purchases of government bonds:

$$q^g(\mathrm{S}) \geq \beta \mathbb{E}\left[\underbrace{R_b(\mathrm{S}, \mathrm{S}') \frac{p_C(\mathrm{S})}{p_C(\mathrm{S}')}}_{\textit{real repayment}} \underbrace{\underbrace{\left(\frac{\phi_c(\omega', \epsilon', \mathrm{S}')}{\phi_c(\omega, \epsilon, \mathrm{S})}\right)^{-\frac{1}{\psi}}}_{\textit{Intertemp. subs.}} \underbrace{\left(\frac{v(\omega', \epsilon', \mathrm{S}')}{\mathbb{E}\left[v(\omega', \epsilon', \mathrm{S}')^{1-\gamma} \mid \mathrm{S}\right]^{\frac{1}{1-\gamma}}}\right)^{\frac{1}{\psi}-\gamma}}_{\textit{Risk aversion}}}_{\textit{SDF}} \,\middle|\, \mathrm{S}\right] \tag{16}$$

with equality if the household is purchasing a positive amount of bonds.

Comparing this equation with the pricing equation (9), it is immediate to infer that if ξ were equal to zero then the household would not buy too many government bonds. Being risk-averse, the household demands a risk premium to expose itself to the risk of the government. The shock ξ plays the role of creating a risk premium in the return of the government bond when compared to the return of the risk-free asset. This allows the model to match the high proportion of sovereign debt held by domestic agents in the data. Moreover, introducing ξ as a shock allows me to study the economy's response to increases in spreads that are not driven by changes in fundamentals of the domestic economy.

4.4 *The household's reaction to sovereign risk*

There are at least three main ways in which sovereign risk affects the household's problem (3). The first effect concerns the aggregate income losses that happen in case of default. Conditional on default, TFP drops by Δ is both sectors for a random amount of periods, which puts downward pressure on the market-clearing wage. If the constraint becomes binding, then unemployment increases. In any case, expected labor income $w(\mathbf{S})L(\mathbf{S})$ is lower in default than in repayment. In states with a higher default probability, the household consequently feels poorer and reduces consumption.

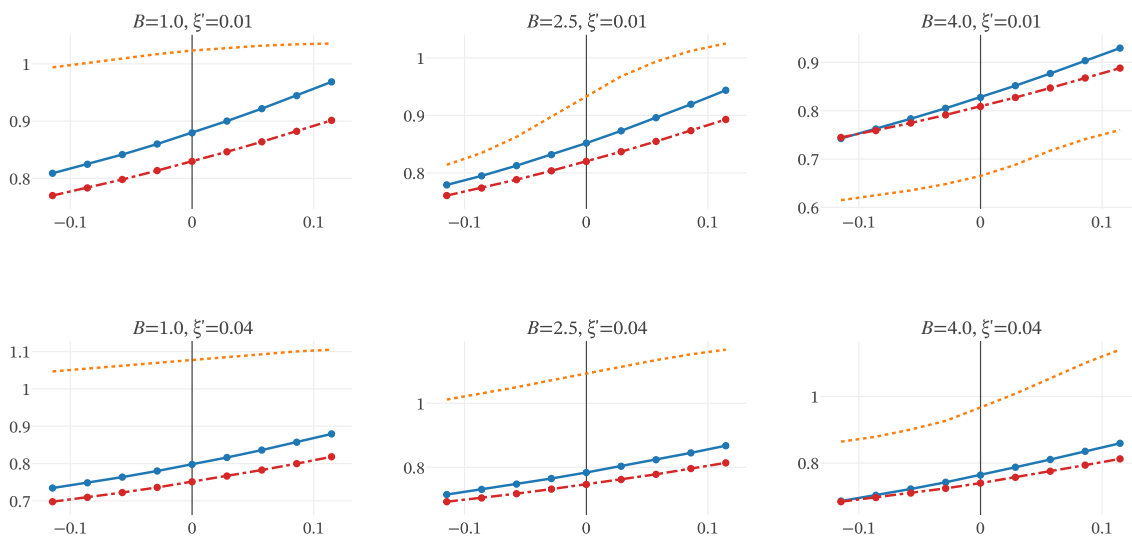


Figure 4: Labor Income and Expected Returns

Note: Blue lines plot income in repayment, red dashed lines plot income in default, orange dotted lines plot the return of holding government debt

A second effect goes through the price of government bonds. $q^g(\mathbf{S})$ reflects the default probability and shocks that make it increase also decrease the resale value of bonds. Households who purchased these bonds in the past make an inmediate capital loss when q^g drops. In the aggregate, a distributional effect shifts the wealth distribution to the left when the default probability increases. The strength of this channel depends critically on the proportion of bonds held by domestic agents, as well as in the level of inequality in domestic bondholdings.

Finally, the household cares about the insurance properties of the government bond. Sovereign risk makes those very different in normal times and in crisis times. Recall the return of a government bond

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

In normal times, the variance of R_b is relatively low. Its variation comes mostly from variation in the future resale price $q^g(\mathrm{S}')$. However, as the default probability increases more and more of the variance of R_b becomes driven by variation in the repayment probability. Moreover, repayment correlates with aggregate income as the government's incentives to default are stronger in bad times. Hence, the conditional covariance between the bond return and the stochastic discount factor of households tends to be larger in crises. This feature makes the bond a bad hedge always but an even worse one when spreads are high.

Figure 4 shows future income and realized bond returns. Both the aggregate income losses and the savings technology effects are evident in the picture. Expected labor income is lower in default and decreasing in TFP, and the difference between default and repayment is increasing in TFP. Moreover, the variance of returns (as well as its covariance with income) increases with indebtedness.

4.5 *Wage rigidities and aggregate demand*

When sovereign risk increases, the demand for consumption is likely to fall. This feeds back to the rest of the economy mainly through the market for nontraded goods.

In the market for traded goods, firms can supply whatever quantities they produce at the international price. Therefore, for a given wage rate w_t prevailing in the economy, traded goods-producing firms observe the current level of TFP and choose employment accordingly.

The market for nontraded goods features more action, which is summarized by its supply curve. To trace it out, suppose a decrease in the relative price of nontraded goods. According to their first-order condition (17), firms respond to this decrease by cutting down production.

$$L_N^d = \left(\alpha_N \frac{p_N}{\max\{w, \bar{w}\}}\right)^{\frac{1}{1-\alpha_N}} \tag{17}$$

When firms in the nontraded sector retract their production they expell workers. This pushes down wages. In normal times, wages fall so some of these workers reallocate to the traded goods sector. At the same time, some others 'return' to work in the nontraded sector. When the constraint is binding, however, these second-round effects cannot happen: the fall in the price of nontradables results in an increase in unemployment and in a larger fall in the production of nontraded goods.

Figure 5 makes this point by showing that the supply curve is flatter when the constraint on wages is binding. This means that when demand falls, quantities fall more and prices fall less than in normal times. Wage rigidities create price stickiness.

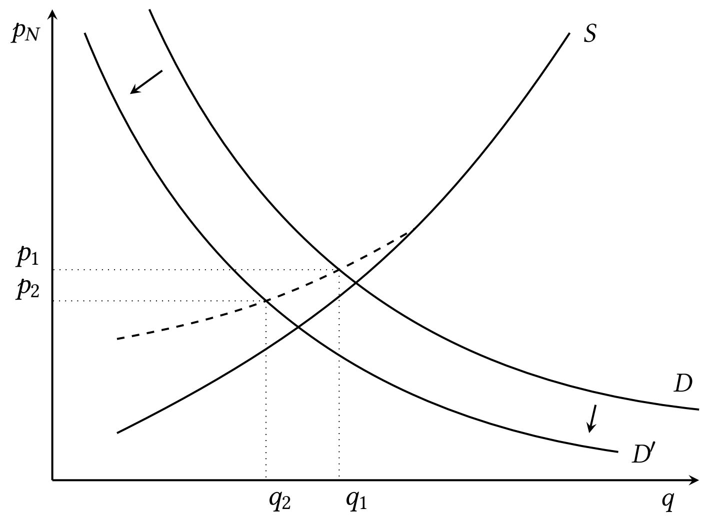


Figure 5: Market Clearing in the Nontradable Sector

The introduction of wage rigidities in this paper departs from the traditional approach of Schmitt-Grohé and Uribe (2016). In it, the wage in period t is constrained be no less than $\gamma_w w_{t-1}$, where $\gamma_w \leq 1$ is a parameter. I follow instead Bianchi, Ottonello, and Presno (2016) and set a constant lower bound $\bar{w}$ on nominal wages. While both assumptions are similar, in this context there are some advantages to the second formulation.

The first obvious advantage is that not having to carry the previous period wage saves one state variable. But there is a second advantage: in the traditional formulation good TFP shocks can be welfare-decreasing if they push the current wage rate too high and generate future unemployment. This is the 'overborrowing' externality emphasized by Schmitt-Grohé and Uribe (2016): individual households do not internalize that their consumption pushes up wages. In a scenario like this, where defaults also artificially depress TFP, a benevolent government might want to default on its debt only to suppress the overconsumption externality. This would lead to counterfactually many defaults in good times. If the government was allowed to choose spending and debt issuances, it would also use fiscal policy to curtail the boom and probably would not need to default in these cases. However, I am constraining the government to follow fiscal rules. Hence, the admittedly less realistic constant lower bound on wages is preferred.

5. Calibration

5.1 Fiscal rules

I estimate fiscal rules for government spending and issuances of new debt, using quarterly data for the Eurozone. Data are taken from Eurostat and cover the period 1999Q1 to 2017Q4. In the model, government consumption and net issuances as fractions of GDP depend on the whole state vector, so in the data I regress those against endogenous variables.

Table 2 summarizes the results across various specifications. For each dependent variable, the first column contains the preferred specification. The second column contains simpler versions of the same regression. Country as well as time fixed effects are included.

	G_t/Y_t		$(B_t' - (1-\rho)B_t)\,/Y_t$	
	(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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2: Estimated Fiscal Rules

The fit for both government consumption and debt issuances is good, with adjusted R^2s at 90% and 70%, respectively. Fiscal policy is countercyclical, with positive responses to unemployment for both spending and issuances. New issuances respond negatively to the debt-to-GDP ratio, consistent with debt stabilization.

Figure 6 shows the fitted values for Spain from the preferred specification. The predicted rules track the observed series closely. Clearly some of the fit is due to the inclusion of time fixed effects, which in the model version of the fiscal rule are absent. In the model, I do include Spain's fixed-effect coefficient as the intercept in the calibrated fiscal rules.

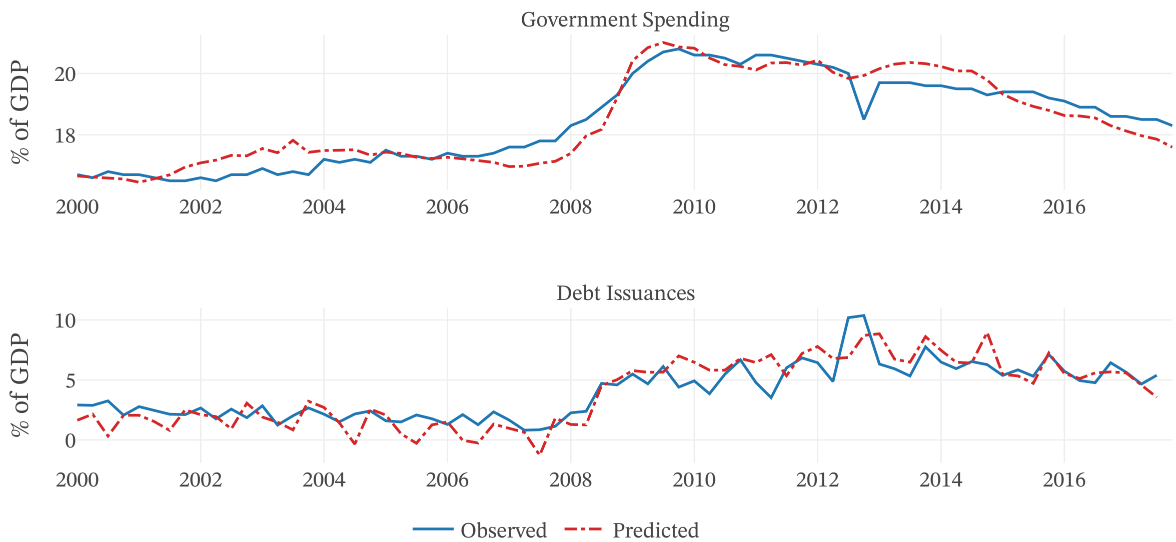


Figure 6: Estimated Fiscal Rules

5.2 *Model parameters*

The current calibration of the model is able to generate a good match to some critical standard targets in the literature. Table 3 reports some critical parameter values. Because of the numerical complexity of the model, I rely on external calibration as much as possible. For the supply side of the economy, I closely follow Anzoategui (2020) and Stockman and Tesar (1995) and set preference parameters ϖ and ϑ_N to match the shares of traded and nontraded goods in both private and public consumption, as well as the elasticity η to the elasticity of relative consumption demand. Because of CES demand, every household consumes traded and nontraded goods in the same proportions. Therefore, ϖ and η only link prices and aggregate quantities through

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

so the estimation from Stockman and Tesar (1995) is valid in this context as well.

The risk-free interest rate is set at a standard value in the literature. For the costs of default, I follow Philippon and Roldán (2018) and set the haircut and conditional TFP losses to a Greek-style default. The

Description	Parameter	Value	Source / Target
Debts and defaults			
Risk-free rate	$r^{\star}$	4% ann.	Anzoategui (2020)
Haircut in case of default	$\hbar$	45%	Philippon and Roldán (2018)
TFP loss in case of default	Δ	10%	Philippon and Roldán (2018)
Reentry probability	θ	0.04167	Cruces and Trebesch (2013)
Traded and nontraded goods			
Share of nontraded in prod	ϖ	0.7397	Anzoategui (2020)
Labor share in prod	α_N, α_T	0.67	Anzoategui (2020)
Share of nontraded in G	ϑ_N	88%	Anzoategui (2020)
Elasticity of nontraded consumption	η	0.74	Anzoategui (2020)
Idiosyncratic income			
Persistence log ϵ_{it}	ρ_ϵ	0.978	D'Erasmo and Mendoza (2016)
Std. deviation log ϵ_{it}	σ_ϵ	0.022	D'Erasmo and Mendoza (2016)
Internally calibrated			
Discount rate of HHs	$1/\beta - 1$	8.7% ann.	Moments in Table 4
Risk aversion	γ	9	Moments in Table 4
Progressivity of tax schedule	τ	22%	Moments in Table 4
Wage minimum	$\bar{w}$	0.889	Moments in Table 4
TFP process	ρ_z, σ_z	(0.97, 0.0015)	Moments in Table 4
Mean risk premium	$\bar{\xi}$	0.06%	Moments in Table 4
Risk premium AR(1)	ρ_ξ, σ_ξ	(0.95, 0.00025)	Moments in Table 4

Table 3: Parameter Values

probability of reentry is set to give an expected duration of default of 25 quarters, on the lower end of the Cruces and Trebesch (2013) estimation for large haircuts.

As for the household idiosyncratic income shocks process, I follow the estimation of D'Erasmo and Mendoza (2016) based on the Spanish income distribution for the same period that I study.

Table 4 provides details on the fit of the model. Statistics in the Model column are computed on a simulation of the benchmark model over 10000 years. The volatilities of consumption and output are the key targets that require improvement.

Target	**Model**	**Data**
AR(1) coef $\log(Y_t)$	0.971	0.966
Std coef $\log(Y_t)$	0.0212	0.0129
AR(1) coef $\log(C_t)$	0.968	0.962
Std coef $\log(C_t)$	0.0203	0.0166
AR(1) coef spread	0.976	0.967
Std coef spread	0.0188	0.103
Avg Debt-to-GDP	53.9%	64.6%
Std Debt-to-GDP	9.6%	23.5%
Avg unemployment	11.4%	15.9%
Std unemployment	6.65%	6.09%
Median dom holdings	42.4%	56.5%
Avg wealth-to-GDP	83.8%	94.5%

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

Table 4: Model Fit

6. Analysis

Figure 7 shows the policy and value functions of a household. The bottom panels show the total value of savings $q^h \phi_a(\mathbf{s}, \mathbf{S}) + q^g(\mathbf{S})\phi_b(\mathbf{s}, \mathbf{S})$ and the proportion of those that correspond to the risk-free bond.

Fig 7 HERE

Figure 7: Household's Value and Policy Functions

Figure 7 captures the fact that as households become richer they get more risk-tolerant and more willing to hold government bonds as part of their savings.

6.1 *Government policy*

Figure 8 shows the government's value function $\mathcal{W}(\Psi(\mathrm{S}, \xi', z', \zeta'), h')$ of the following period as function of the realization of shocks. Each panel shows welfare as a function of next period's TFP realization z'. The first row corresponds to a low realization of ξ', while in the second row spreads are high. Finally, the columns consider different S for the *current* period: initial debt increases from left to right. Higher debt levels increase the value of default relative to repayment. For intermediate amounts of initial debt, moreover, a higher realization of future TFP raises the relative value of repayment. Higher spreads also raise the relative value of default.

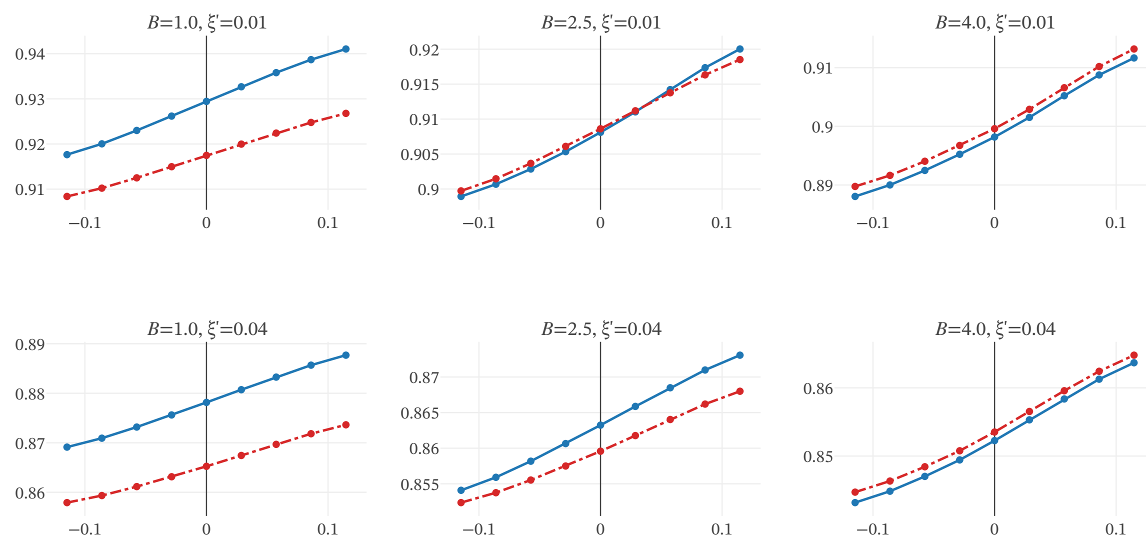


FIGURE 8: WELFARE FUNCTIONS

Note: Blue lines plot the value of repayment, red dashed lines plot the value of default

Figure 9 shows the lump-sum transfers that would clear the government's budget constraint in states $\Psi(\mathrm{S}, \xi', z', \zeta')$ of next period, as a function of (ξ', z', ζ'). Unsurprisingly, high levels of indebtedness shrink the government budget constraint and force it to collect high lump-sum taxes. In repayment, a higher level of future TFP induces high lump-sum taxes as well. This effect is driven by relatively low unemployment in those states, which leaves room for the government to reduce its leverage.

Figure 10 shows the price of debt $q^g(\mathrm{S})$ at different states S. The left panel shows that spreads rise (the price of debt falls) steeply when debt reaches a certain threshold. The effect of TFP is less stark but higher values of z are associated with lower spreads. Both of these are taken for a fixed distribution when the economy is not in default.

The right panel shows the impact of the distribution (for fixed values of B and z when the economy is not in default). Higher spreads occur when the economy is poorer and more unequal. This is because

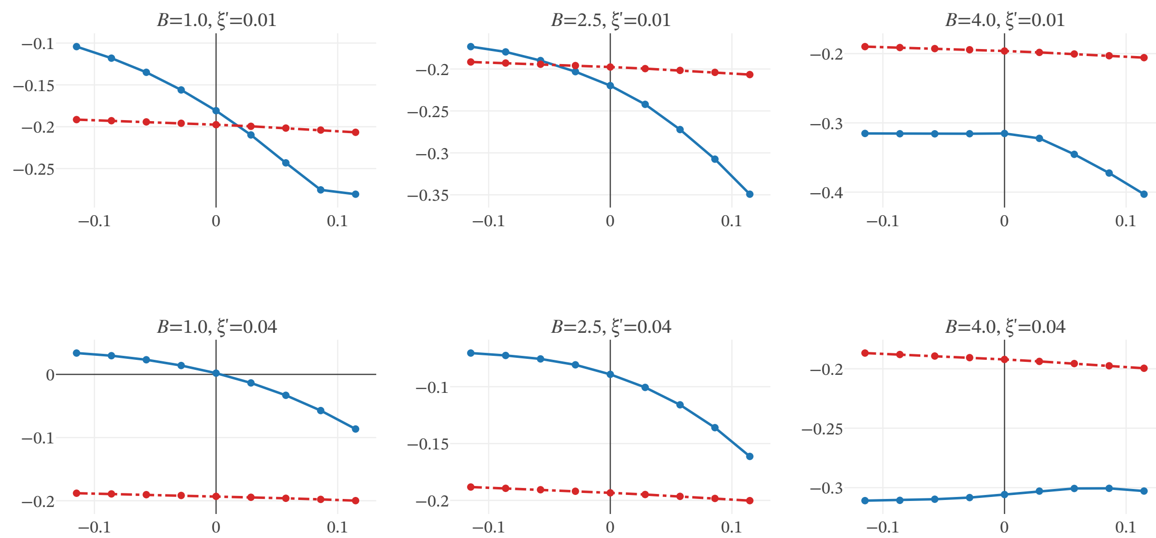


Figure 9: Transfers

Note: Blue lines plot transfers in repayment, red dashed lines plot transfers in default

the value of autarky depends strongly on how rich the economy is: with lower aggregate wealth, more agents are close to their borrowing limit and would suffer from the loss in TFP (and hence wages and employment) that follows a default. The effect of variance also goes through the value of autarky but through a different channel: when inequality is greater, defaults become a better way to redistribute.

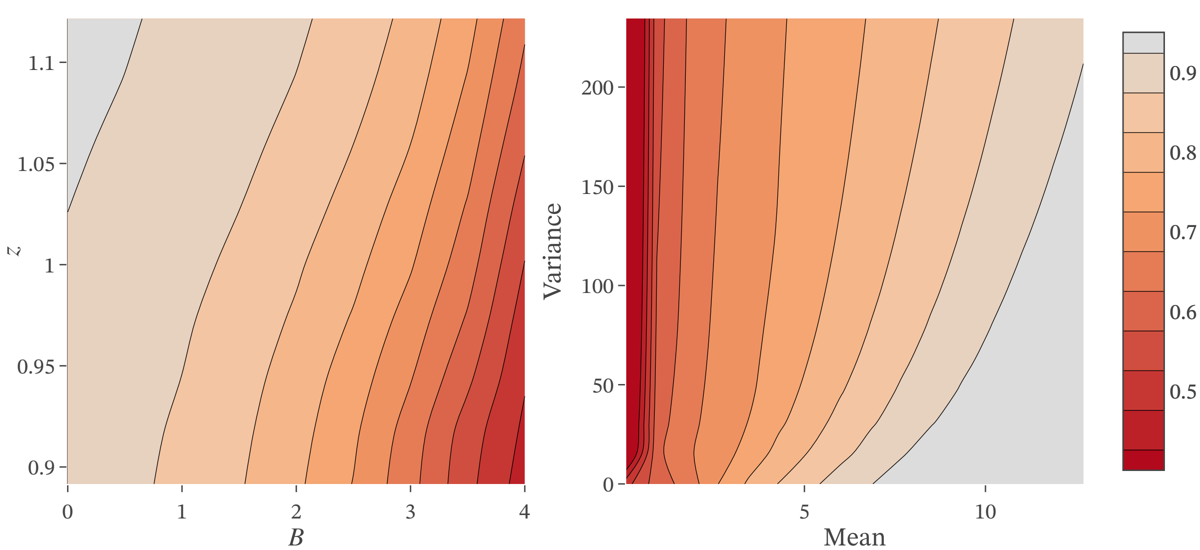


Figure 10: Price of Debt

6.2 *Macroeconomic conditions*

The unemployment rate is shown in Figure 11. Unemployment decreases with productivity and increases with government debt. The right panel shows that unemployment is related negatively to total wealth and positively to inequality.

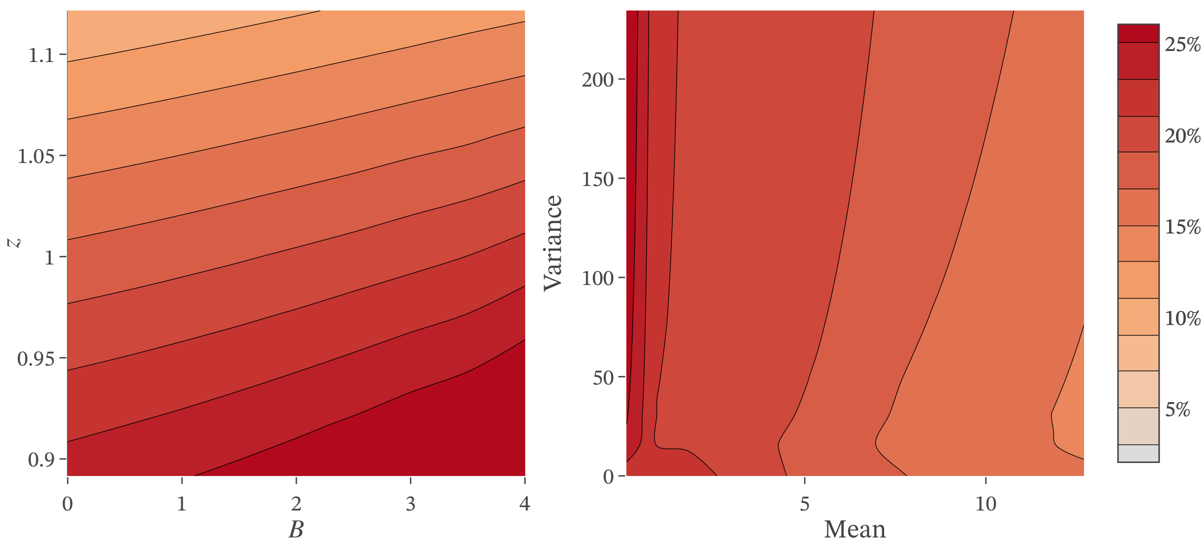


FIGURE 11: UNEMPLOYMENT

7. SIMULATION RESULTS

To investigate the effect of sovereign risk in the model economy, I simulate the model solution for 4000 years. Using the simulated data, I can analyze the behavior of the economy taking into account the frequency with which each state **S** is visited. Figure 22 in the Appendix shows a snapshot of a hundred years of the simulated data. One of the salient features of that figure is how closely the expected price of nontradables (based on the lognormal approximation of the wealth distribution) matches the actual market-clearing price of nontradables.

The main driver of aggregate fluctuations in this economy is the TFP shock z. I investigate the elasticity of output to TFP by estimating equations like

$$\log Y_{t+h} = \alpha_h + \beta_h \epsilon_t^z + \gamma_h X_t + \eta_{t+h} \tag{18}$$

where ϵ_t^z is the innovation in productivity at time t, X_t are controls, and Y_{t+h} is the level of output h quarters ahead. Figure 12 shows the elasticity of output to a shock in TFP at different horizons by estimating (18) without controls (ϵ_t^z is exogenous by construction).

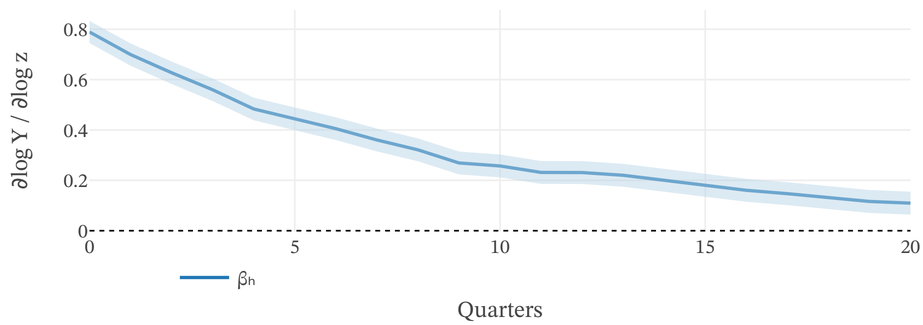
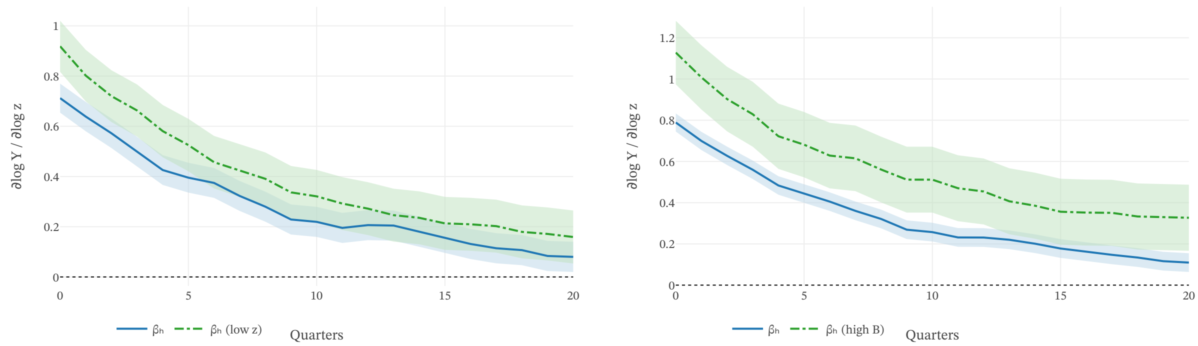


Figure 12: Response of Output to a TFP shock

95% confidence intervals shaded

7.1 *Amplification of productivity shocks*

Figure 13 illustrates that the response of output to the TFP shock is nonlinear and state-dependent. For this, I re-estimate (18) setting $X_t = \epsilon_t^z \cdot 1_{(\epsilon_t^z < \bar{\epsilon})}$ and $X_t = \epsilon_t^z \cdot 1_{(B_t > \bar{B})}$. I set $\bar{\epsilon}$ to the bottom 15th percentile of its distribution to capture negative shocks and $\bar{B}$ to the top 75th percentile of its distribution to capture times when the government is relatively indebted. In both cases, the reaction of output is amplified. Moreover, when the government is more indebted, productivity shocks affect output also more persistently.

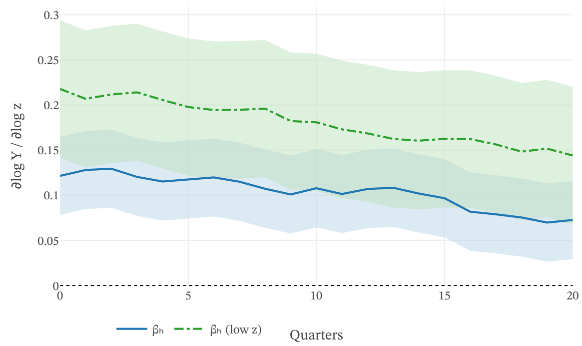


(a) For large shocks

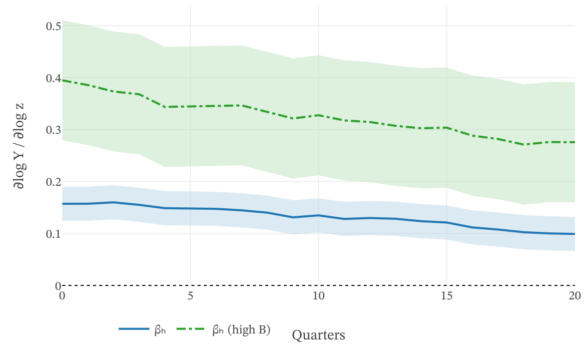
(b) For indebted economies

Figure 13: Response of Output to a TFP shock

Figures 14 and 15 relate the nonlinear and state-dependent responses of output to those of consumption and the default probability. The response of consumption to TFP is significantly amplified when the economy is highly indebted.



(A) For large shocks



(B) For indebted economies

Figure 14: Response of Consumption to a TFP shock

Fig 15a here

(A) For large shocks

Fig 15b here

(B) For indebted economies

Figure 15: Response of the Default Probability to a TFP shock

Fig 16 here

Figure 16: Response of Output to a Risk-premium shock

7.2 *Risk-premium shocks*

7.3 *Ergodic distributions*

Figure 17 plots estimated densities for output and consumption along the simulated path. To compute these, I subtract the mean and divide by the standard deviation of each variable. The estimated densities reveal a left skew in consumption.

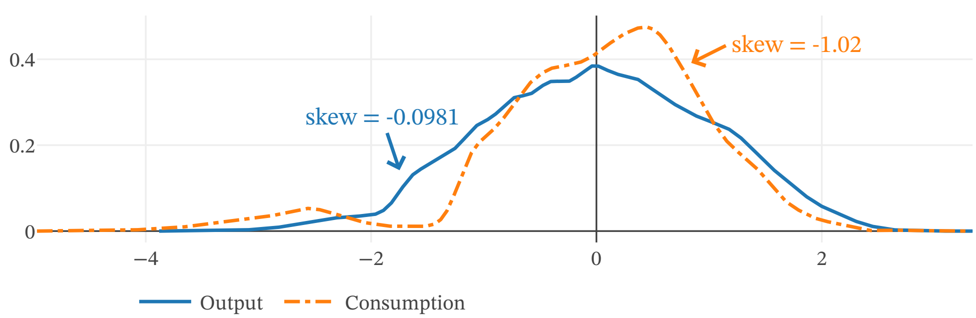


Figure 17: Ergodic Densities for Normalized Output and Consumption

Figure 23 in the Appendix recomputes the density of normalized output and consumption conditioning on a positive default probability (but still normalizing as before). This exercise reveals that the extra mass on the left tail of consumption comes from crisis episodes. Figure 24 shows the fears of savers: conditional on default, output and (especially) consumption fall to extremely negative levels. Most of the mass of the consumption distribution is between 2 and 4 standard deviations below the unconditional mean.

8. Crises

Using the simulated series, I focus on episodes of crisis. I define an episode of high spreads as a period when the default probability has been above the top 95th percentile of its distribution for seven quarters but a default did not actually happen during that time.

Figure 18 plots endogenous variables around episodes of high spreads. Time is measured in years so spreads are high between times -0.75 and 0.75. TFP, output, and consumption are significantly below their normal times values. At the same time, unemployment is high and the mean and variance of the wealth distribution are increasing, consistent with the rich realizing high returns on their debt holdings. Output hits a minimum of almost 10% below its long-run mean, while TFP varies between -5% and -2% at the trough of the episode. As TFP really only affects the traded sector (which is about 25% of the economy), this is a sizeable amplification. Consumption also drops significantly below its long-run mean by about 6%.

Figure 18 shows some of the dynamics at play. In the buildup to the crisis consumption falls both in levels and as a fraction of a measure of disposable income. There is also a significant fiscal contraction: there is a sustained increase in taxes along with a slight fall in government spending. Both of these counteract the increase in government debt, which is driven at first by the recession (which causes tax collections to drop) and later by the increase in the government's borrowing rate. Unemployment is high throughout the period, while debt holdings become concentrated on the rich.

Figure 19 shows events in 2.5-year windows around the default episodes in the same simulation for comparison.

8.1 *Amplification forces in the crisis*

Figure 20 takes the benchmark economy and its episodes of high spreads and compares it with an alternate economy in which the government followed a policy of always repaying the debt. The drops in output and consumption are muted in the no-default economy. The difference in welfare is substantial: the average household would give up the equivalent of 10% of consumption to be able to move to the economy with no default.

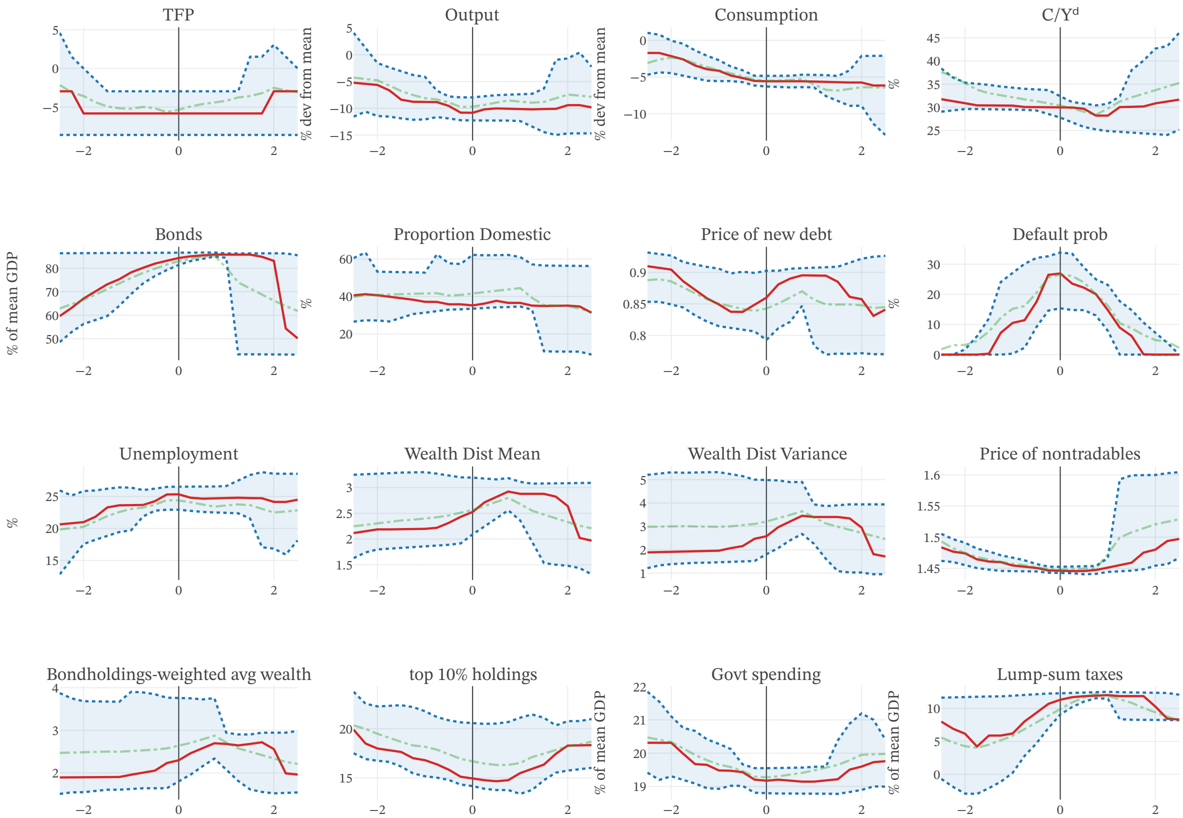


FIGURE 18: TIMES OF HIGH SPREADS

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

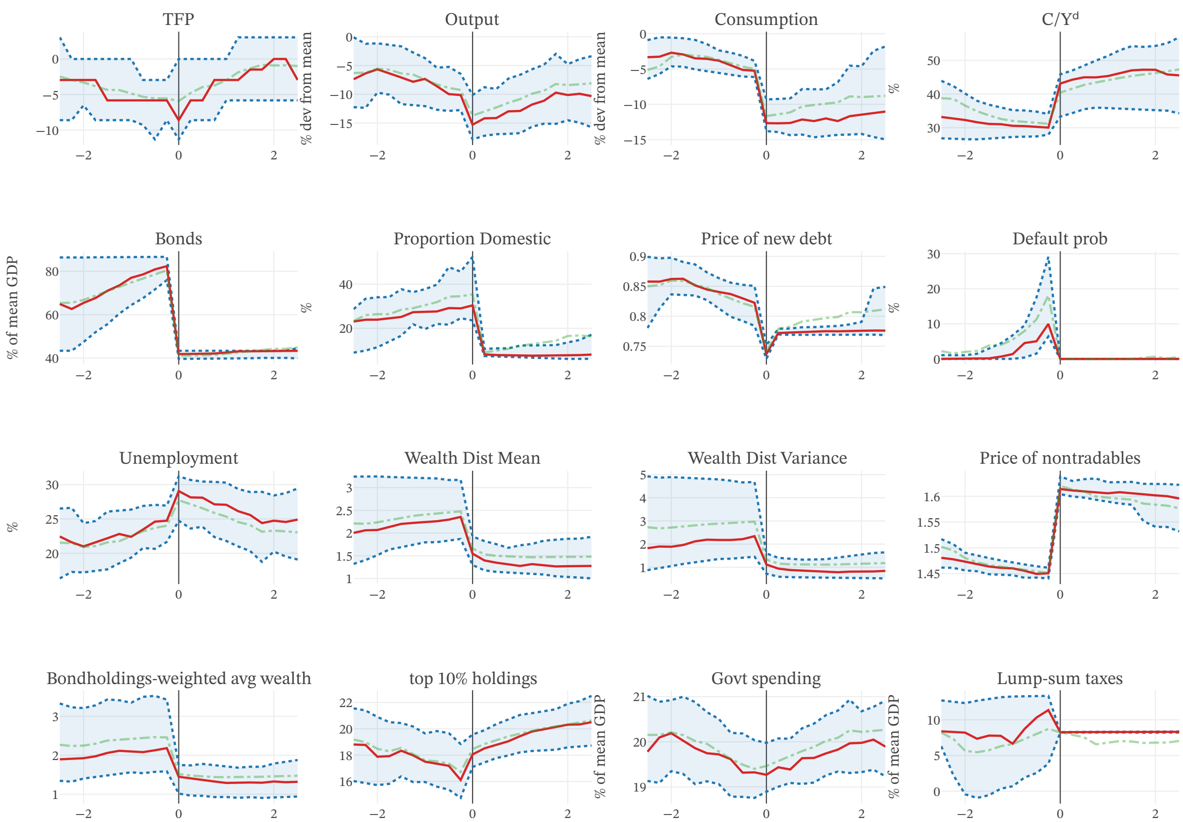


Figure 19: Outcomes around Defaults

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

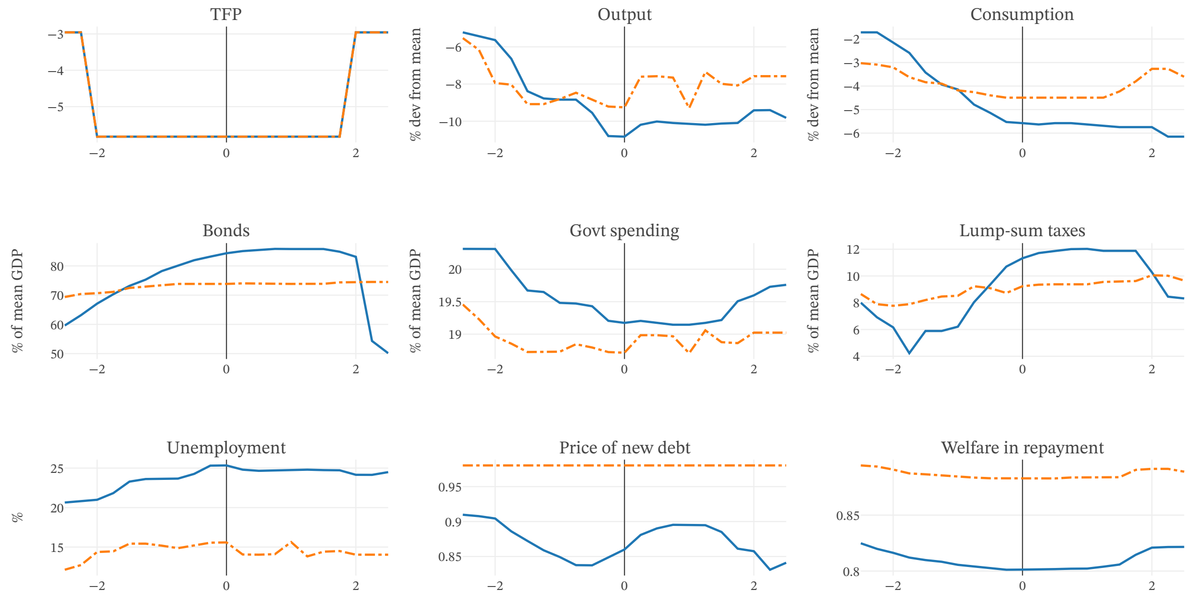


Figure 20: Crises

Blue: Benchmark, Dashed orange: No default

Table 5 shows statistics from simulation of both models. The volatility of output is 25% lower in the no-default case, while that of consumption is reduced to less than a half. The no-default economy also has about half the unemployment as the benchmark.

Moment	**Benchmark**	$\Delta = 0$	**No dom. holdings**	**No default**
AR(1) coef log(Y_t)	0.971	0.96	0.963	0.982
Std coef log(Y_t)	0.0212	0.00437	0.0259	0.00284
AR(1) coef log(C_t)	0.968	0.952	0.961	0.999
Std coef log(C_t)	0.0203	0.00484	0.0223	0.000293
AR(1) coef spread	0.976	0.958	0.965	1
Std coef spread	0.0188	0.0687	0.0256	0
Avg Debt-to-GDP	53.9%	50.9%	57.3%	60.2%
Std Debt-to-GDP	9.6%	12.1%	10.4%	8.84%
Avg unemployment	11.4%	9.86%	13.4%	9.3%
Std unemployment	6.65%	1.29%	7.29%	1.23%
Median dom holdings	42.4%	13.1%	0%	124%
Avg wealth-to-GDP	83.8%	70.8%	82.7%	75.6%
Default frequency	1.91%	6.36%	3.32%	0%

Table 5: Models

Figure 21 repeats the previous exercise but now compares crises in the benchmark model using different comparison models. These feature the same policy for government default as the benchmark: they are designed to show how the private economy would react in a world where the *consequences* of default were different.

The first comparison model I consider is one in which defaults carry no aggregate losses. By setting Δ to zero, TFP in case of default does not fall and neither does expected income when sovereign risk increases.

The second model makes default carry only TFP costs. By setting $\hbar$ to zero and having the government keep paying the coupon while in default, I effectively make the government bond risk-free. However, by keeping the default policy the same as in the benchmark, agents still expect their future income to fall when default risk is high.

Fig 21 HERE

Figure 21: Amplification Channels

Red: Benchmark, Blue: No aggregate losses, Orange: Only aggregate losses

9. Concluding Remarks

Inspired by events in the Eurozone crisis, this paper analyzes a model in which households' consumption demand is negatively affected by the presence of sovereign risk. The mechanisms in the model generate substantial amplification of underlying shocks.

The amplification mechanism exacerbates the equilibrium volatility of aggregate consumption, creating large welfare costs of sovereign risk. Taken one at a time, anticipation of the income losses of default explains most of the amplification. However, this effect interacts substantially with the anticipation of redistribution.

In the model, extra volatility in output emerges as a consequence of demand shortages triggered by sovereign risk spikes during particular downturns. This mechanism helps explain salient features of emerging-market business cycles. While both the relative volatility of consumption to output and the volatility of output itself are typical calibration targets in the sovereign debt literature, the setup presented here offers a more complete explanation of these phenomena by explicitly considering the saving behavior of private agents as well as the interest rate they face when they are net savers, as in the case of Spain in the 2000s.

References

Aguiar, M. and G. Gopinath (2007): "Emerging Market Business Cycles: the Cycle is the Trend," *Journal of Political Economy*, 115, 69–102.

Aiyagari, S. R. and E. R. McGrattan (1998): "The optimum quantity of debt," *Journal of Monetary Economics*, 42, 447–469.

Andreasen, E., G. Sandleris, and A. van der Ghote (2011): "The Political Economy of Sovereign Defaults," Business School Working Papers 2011-07, Universidad Torcuato Di Tella.

Anzoategui, D. (2020): "Sovereign Debt and the Effects of Fiscal Austerity," mimeo, Rutgers University.

Arellano, C. (2008): "Default Risk and Income Fluctuations in Emerging Economies," *American Economic Review*, 98, 690–712.

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

——— (2018b): "Inflation Target and Sovereign Default Risk," mimeo, University of Rochester.

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.

Chatterjee, S. and B. Eyigungor (2012): "Maturity, Indebtedness, and Default Risk," *American Economic Review*, 102, 2674–99.

Cruces, J. J. and C. Trebesch (2013): "Sovereign Defaults: The Price of Haircuts," *American Economic Journal: Macroeconomics*, 5, 85–117.

Cuadra, G., J. Sánchez, and H. Sapriza (2010): "Fiscal Policy and Default Risk in Emerging Markets," *Review of Economic Dynamics*, 13, 452–469.

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

Dovis, A. (2018): "Efficient Sovereign Default," *The Review of Economic Studies*, rdy012.

Dovis, A., M. Golosov, and A. Shourideh (2016): "Political Economy of Sovereign Debt: A Theory of Cycles of Populism and Austerity," Working Paper 21948, National Bureau of Economic Research.

Eaton, J. and M. Gersovitz (1982): "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *The Review of Economic Studies*, 48, 289–309.

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.

Ferriere, A. and G. Navarro (2017): "The Heterogeneous Effects of Government Spending: It's All About Taxes," .

Gennaioli, N., A. Martin, and S. Rossi (2014): "Sovereign Default, Domestic Banks, and Financial Institutions," *Journal of Finance*, 69, 819–866.

Guembel, A. and O. Sussman (2009): "Sovereign Debt without Default Penalties," *The Review of Economic Studies*, 76, 1297–1320.

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

Leland, H. E. (1998): "Agency Costs, Risk Management, and Capital Structure," *Journal of Finance*, 53, 1213–1243.

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.

Mendoza, E. G. and V. Z. Yue (2012): "A General Equilibrium Model of Sovereign Default and Business Cycles," *The Quarterly Journal of Economics*, 127, 889–946.

Na, S., S. Schmitt-Grohé, M. Uribe, and V. Yue (2018): "The Twin Ds: Optimal Default and Devaluation," *American Economic Review*, 108, 1773–1819.

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

Panizza, U., F. Sturzenegger, and J. Zettelmeyer (2009): "The Economics and Law of Sovereign Debt and Default," *Journal of Economic Literature*, 47, 651–98.

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.

Schmitt-Grohé, S. and M. Uribe (2016): "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment," *Journal of Political Economy*, 124, 1466–1514.

Stockman, A. C. and L. L. Tesar (1995): "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *The American Economic Review*, 85, 168–185.

Woodford, M. (1990): "Public Debt as Private Liquidity," *American Economic Review*, 80, 382–388.

A. Appendix: Solution Details

A.1 The household's problem

To make the problem more tractable, I rewrite the controls in a way that eliminates the budget constraint and replaces it with inequalities that are easier to handle. Let

$$s(a', b', \mathbf{S}) = \frac{q^h(\mathbf{S})a' + q^g(\mathbf{S})b'}{q^h(\mathbf{S})} \qquad \geq \bar{a}$$
$$\theta(a', b') = \frac{a' - \bar{a}}{s - \bar{a}} \qquad \in [0, 1]$$

where the constraint set (now a rectangle) is highlighted in red and

$$a'(s, \theta) = \bar{a} + \theta_a(s - \bar{a})$$
$$b'(s, \theta, \mathbf{S}) = (1 - \theta_a)(s - \bar{a})\frac{q^h(\mathbf{S})}{q^g(\mathbf{S})}$$

I further decompose the household's problem into two value functions, v and w. The first value function reflects the consumption-savings decision, while the second value function focuses on the portfolio allocation of those savings. We have

$$v(\omega, \epsilon, \mathbf{S}) = \max_{s,c} \left((1 - \beta)c^{\frac{\psi-1}{\psi}} + \beta w(s, \epsilon, \mathbf{S})^{\frac{\psi-1}{\psi}}\right)^{\frac{\psi}{\psi-1}}$$
$$\text{subject to } p_C(p_N)c + q^h(\mathbf{S})s = \omega + \ell(\mathbf{S}, p_N)\epsilon - T(\mathbf{S}, p_N)$$
$$s \geq \bar{a}$$

and

$$w(s, \epsilon, \mathbf{S}) = \max_{\theta} \mathbb{E}\left[\left(v(a' + R_b(\mathbf{S}')b', \epsilon', \mathbf{S}')\right)^{1-\gamma} | \omega, \epsilon, \mathbf{S}\right]^{\frac{1}{1-\gamma}}$$
$$\text{subject to } R_b(\mathbf{S}) = 1_{(\zeta=1)}\kappa + (1 - \rho)q^g(\mathbf{S})$$
$$\theta \in [0, 1]$$
$$a' = a'(s, \theta)$$
$$b' = b'(s, \theta, \mathbf{S})$$

What makes this transformation so tractable is that ω and s naturally belong in the same domain, so one can use the same grid for both.

A.2 Solution method

The algorithm follows closely the definition of equilibrium: to solve for an equilibrium, I solve a series of nested problems. Given government policies, I find a competitive equilibrium by finding functions of the aggregate state that describe the aggregates in the economy, in such a way that they are consistent with the household problem and policy functions.

Algorithm Given a policy for the government, I

1. Guess a law of motion for the distribution.
2. For each state $\mathbf{S}$
   (a) Compute $q^g(\mathbf{S})$ from the foreigners' sdf (9).
   (b) Guess a relative price of nontradables p_N
      - Get the wage rate w as well as total labor demand L^d and profits of the firms Π.
      - Compute lump-sum taxes T from gov't budget constraint (with τwL in hand).
      - Solve the household's problem at prices w, p_N, profits Π, and transfers T.
      - Check market clearing (11) for nontraded goods.

   (c) Iterate on the function $p_N(\mathbf{S})$ to convergence
3. Iterate on the law of motion for the distribution using the households' policy functions.

Finally, I update the government's policy according to (15) and iterate until a policy that respects it is found.

A.3 More model results

Figure 22: A simulated path

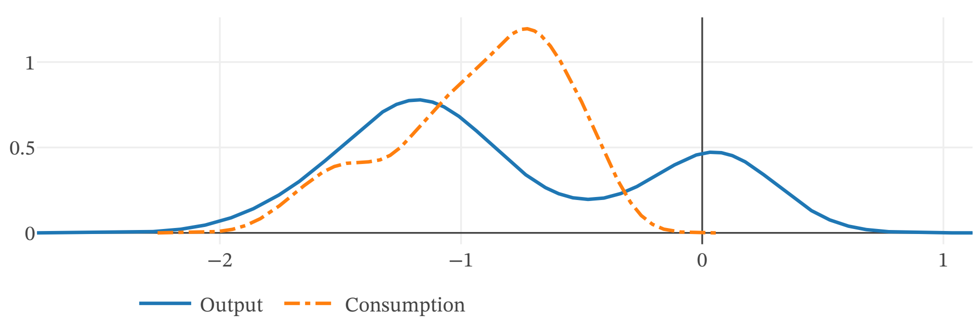


Figure 23: Densities for Output and Consumption during Crises

Densities conditional on a default probability above 15%

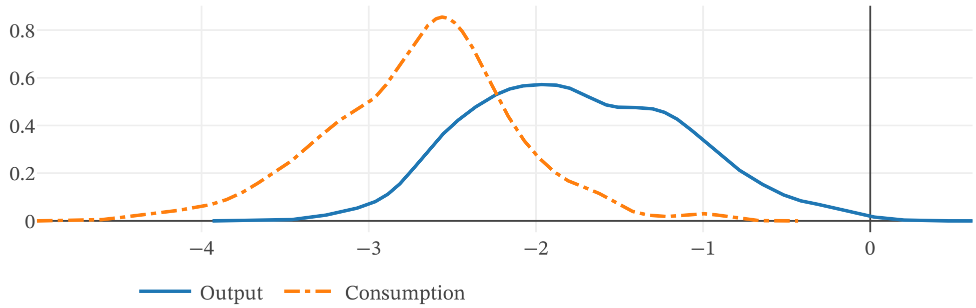


Figure 24: Ergodic Densities for Output and Consumption during Defaults

B. Appendix: Evidence

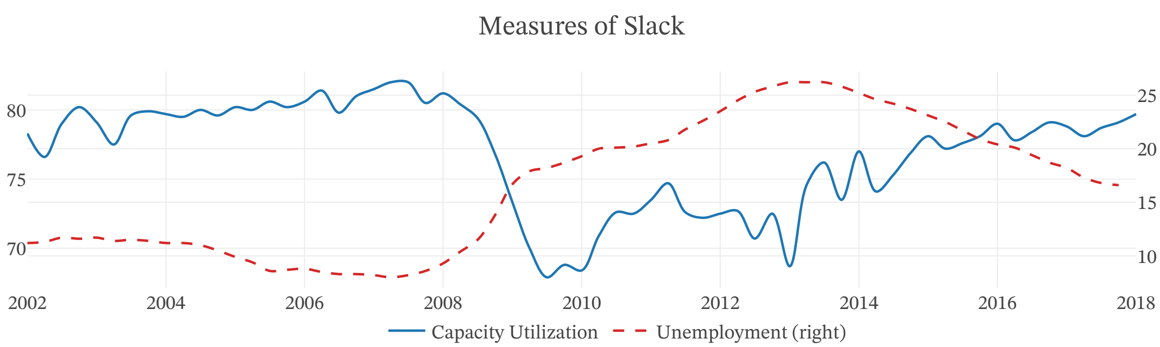


Figure 25: Slack in the Spanish economy

Source: Eurostat

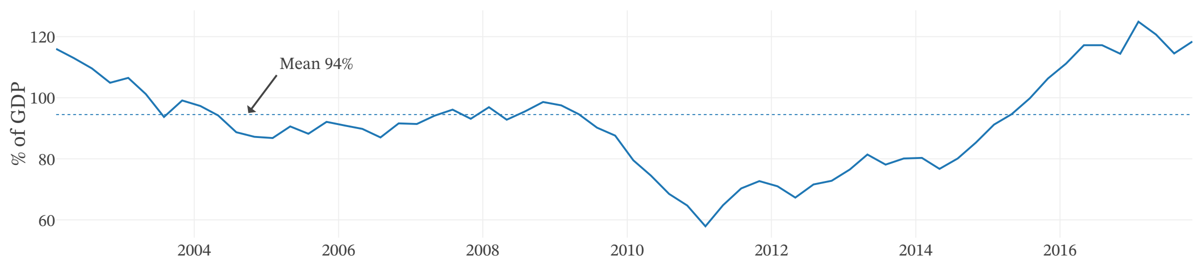


Figure 26: Net Worth of Spanish Households

Source: Eurostat

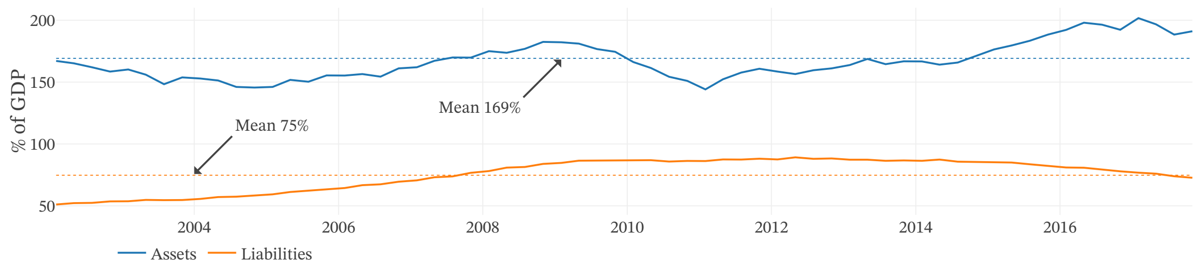


Figure 27: Net Worth of Spanish Households

Source: Eurostat

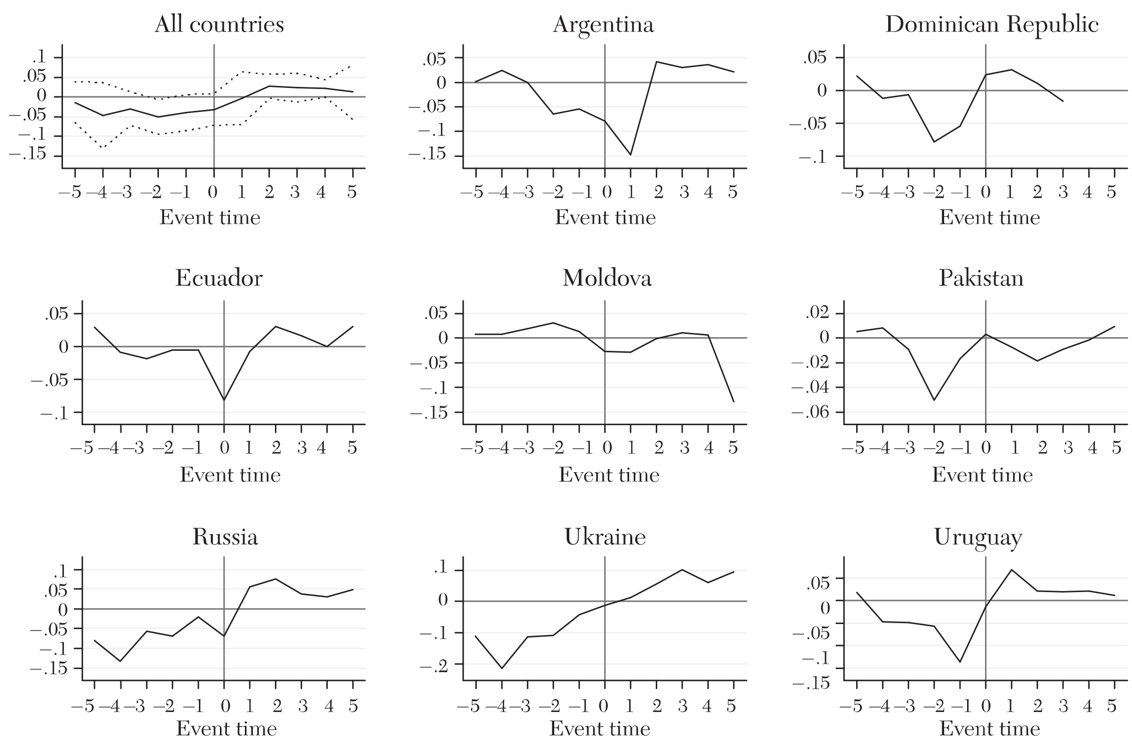


Figure 28: Defaults and output growth

Source: Panizza et al. (2009)

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

Series logged and HP-filtered with $\lambda = 1600$. Std deviations in %.

Table 6: The Cycle is the Trend

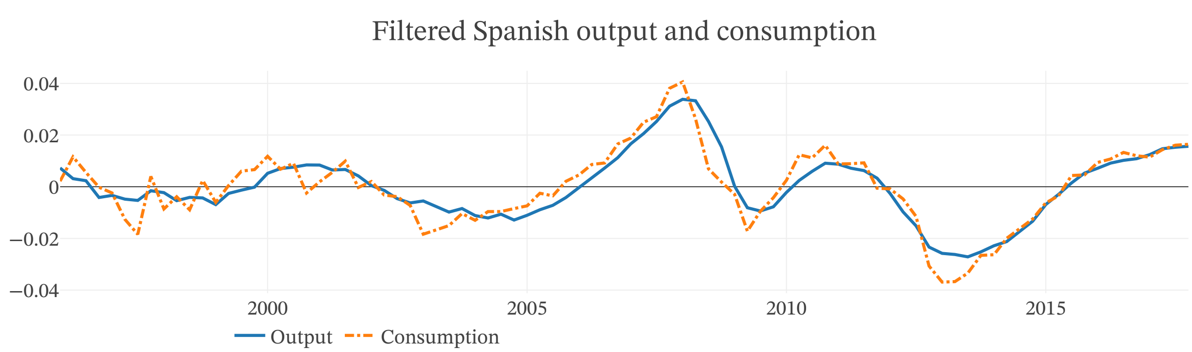


Figure 29: Spanish detrended output and consumption in the 2000s

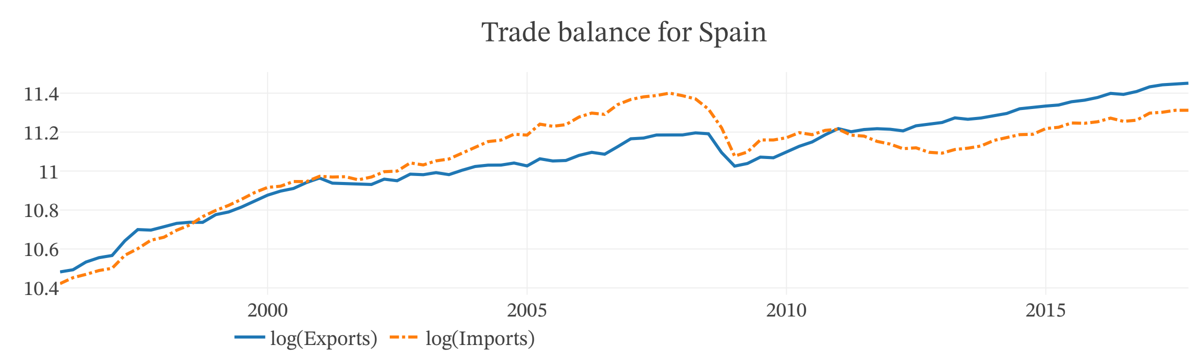


Figure 30: Spanish trade balance in the 2000s

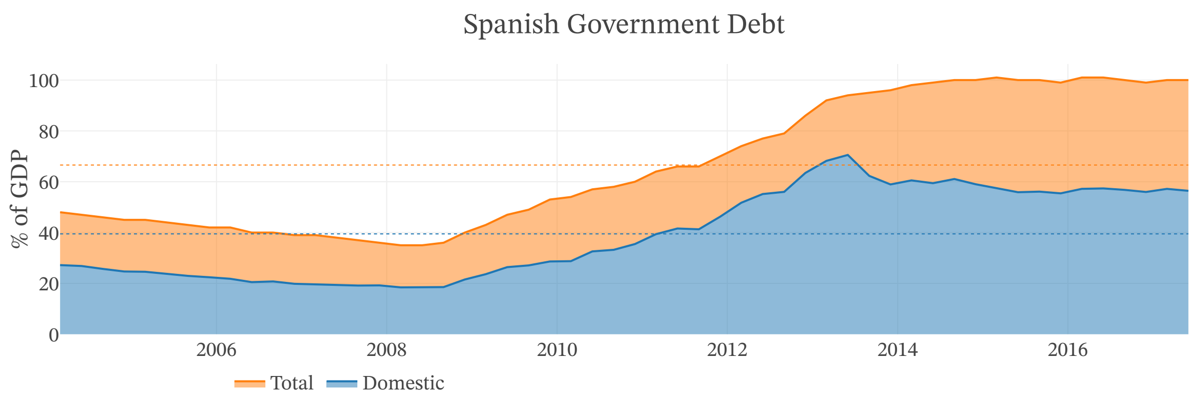


Figure 31: Composition of Spanish Debt

Dotted lines show average levels

C. Appendix: Data sources

Variable	Source	Coverage	Code
GDP	Eurostat	1996Q1:2017Q4	namq_10_gdp
HH Consumption	OECD	1996Q1:2017Q4	
Imports	Eurostat	1996Q1:2017Q4	namq_10_gdp
Exports	Eurostat	1996Q1:2017Q4	namq_10_gdp
Government Spending	Eurostat	1996Q1:2017Q4	namq_10_gdp
Government Debt	Eurostat	1996Q1:2017Q4	gov_10q_ggdebt
Interest Rate on Gov't Bonds	Eurostat	1996Q1:2017Q4	irt_lt_mcby_q
Unemployment	Eurostat	1996Q1:2017Q4	une_rt_q
Spanish HHs' wealth	Eurostat	1998Q4:2018Q2	nasq_10_f_bs
Spain's Debt Composition	Banco de España	2004Q1:2017Q4	

Table 7: Data Sources