Fiscal Stimulus under Sovereign Risk *

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Abstract

What is the optimal fiscal policy response to a recession when the government is subject to sovereign risk? We study this question in a model of endogenous sovereign default with nominal rigidities. Increasing spending in a recession reduces unemployment, but exposes the government to a debt crisis. We quantitatively analyze this trade-off between stimulus and austerity and find that expanding government spending may be undesirable, even in the presence of sizeable Keynesian stabilization gains and inequality concerns. Consistent with these findings, we show that sovereign risk is a key driver of the fiscal procyclicality observed worldwide.

Keywords: Fiscal stabilization policy, sovereign risk, austerity

JEL Codes: E62, F34, F41, F44, H50.

1 Introduction

There is a long-standing view that fiscal policy should play a stabilizing role in business cycles, especially when there are constraints on monetary policy. The textbook Keynesian argument is that by spending more in a recession, the government can prop up aggregate demand and help mitigate the rise in unemployment. Yet most countries around the world do not follow this prescription (see, e.g., Kaminsky, Reinhart and Végh, 2004). As shown in Figure 1, the 2011-2012 Eurozone crisis provides an emblematic example in this regard. In the face of a severe recession and mounting unemployment, governments in southern Europe significantly reduced spending. This contraction in spending occurred despite their inability to use monetary policy, which left fiscal policy as the only instrument available for macroeconomic stabilization.
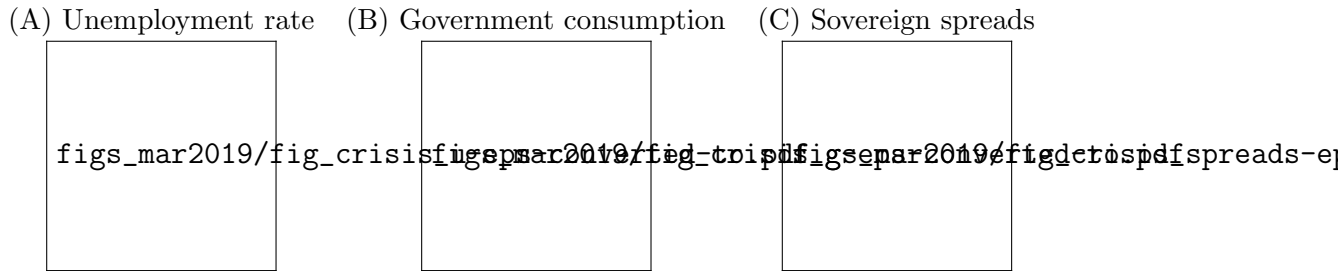
(A) Unemployment rate   (B) Government consumption   (C) Sovereign spreads

figs_mar2019/fig_crisis figs_mar2019/fig-crisis figs_mar2019/fig_crisis spreads-e

Figure 1: Unemployment, Fiscal Policy, and Sovereign Spreads during the Eurozone Crisis

Notes: Unemployment rate and sovereign spreads expressed in percentage-point deviations from their 2008.Q1 values. Government consumption is set to 2008.Q1=100. "Average" denotes the simple average of Greece, Ireland, Italy, Portugal, and Spain. Data source: Eurostat.

In this paper, we examine the optimal fiscal policy amid sovereign risk and macroeconomic stabilization concerns. We provide a framework that articulates the dilemma at the heart of the austerity-stimulus debate (e.g., Barro, 2012; Krugman, 2015; Alesina, Favero and Giavazzi, 2020): Should the government apply a stimulus to mitigate a recession at the expense of higher sovereign spreads, or should it practice austerity to reduce the probability of a debt crisis—even if doing so induces a more severe recession?

We consider a small open economy in which the government borrows externally, subject to default risk, and nominal rigidities give rise to the possibility of involuntary unemployment. We first construct a benchmark environment under which Keynesian policies would be optimal, without the risk of sovereign default. To this end, we incorporate two key elements that have been identified in theory as providing important scope for fiscal policy as a stabilization tool. First, we consider nominal rigidities, in the form of downward nominal wage rigidity, and a fixed exchange rate regime. As in the classic Mundell-Fleming argument, an increase in government spending entails only limited crowding-out effects and is effective for reducing involuntary unemployment. Second, we consider households that are hand-to-mouth and face an uninsurable idiosyncratic risk

of unemployment. These two elements generate large fiscal multipliers and substantial welfare gains from countercyclical fiscal policy. Higher spending during recessions leads to a reduction in the output gap and in inequality.

We first provide a theoretical characterization of the trade-off between stimulus and austerity in this environment. A modified Samuelson rule decomposes the effects of government spending into three objects. First, the traditional Samuelson term equates the marginal rate of substitution between private and public consumption to the marginal rate of transformation. Second, a stimulus term emerges because an increase in government spending relaxes nominal frictions and implies that higher public consumption does not fully crowd out private consumption. Finally, an austerity term captures the costs of raising revenues for the government. An analytical example shows that when there are no costs from raising tax revenues and the fiscal multiplier is one, the government achieves full employment and follows a countercyclical fiscal policy. To the extent that raising tax revenues is costly, this implies that the government may resort to borrowing to finance spending. However, the presence of endogenous sovereign default generates a motive for austerity, since higher borrowing raises sovereign spreads for the government. The dilemma the government faces in a recession is that debt-financed spending lowers unemployment, but it raises sovereign spreads. Moreover, by increasing the debt burden, this limits future fiscal space and reduces the ability to mitigate a recession in the future.

A calibrated version of this model for the Spanish economy shows that when the government can commit to repaying the debt, fiscal policy is essentially Keynesian: During recessions, the government increases spending that is financed by external borrowing and stabilizes involuntary unemployment. In this setting, optimal government spending has a strongly negative correlation with economic activity, and unemployment volatility is an order of magnitude smaller than that observed in the data. Incorporating default risk drastically changes the desirability of a Keynesian fiscal stimulus. Quantitatively, despite the large Keynesian benefits from fiscal stimulus, default risk can overturn the cyclicality of optimal fiscal policy. In the economy calibrated to match debt and spread levels in the data, we find that optimal policy is strongly procyclical, with a 0.7 correlation with output (vs. -0.8 for the economy without default risk). Moreover, the volatility in unemployment increases by an order of magnitude relative to the economy without default risk and is also close to the one observed in the data.

Although the optimal fiscal policy is overall procyclical, the model displays strong state dependence, whereby the response of government spending is non-monotonic with respect to the level of sovereign debt. When the stock of debt is relatively low, government spending expands in recessions because the Keynesian benefits outweigh concerns about sovereign risk. Similarly, when the stock of debt is very high, it is optimal for the government to default and redirect resources toward spending rather than repaying debt. It is for intermediate values of debt that the optimal response is characterized by austerity: The government reduces spending to mitigate

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the rise in borrowing costs and reduce the probability of a debt crisis. An important implication of this state dependence is that recessions turn out to be more severe when preceded by high levels of debt. The model's prediction of state dependency is consistent with the dynamics of fiscal policy in Spain in the run-up to the debt crisis. State dependency also helps rationalize the evidence provided by Romer and Romer (2019) whereby countries with more "fiscal space" suffer recessions that are less severe.

Finally, we provide empirical evidence that governments' consumption during downturns is consistent with the normative analysis from our model. Specifically, we study the dynamics of government consumption during recession episodes for countries with different sovereign risks in a panel of 70 countries for the period 1980-2016. We document that countries with high sovereign default risk, measured by credit ratings or historical default rates, exhibit more fiscal austerity during downturns than countries with low default risk. In addition, in countries with high sovereign risk, recessions associated with higher initial net foreign liability positions are characterized by more pronounced austerity. Furthermore, consistent with our model, countries with higher default risk exhibit more procyclical government consumption over the cycle than countries with low default risk.

Related Literature.   Our paper is related to several strands of the literature. First, it is related to the New Keynesian literature that studies the role of government spending as a macroeconomic stabilization tool, especially in the presence of constraints on monetary policy that arise from a fixed exchange rate or a zero lower bound. Some recent influential examples in both open and closed economies include Gali and Monacelli (2008); Eggertsson (2011); Christiano, Eichenbaum and Rebelo (2011); Werning (2011); Woodford (2011); Nakamura and Steinsson (2014); Farhi and Werning (2017); and Michaillat and Saez (2018).[1] We contribute to this literature by incorporating sovereign risk, which is a central ingredient in the debate regarding fiscal policy discussions. We characterize how sovereign risk shapes the optimal conduct of fiscal policy, and show that accounting for sovereign risk is crucial for understanding the observed procyclicality of fiscal policy and how fiscal space affects the severity of recessions.

Second, our model of sovereign risk follows the literature on sovereign default in the tradition of Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), and Arellano (2008). An important precursor of our paper is Cuadra, Sanchez and Sapriza (2010), which expands the canonical model to incorporate government spending and distortionary taxation. In their model, sovereign risk can induce the procyclicality of tax rates, but it does not affect the cyclicality of government consumption, which follows the same pattern as private consumption. Because private and public goods are normal goods and the production structure is neoclassical, Cuadra et al.'s model features

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[1]Related to this literature, a vast body of work empirically studies the effect of changes in government spending on the economy. See Ramey (2019) for a recent survey.

procyclical public and private consumption regardless of whether the government can commit to repay. By contrast, in our model, government spending is countercyclical without sovereign risk but procyclical with sovereign risk. Other contributions in a similar vein are Aguiar and Amador (2016); Arellano and Bai (2017); and Balke and Ravn (2016).[2] These studies abstract from the Keynesian channel, and hence they cannot address the main trade-off we examine in this paper.

An earlier paper that considers nominal rigidities in a sovereign default model is Na, Schmitt-Grohé, Uribe and Yue (2018). They study an optimal exchange rate policy and show that their model can account for the "twin Ds" phenonomenon (i.e., the joint occurrence of large devaluations and sovereign defaults). The focus of our paper, in contrast, is on the optimal fiscal policy in the context of a fixed exchange rate. Our contribution is to provide the first analysis of the trade-off between fiscal stimulus and sovereign risk and show how this trade-off shapes the conduct of fiscal policy over the business cycle. e spending cuts during recessions can backfire by raising incentives to default and worsening spreads.

Our paper is also related to a literature that studies how increases in sovereign spreads can translate into higher borrowing costs for the private sector and negatively affect economic activity, an idea linked to the seminal work of Giavazzi and Pagano (1990) on expansionary fiscal contractions. Important examples include Mendoza and Yue (2009); Broner, Erce, Martin and Ventura (2014); Uhlig (2010); Drautzburg and Uhlig (2015); Corsetti, Kuester, Meier and Muller (2013, 2014); Bocola (2016); and Gourinchas, Philippon and Vayanos (2017). We complement this literature by showing that sovereign risk considerations can cause austerity being optimal in an environment in which fiscal stimulus is expansionary.

Finally, our paper is related to the literature on fiscal procyclicality. Several studies have documented how fiscal policies are more procyclical in emerging economies than in developed economies (see, for example, Gavin and Perotti, 1997; Kaminsky et al., 2004; Talvi and Vegh, 2005; Ilzetzki and Végh, 2008). We complement this literature by studying differences in the procyclicalities linked to default risk.

2 Model

We present a small open economy in which the government borrows externally, subject to default risk, and nominal rigidities generate the possibility of involuntary unemployment. We use the framework as a laboratory to examine the optimality of fiscal stimulus under sovereign risk.

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[2]In Balke and Ravn (2016) there is unemployment due to search and matching frictions, but government spending affects employment through wealth effects on search efforts, and not through aggregate demand, as in our setup. An element we share with their work is that our model also features household heterogeneity and an insurance channel from fiscal policy.

2.1 Households

There is a unit mass of households indexed by j. Households' preferences over private and public consumption are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U(c_{jt}) + v(g_t^N) \right], \tag{1}$$

where c_{jt} denotes the private consumption of household j in period t; g_t^N denotes public spending in non-tradable goods; $\beta \in (0,1)$ is the subjective discount factor; and $\mathbb{E}_t$ denotes the expectation operator conditional on the information set available at time t.[3] We assume constant relative risk-aversion utility functions for private and public consumption with the same risk-aversion coefficient $U(c) = (1 - \psi_g)\frac{c^{1-\sigma}}{1-\sigma}$ and $v(g) = \psi_g \frac{g^{1-\sigma}}{1-\sigma}$, with $\sigma > 0$, $\psi_g \in (0,1)$. We assume also that the consumption good is a composite of tradable (c^T) and non-tradable (c^N) goods, with a constant elasticity of substitution (CES) aggregation technology $c = C(c^T, c^N) = [\omega(c^T)^{1-\frac{1}{\xi}} + (1-\omega)(c^N)^{1-\frac{1}{\xi}}]^{\frac{\xi}{\xi-1}}$, where $\omega \in (0,1)$ and $\xi > 0$ is the elasticity of substitution between tradable and non-tradable goods.

Households are endowed with one indivisible unit of labor. Because of the presence of downward wage rigidity and rationing (to be described below), each household's actual hours worked are given by $h_{jt} \in \{0,1\}$, which is taken as given by the individual household. Each period, households receive a tradable endowment y_t^T and profits from the ownership of firms producing non-tradable goods Π_t^N. We assume that y_t^T is stochastic and follows a stationary first-order Markov process. In addition, households face a tax $\mathcal{T}_t(h_{jt})$ (transfer if negative). This tax is contingent on their idiosyncratic employment status h_{jt}, which reflects the availability of unemployment insurance. As is standard in the sovereign debt literature, we assume in the baseline model that households do not have direct access to financial markets. In Section 4.4, we relax this assumption and allow a fraction of households to save/borrow in international capital markets.

Households' sequential budget constraint, expressed in domestic currency, is therefore given by

$$P_t^T c_{jt}^T + P_t^N c_{jt}^N = P_t^T y_t^T + \Pi_t^N + W_t h_{jt} - \mathcal{T}_t(h_{jt}) \equiv \mathcal{Y}_t(h_{jt}), \tag{2}$$

where P_t^T and P_t^N denote the price of tradables and non-tradables in units of domestic currency, W_t denotes the wage in domestic currency, and $\mathcal{Y}_t(h_{jt})$ denotes the total household's disposable income, which depends on aggregate variables and the idiosyncratic employment status h_{jt}.

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[3]We abstract from government spending in tradables because this represents a small share of total public spending and because only spending on non-tradables has a macroeconoomic stabilization role.

Households' optimality yields

$$\frac{P_t^N}{P_t^T} = \frac{1-\omega}{\omega} \left(\frac{c_{jt}^T}{c_{jt}^N} \right)^{\frac{1}{\xi}}. \tag{3}$$

Because of homothetic preferences, for all households the consumption of tradables relative to that of non-tradables depends only on the relative prices of these two goods.

2.2 Firms

Firms are competitive and have access to a production function for non-tradables $F(h) = h^\alpha$, with $0 \leq \alpha \leq 1$. Firms' profits each period are given by

$$\Pi_t^N = P_t^N F(h) - W_t h_t. \tag{4}$$

The optimal choice of employment h_t^d for a firm equates the value of the marginal product of labor and the wage rate:

$$P_t^N F'\left(h_t^d\right) = W_t. \tag{5}$$

2.3 Government

The government determines public spending, external borrowing, and default decisions, subject to a predetermined tax scheme. In terms of monetary policy, we assume that the government follows a fixed exchange rate policy $e_t = \bar{e}$. Alternatively, one can think of the economy as being part of a currency union.[4]

External borrowing. The government issues a long-term bond with a deterministic decay rate (Hatchondo and Martinez, 2009; Chatterjee and Eyigungor, 2012). In particular, a bond issued in period t promises to pay $\delta(1-\delta)^{j-1}$ units of the tradable good in period $t+j$, for all $j \geq 1$. Hence, debt dynamics are given by $b_{t+1} = (1-\delta)b_t + \iota_t$, where b_t is the stock of bonds due at the beginning of period t, and ι_t represent the flow of new issuances in period t.

Debt contracts cannot be enforced, and each period the government may decide to default. The government's default incurs two costs. The first cost is that the government is excluded

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[4]It would also be straightforward to extend our analysis to allow for an arbitrary exchange-rate policy, implemented, for example, with a Taylor rule for nominal interest rates. As long as the exchange-rate policy is not able to fully eliminate the slack in the labor market, we expect our results to be similar. Notice that we abstract here from considering fiscal policies that can mimic a nominal depreciation, in the spirit of the equivalence results of Correia, Nicolini and Teles (2008). Our calibration of the nominal rigidities will, in effect, target an increase in unemployment, and so implicitly we capture the fact that these policies are used to a limited extent.

from financial markets for a stochastic number of periods. Denote by ζ_t a variable that takes the value of 1 if the government can issue bonds in period t and 0 otherwise. Its evolution is given by $\zeta_t = (1 - \chi_t)\zeta_{t-1} + \vartheta_t(1 - \zeta_{t-1})$, where $\chi_t = 0(1)$ if the government repays (defaults) in period t, and $\vartheta_t \in \{0, 1\}$ is a random variable that takes the value of 1 in period t when the government reenters the financial market, which occurs with probability θ, and it starts over with zero debt holdings. The second cost is a utility loss for households $\psi_\chi(y^T)$, which we assume to be increasing in tradable income. This utility loss can be seen as capturing various default costs related to reputation, sanctions, or misallocation of resources.[5]

The government's budget constraint is given by

$$P_t^N g_t^N = \int_{j \in [0,1]} \mathcal{T}(h_{jt})\, \mathrm{d}j + (q_t e_t \iota_t - \delta e_t b_t)\zeta_t, \tag{6}$$

where e_t is the nominal exchange rate and q_t is the price of the bond in units of foreign currency. The budget constraint (6) indicates that tax revenues and new debt issuance have to finance public spending and the repayment of outstanding debt obligations.

Taxes. We assume that the government has a limited ability to raise tax revenues. The tax scheme has three components: taxes, transfers, and unemployment insurance. Tax revenues are assumed to be a fixed proportion $\tau \in (0,1)$ of households' total income. As shown in Vegh and Vuletin (2015), tax rates change, on average, about every 5 years for corporate and personal income taxes and every 8 years for value-added taxes. For simplicity, we assume they are fixed in our baseline model. However, in Section 4.4 we allow for tax rates to vary subject to a cost calibrated to match the volatility of observed changes and obtain results very similar to those in our baseline with fixed tax rates.[6]

The government provides lump-sum transfers $T_t \geq \underline{T}$ denominated in units of tradables. We rule out lump-sum taxes by setting $\underline{T} = 0$.

Finally, in the unemployment insurance scheme, the government taxes each employed household with τ_t^e units of domestic currency in period t and transfers τ_t^u units of domestic currency to each unemployed household. In the absence of labor disutility and moral hazard associated with unemployment insurance, an optimal insurance mechanism would equalize the disposable income for employed and unemployed households. In effect, this would lead to a representative-agent economy with complete markets for idiosyncratic risk. To preserve meaningful heterogeneity, we

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[5]An alternative assumption used in the literature is the cost of default in terms of output. Under the assumption that the utility function is log over the composite consumption and output losses from default are proportional to the composite consumption in default, the losses from default would be identical for the output cost and utility cost specifications. If the fraction of output losses in the tradable and non-tradable sectors is the same, the cost in terms of consumption is indeed proportional.

[6]Note that a fixed tax rate delivers procyclical tax revenues, in line with the data (Gavin and Perotti, 1997).

assume an imperfect insurance scheme. For simplicity, we assume that this scheme is such that the disposable income of employed households and that of unemployed households are proportional to each other:

$$\mathcal{Y}_t(0) = \kappa \mathcal{Y}_t(1) \quad \text{for all } t, \tag{7}$$

with $\kappa \in [0, 1]$. A value of $\kappa = 1$ represents the case with complete insurance. We require that unemployment insurance be self-financed, which implies that

$$\tau_t^u(1 - h_t) = \tau_t^e h_t \quad \text{for all } t, \tag{8}$$

where $h_t \equiv \int_{j \in [0,1]} h_{jt} \, \mathrm{d}j$ denotes aggregate hours worked. Equations (7) and (8) define the path of state-contingent taxes $\{\tau_t^e, \tau_t^u\}_{t=0}^{\infty}$ for any period t under the insurance scheme.

The assumed tax scheme implies that the government budget constraint can be expressed as

$$P_t^N g_t^N + T_t P_t^T = \tau(P_t^T y_t^T + \Pi_t^N + W_t h_t) + (q_t e_t i_t - \delta e_t b_t)\zeta_t. \tag{9}$$

2.4 Foreign Lenders

Sovereign bonds are traded with atomistic, risk-neutral foreign lenders. In addition to investing through the defaultable bonds, lenders have access to a one-period, riskless security that pays a net interest rate r (both in foreign currency). By a no-arbitrage condition, equilibrium bond prices are given by

$$q_t = \frac{1}{1+r} \mathbb{E}_t[(1 - \chi_{t+1})(\delta + (1 - \delta)q_{t+1})]. \tag{10}$$

This equation will play a critical role when we turn to the optimal fiscal policy. If the government seeks to apply a debt-financed stimulus, lenders will anticipate that a future default is more likely and therefore demand lower bond prices to compensate for a higher default risk.

2.5 Wage Rigidity and Competitive Equilibrium

Let $c_t^N \equiv \int_{j \in [0,1]} c_{jt}^N \, \mathrm{d}j$ and $c_t^T \equiv \int_{j \in [0,1]} c_{jt}^T \, \mathrm{d}j$ denote aggregate consumption for tradables and non-tradables. In equilibrium, the market for non-tradable goods clears:

$$c_t^N + g_t^N = F(h_t^d). \tag{11}$$

We assume that the law of one price for tradable goods holds; that is, $P_t^T = P_t^{T,*} e_t$, where $P_t^{T,*}$ denotes the price of the tradable good in foreign currency, which is assumed to be constant and normalized to one.

We assume there exists a minimum wage in nominal terms, $\overline{W}$, such that

$$W_t \geq \overline{W}. \tag{12}$$

The existence of a minimum wage gives rise to a non-Walrasian labor market. We follow the notion of equilibrium in models with rationing (e.g., Barro and Grossman, 1971; Drèze, 1975; Benassy, 1975; Schmitt-Grohé and Uribe, 2016) and assume that aggregate hours worked are the minimum between labor demand and labor supply:

$$h_t = \min(1, h_t^d). \tag{13}$$

If $h_t < 1$, it has to be that $W_t = \overline{W}$. If $W_t > \overline{W}$, the aggregate number of hours worked equals the aggregate endowment of labor.[7] These conditions can be summarized as

$$\left(W_t - \overline{W}\right)\left(1 - h_t\right) = 0. \tag{14}$$

When the economy features unemployment, we assume that there is a random allocation of hours across households every period. This means that every household has a probability h_t of being employed every period.

A competitive equilibrium, for a given set of government policies, is then defined as follows.

Definition 1 (Competitive Equilibrium). Given initial debt b_0 and ζ_0 and sequences of exogenous processes $\{y_t^T, \vartheta_t\}_{t=0}^{\infty}$; government policies $\{g_t^N, b_{t+1}, \chi_t, T_t, e_t\}_{t=0}^{\infty}$; and credit market access $\{\zeta_t\}_{t=0}^{\infty}$, a *competitive equilibrium* is a sequence of allocations $\{(c_{jt}^T, c_{jt}^N, h_{jt})_{j \in [0,1]}, h_t^d\}_{t=0}^{\infty}$ and prices $\{P_t^N, P_t^T, W_t, q_t\}_{t=0}^{\infty}$ such that (i) consumption $\{(c_{jt}^T, c_{jt}^N)_{j \in [0,1]}\}_{t=0}^{\infty}$ solves the household's problem; (ii) employment $\{h_t^d\}_{t=0}^{\infty}$ solves the firm's problem; (iii) government policies satisfy the budget constraints and ζ_t follows its law of motion; (iv) the bond-pricing equation (10) holds; (v) the market for non-tradable goods clears (11); and (vi) the labor market allocations and wages satisfy conditions (12)-(14).

Notice that using the households' budget constraint (2), the definition of the firms' profits, the government budget constraints, and market-clearing condition (11), we arrive at the resource constraint for tradables:

$$c_t^T = y_t^T + \zeta_t[q_t \iota_t - \delta b_t]. \tag{15}$$

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[7]Our modeling of wage rigidity is similar to that in Schmitt-Grohé and Uribe (2016). In their case, $\overline{W}$ depends on the previous period wage. To simplify numerical computations, we take $\overline{W}$ as an exogenous (constant) value.

2.6   Optimal Fiscal Policy

We now study Markov equilibria in which the government chooses policies sequentially and without commitment. We consider a benevolent and utilitarian government that chooses fiscal policies to maximize households' welfare, subject to implementability conditions. As stated above, we focus on a fixed exchange-rate regime, which leaves fiscal policy as the central instrument for macroeconomic stabilization.[8]

Welfare criterion.   The objective of the government is to maximize the average expected lifetime utility of households:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [\mathcal{U}_t(\mathbf{c}_{jt}^T, \mathbf{c}_{jt}^N) + v(g_t^N) - (1 - \zeta_t)\psi_\chi(y_t^T)],$$

where $\mathbf{c}_{jt}^T = \{c_{jt}^N\}_{j\in[0,1]}$; $\mathbf{c}_{jt}^N = \{c_{jt}^N\}_{j\in[0,1]}$; $\mathcal{U}_t(\mathbf{c}_{jt}^T, \mathbf{c}_{jt}^N) \equiv \int_{j\in[0,1]} u(c_j^T, c_j^T)\, \mathrm{d}j$; and $u(c^T, c^N) = U(C(c^T, c^N))$. The following result establishes that the social period utility from private consumption admits an aggregation result, in the sense that $\mathcal{U}_t(\cdot)$ can be expressed as a function of only aggregate variables.

Lemma 1. *The social period utility from private consumption can be expressed as*

$$\mathcal{U}_t(\mathbf{c}_{jt}^T, \mathbf{c}_{jt}^N) = \underbrace{u(c_t^T, c_t^N)}_{\substack{\text{Utility of} \\ \text{aggregate} \\ \text{consumption}}} \times \underbrace{\Omega(h_t)}_{\substack{\text{Inequality} \\ \text{concerns}}},$$

where $\Omega(h) \equiv \frac{h+(1-h)\kappa^{1-\sigma}}{(h+(1-h)\kappa)^{1-\sigma}}$.

Lemma 1 indicates that the expression for welfare that would prevail in a representative-agent economy is modified to allow for inequality concerns, which can be summarized entirely in the term $\Omega(h)$. This result is useful, because it implies that welfare can be evaluated based on a minimum but critical departure from a representative-agent economy. For a given aggregate consumption bundle $\{c_t^T, c_t^N\}$, a positive unemployment rate introduces a dispersion in consumption between agents as long as there is no perfect unemployment insurance. The concavity in the utility function implies that this dispersion introduces an additional welfare loss from unemployment.

Government problem.   We cast the government problem in recursive form. In every period in which the government has access to financial markets, it chooses whether to repay or default.

Given initial states (y^T, b), we have that

$$V(y^T, b) = \max_{\chi \in \{0,1\}} \{(1 - \chi)V^R(y^T, b) + \chi V^D(y^T)\}, \tag{16}$$

where $V^R(y^T, b)$ and $V^D(y^T)$ denote, respectively, the value of repayment and the value of default. As we show in Lemma B.1, the value of repayment can be expressed as

$$V^R(y^T, b) = \max_{g^N, c^T, b', h \leq 1} u(c^T, F(h) - g^N)\Omega(h) + v(g^N) + \beta \mathbb{E}V(y^{T'}, b') \tag{17}$$

$$\text{subject to}$$

$$c^T + \delta b \leq y^T + q(y^T, b')[b' - (1 - \delta)b]$$

$$\mathcal{P}^N(c^T, h, g^N)g^N \leq q(y^T, b')[b' - (1 - \delta)b] + [y^T + \mathcal{P}^N(c^T, h, g^N)F(h)]\tau$$

$$\mathcal{P}^N(c^T, h, g^N)F'(h) \geq \bar{w}.$$

The last restriction in (17) captures the implementability constraints associated with the labor market equilibrium. In this formulation, we have used the fact that the relative price of non-tradable goods can be expressed as $\mathcal{P}^N(c_t^T, h_t, g_t^N) \equiv \frac{1-\omega}{\omega}\left(\frac{c_t^T}{F(h_t) - g_t^N}\right)^{\frac{1}{\xi}}$, as obtained by combining households' optimality condition (3) and market-clearing condition (11). In addition, $\bar{w} \equiv \overline{W}/\bar{e}$ denotes the wage rigidity parameter in terms of tradable goods and $q(y^T, b')$ denotes the bond price schedule, taken as given by the government.

The value of default, in turn, is given by

$$V^D(y^T) = \max_{g^N, h \leq 1} u(y^T, F(h) - g^N)\Omega(h) + v(g^N) - \psi_\chi(y^T) + \beta \mathbb{E}\left[(1 - \theta)V^D(y^{T'}) + \theta V(y^{T'}, 0)\right], \tag{18}$$

$$\text{subject to}$$

$$\mathcal{P}^N(y^T, h, g^N)g^N \leq [y^T + \mathcal{P}^N(y^T, h, g^N)F(h)]\tau$$

$$\mathcal{P}^N(y^T, h, g^N)F'(h) \geq \bar{w}.$$

We can now define Markov perfect equilibrium.

Definition 2 (Markov perfect equilibrium). A Markov perfect equilibrium is defined by policy functions $\{\hat{c}^T(y^T, b), \hat{g}^N(y^T, b), \hat{T}(y^T, b), \hat{b}(y^T, b), \hat{h}(y^T, b), \chi(y^T, b)\}$; value functions $\{V(y^T, b)$ $V^R(y^T, b), V^D(y^T)\}$; and a bond price schedule $q(y^T, b)$ such that (i) given the bond price schedule, policy functions solve problems (16), (17), and (18) and (ii) the bond price schedule satisfies (10).

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3 Fiscal Policy Trade-Offs

In this section, we articulate the trade-off between stimulus and austerity the government faces. We show how an increase in spending can help reduce unemployment and expand output in a recession, in line with the Keynesian channel, and how these benefits must be balanced with sovereign default risk concerns.

3.1 Fiscal Transmission

Before analyzing the optimality conditions of the government, it is useful to consider the transmission from fiscal policy to employment. Combining households and firms' optimality conditions and market clearing, (3),(5), and (11), we can obtain the following condition:

$$\frac{1-\omega}{\omega}\left(\frac{c_t^T}{F(h_t)-g_t^N}\right)^{\frac{1}{\xi}}F'(h_t)=w_t. \tag{19}$$

The left-hand side is decreasing in h and increasing in g^N. If wages were flexible, we would have that for any c_t^T, g_t^N, wages would fall until $h=1$. However, when the wage necessary to clear the market is below $\overline{W}$, the economy will suffer from unemployment. In this situation, an increase in government spending will raise equilibrium employment. Because public and private consumption goods are imperfect substitutes, the increase in spending generates an excess demand for non-tradable goods, which raises the relative price of non-tradables. In turn, the increase in the relative price of non-tradables leads to a higher value of the marginal product of labor and to higher employment. Essentially, through an aggregate demand amplification, the increase in government spending generates an increase in non-tradable output, and hence private consumption does not fall one to one with government spending.

To see this more clearly, assume that the production function is linear and wage rigidity is binding. Then (19) can be expressed as

$$h_t=g_t^N+\left[\frac{1-\omega}{\omega}\frac{1}{\bar{w}}\right]^{\frac{1}{\xi}}c_t^T. \tag{20}$$

Equation (20) reveals that for a given c_t^T, the fiscal multiplier is one under linear production whenever the economy is away from full employment. We emphasize that the linearity of the production function is critical for this result. When the production function features decreasing returns, firms require a higher price to increase production. Through an expenditure-switching effect, this leads to a reduction in the private consumption of non-tradables. Thus, the fiscal

multiplier is below one, and there is crowding out of private consumption.[9]

Equation (20) also shows that employment is increasing in c^T. The higher the amount of tradable resources available, the higher the aggregate demand for non-tradables, and thus this results in higher employment. In a model in which households cannot borrow externally, c_t^T is determined entirely by the tradable endowment and the government's borrowing decisions. By equation (15), a higher level of government borrowing therefore increases tradable resources and employment. Moreover, this implies that an increase in spending financed by debt will deliver larger increases in output than one financed with lump-sum taxes.[10] By the same token, (20) underscores how a policy of transfers to households financed with government debt delivers lower output gains compared with those generated by a policy of spending directly on non-tradables (also financed with debt).

When households do have access to external financial markets, as we consider in Section 4.4, they can potentially offset government borrowing choices. Of course, in a model that features Ricardian equivalence, how the government finances spending is irrelevant. However, Ricardian equivalence fails in our model because of financing frictions for the government and, in particular, the limits on lump-sum taxes. Therefore, while household savings may increase in response to larger borrowing by the government, they do not completely offset the increase in tradable resources from higher government borrowing. Hence, we still obtain in that extension that debt-financed stimulus is more powerful than a tax-financed stimulus.

3.2   Normative Analysis: An Analytical Decomposition

We now analyze the optimality conditions of the government and chacterize the key trade-off it faces.

3.2.1   Modified Samuelson Rule

Let us examine the first-order condition with respect to g^N in the government problem (17). Using μ and η to denote, respectively, the Lagrange multipliers associated with the wage rigidity constraint and the government budget constraint, we arrive at the following modified Samuelson

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[9]It should also be clear that if the government could directly manipulate the relative price of non-tradables by varying the exchange rate or using specific tax instruments, the stimulus term would not arise because the government would undo the effects of the nominal rigidity.

[10]The way in which c^T goes up with debt-financed government spending operates through a general equilibrium effect. When the government raises g^N, there is larger demand for non-tradables, which in equilibrium raises profits and labor income.

rule (MSR):

$$\underbrace{v'(g^N) - u_N(c^T, c^N)\Omega(h)}_{\text{Samuelson}} + \underbrace{\mu F'(h)\frac{\partial \mathcal{P}^N}{\partial g^N}}_{\text{Stimulus}} - \underbrace{\eta\left(p^N + \frac{\partial \mathcal{P}^N}{\partial g^N}(g^N - F(h)\tau)\right)}_{\text{Austerity}} = 0, \qquad \text{(MSR)}$$

where $u_N(c^T, c^N) \equiv \partial u(c_t^T, c_t^N)/\partial c^N$ and all variables correspond to time t. This condition equates the marginal benefits from spending with the marginal costs. We will next examine the three terms in this condition, which we label "Samuelson," "Stimulus," and "Austerity," and how the key elements of the model shape these terms.

3.2.2   Frictionless case (Samuelson)

Let us first focus on a frictionless version of the model (i.e., one in which there are no financing frictions for the government and no nominal rigidities). In this case, the net marginal benefits are given by the first term in (MSR): The government would equate the marginal benefits of higher government spending, $v'(g_t^N)$, to the marginal costs of less private consumption, $u_N(c_t^T, c_t^N)$—or, put differently, the government equates the marginal rate of substitution between private and public consumption to the marginal rate of transformation, which is equal to one in the model. This is the classic Samuelson rule for the efficient provision of public goods (Samuelson, 1954). Assuming that the utility from tradables and that from non-tradables are separable, and given the assumption of homothetic preferences, this would imply that government spending would be a constant fraction of non-tradable output. The logic behind this principle is that movements in output get translated into absolute movements in government spending, while keeping constant the share of public consumption.

3.2.3   Stimulus benefits

In the presence of nominal rigidities, a second term in (MSR) emerges because private consumption is not completely crowded out by public consumption when there is slack in the labor market. As explained above, an increase in g^N raises $\mathcal{P}^N$ and increases employment. At the margin, one unit of increase in g^N relaxes the wage rigidity constraint by $F'(h)\partial\mathcal{P}^N/\partial g^N$, which in turn has a shadow value of μ_t.

To shed light on the marginal utility benefits from the stimulus term, we can turn to the first-order condition with respect to h_t. Assuming $h < \bar{h}$, we have that the marginal benefit from

raising employment at the optimum must be such that

$$-\mu\left(\frac{\partial \mathcal{P}^N}{\partial h}F'(h) + p^N F''(h)\right) = \underbrace{u_N(c^T, c^N)\Omega(h)F'(h)}_{\text{higher } c^N} + \underbrace{U(c^T, c^N)\Omega'(h)}_{\text{inequality}}$$

$$+ \eta\underbrace{\left[\left(\frac{\partial \mathcal{P}^N}{\partial h}F(h) + p^N F'(h)\right)\tau - \frac{\partial \mathcal{P}^N}{\partial h}g^N\right]}_{\text{effect on budget constraint}}. \quad (21)$$

The right-hand side of equation (21) captures the marginal benefit from relaxing the wage rigidity constraint. The first term is given by the shadow value of the higher amount of output available for consumption. The second term represents the reduction in inequality. The third term arises whenever the government budget constraint binds, $\eta_t > 0$: A change in employment alters the tax revenues, which are proportional to output, and also the price at which the government makes purchases.

A simple example. To more clearly illustrate the stimulus benefit, consider a simple case in which the government has access to lump-sum taxes $\underline{T} = \infty$ and the production function is linear. The following proposition provides a sharp result on the desirability of government stimulus; namely, full employment is optimal at all times if there is either a utility from public spending or there are inequality concerns.

Proposition 1 (Benefits of Fiscal Stimulus)**.** *Assume that $\alpha = 1$ and $\underline{T} = -\infty$. Then, if either $v' > 0$ or $\kappa < 1$, we have that $h_t = 1$ $\forall t$ is strictly optimal.*

To understand this result, consider a version of the model with (i) a representative agent, $\kappa = 1$; (ii) no value from public spending, $v(g) = 0$; and (iii) strictly decreasing returns to scale $\alpha < 1$. In this situation, an increase in government spending crowds out private consumption and provides no benefits (i.e., it is optimal to set $g^N = 0$).

Consider now the case with $\alpha = 1$ so that we have a unit fiscal multiplier, and assume that $\kappa < 1$. In this version of the model, there are no crowding-out effects from government spending as long as $h < 1$ (due to linearity), and a higher level of employment helps to reduce inequality. In this situation, an economy with unemployment is suboptimal because raising spending (financed with taxes) provides, in effect, full insurance against idiosyncratic risk without reducing the aggregate level of private consumption.

Consider, finally, an economy with a representative agent, $\kappa = 1$, linear production, and $v'(g) > 0$. In this case, it is again optimal to ensure full employment. This is because raising spending provides utility to households without reducing their private consumption. Notice that whereas stimulus is able to implement full employment, there is still a loss relative to the flexible

wage economy because the level of spending exceeds the one prescribed by the Samuelson rule.[11]

A natural question that follows is how the government should adjust spending through the business cycle to ensure that the economy is at full employment. The next corollary shows that if tradable consumption comoves positively with the endowment of tradables (as would typically be the case in incomplete market models), the government follows a countercyclical fiscal policy as long as the wage rigidity is binding.

Corollary 1 (Countercyclical Fiscal Policy). *Consider the same the assumptions as in Proposition 1. Given states $\{b, y^T\}$ and $\{\tilde{b}, \tilde{y}^T\}$ such that $c^T(b, y^T) > c^T(\tilde{b}, \tilde{y}^T)$ and a binding wage rigidity, we have that $g^N(\tilde{b}, \tilde{y}^T) > g^N(b, y^T)$.*

The intuition is that a low tradable endowment generates a contraction in aggregate demand and requires a higher amount of spending to reduce the slack in the labor market.

3.2.4 Financing Costs

When the government faces financing frictions, there are additional costs from spending that go beyond the potential crowding-out effects of private consumption. The austerity term in equation (MSR) captures the marginal utility cost of how an increase in spending tightens the government budget constraint. If the government spends one additional unit, it directly tightens the budget constraint by p^N, which is the cost for the government to provide the extra unit of public goods. In addition, two general equilibrium effects arise from the increase in p^N that results from the increase in spending. First, the increase in the price raises the inframarginal units of spending, and this tightens the budget constraint by $(\partial \mathcal{P}_t^N / \partial g_t^N) g_t^N$. At the same time, an offsetting general equilibrium effect occurs because the increase in g^N also raises tax revenues (because revenues represent a fraction of total income). The overall marginal utility cost of tightening the government budget constraint is given by the product of the sum of these three terms and η, the Lagrange multiplier on the government budget constraint. Notice in particular that if the government had access to lump sum taxes, the Lagrange multiplier on the government budget η would be zero, and the austerity term would vanish.[12]

We argue next that the austerity term depends critically on the degree of default risk. The Euler equation for government borrowing is as follows:

$$(\lambda_t + \eta_t)\left(q_t + \frac{\partial q_t}{\partial b_{t+1}}i\right) = \beta \mathbb{E}_t[(\lambda_{t+1} + \eta_{t+1})(1 - \chi_{t+1})(\delta + q_{t+1}(1 - \delta))], \tag{22}$$

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[11]In terms of the complementary slackness condition (14), the government is at a point with $h = 1$ and $w_t = \bar{w}$.

[12]That η would be zero is apparent from the fact that τ appears only in the second constraint in (17).

where λ_t denotes the Lagrange multiplier on the resource constraint on tradables in period t.[13] This condition says that the marginal benefit from borrowing today is equal to the marginal cost of repaying the debt tomorrow. Borrowing one additional unit today helps relax today's government budget constraint as well as today's resource constraint for tradables, with a total marginal utility benefit of $\lambda_t + \eta_t$. By the same token, repaying the debt tomorrow has the opposite effects, as captured by the term $\lambda_{t+1} + \eta_{t+1}$ on the right-hand side.

How the government trades off these two effects is shaped critically by how the bond price changes in response to higher debt $\partial q_t / \partial b_{t+1}$. When an increase in borrowing raises default risk significantly, this implies lower revenues from bond issuances, and in effect this leads to higher cost from stimulus since more borrowing is needed to finance the same level of stimulus.[14]

3.3 Stimulus versus Austerity: A Counterfactual Experiment

To shed light on how the government chooses the actual optimal level of spending, we conduct a perturbation exercise in which we allow the government to choose a level of spending that differs from the optimal one. The idea is to trace how output and sovereign spreads would differ if the government were to choose a different level of spending.

Let us describe the experiment in more detail. We study how a change in spending today, taking as given all future policies and value functions as defined in the Markov equilibrium, affects current allocations and prices. To balance the changes in spending, we assume the government adjusts the debt level and transfers to satisfy the budget constraint. Formally, in terms of the government's problem (17), rather than maximizing with respect to the entire set of allocations, we fix an arbitrary level of government spending and solve optimally for the remaining allocations conditional on that level of spending. Our model simulations will be based on the optimal level of spending chosen by the government, but to understand the optimal choice it is instructive to consider alternative values of spending.

The results of this experiment are shown in Figure 2, using the parameter values of the calibrated economy we will describe in Section 4. As initial values for the states, we assume that tradable endowment income is one standard deviation below its unconditional mean and current debt is 10% above its average (results are qualitatively similar for other states). In each panel, the solid dot indicates the level of the variable of interest at the optimal level of government

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[13]The multiplier λ_t is in turn equal to $\lambda_t = u_T + \xi_t \partial \mathcal{P}_t^N / \partial c_t^T$. The second term arises because the government internalizes the fact that higher borrowing raises tradable resources and helps mitigate the wage rigidity through the general equilibrium effect. When we analyze household borrowing in Section 4.4, the increase in government borrowing can be partly offset by household borrowing. Formally, as we show below, this translates into an additional term in (22), which is the Lagrange multiplier on households' Euler equation—the additional implementability constraint in the government's problem.

[14]Notice that while a lower bond price reflects that the government will pay in fewer states of nature tomorrow, it still faces higher default costs, which represent a deadweight loss for the economy.

spending, which, as panel (a) shows, achieves the maximum welfare. The blue lines trace the values of all variables if the government were to choose the alternative value of spending.

(a) Welfare   (b) Unemployment   (c) c^N

(d) p^N (e) Spreads   (f) Borrowing
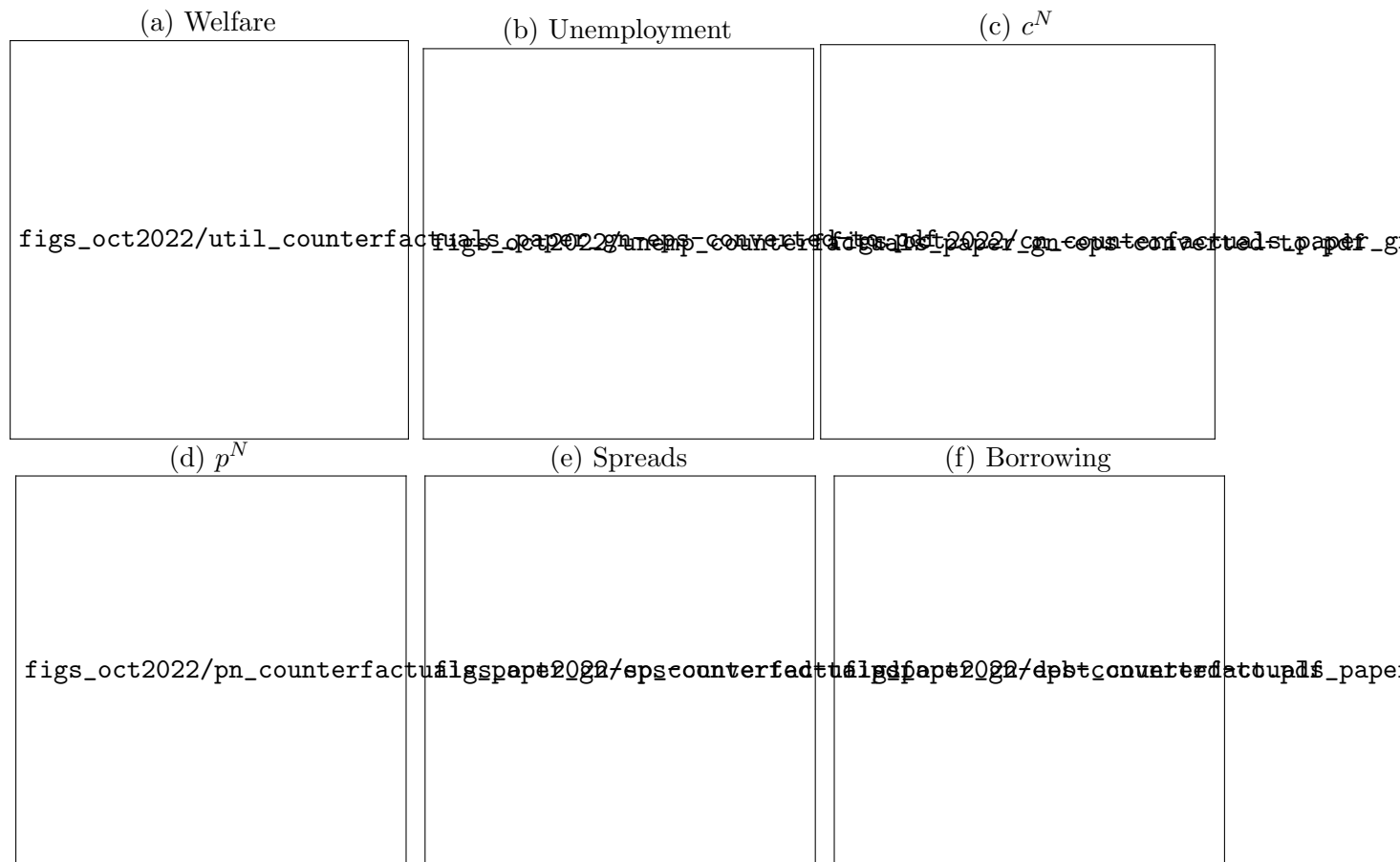
Figure 2: Welfare, Prices, and Allocations with Alternative Spending.

Notes: Blue lines indicate the values of different model variables as a function of an arbitrary level of government spending, given that current tradable income is set to one standard deviation below its unconditional mean and current debt is 10% above its average level. From next period on, allocations and value functions are given by the Markov equilibrium. Solid dots indicate the equilibrium levels associated with optimal government spending.

As Figure 2 shows, an increase in government spending stimulates economic activity. The increase in spending raises the price of non-tradables (panel d) and lowers unemployment (panel b). As explained above, the increase in demand for non-tradable goods leads firms to produce more in equilibrium. This is part of the standard channel from fiscal policy in open economies and is consistent with a large empirical literature (see, e.g., Monacelli and Perotti, 2010a; Ilzetzki, Mendoza and Végh, 2013).[15] We can also see that since non-tradable consumption increases together with government consumption (panel c), the fiscal multiplier is larger than one. As

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[15]For advanced economies, the results are somewhat more mixed. For example, Miyamoto, Nguyen and Sheremirov (2019) find that whereas in emerging economies, the real exchange rate appreciates in response to government spending, it depreciates in advanced economies (see also Monacelli and Perotti, 2010b).

discussed in Section 3.1, the fiscal multiplier is bigger than one because spending is debt financed and raises c^T.

Panel (e) of Figure 2 also shows that the increase in government spending leads to an increase in spreads. Such an increase reflects the higher risk of future default associated with higher debt levels. This increase in spreads raises the debt burden, limits fiscal space in the future and is a key factor that deters the government from providing a sufficient stimulus to attain full employment. In the next section, we will study quantitatively the austerity-stimulus trade-off faced by the government and show how this shapes the conduct of fiscal policy over the business cycle.

4   Quantitative Analysis

4.1   Calibration

We calibrate the model to match key moments of the Spanish economy and use a year as the model period. We calibrate the model to Spain because, as stated in the introduction, the recent Eurozone crisis provides a prototypical example of the main mechanisms featured in our model: a sharp increase in unemployment and sovereign default risk and a currency peg that leaves fiscal policy as the only instrument for macroeconomic stabilization. The model is solved numerically using value function iteration. For details on the solution method, see Appendix D.

We assume the following functional form for the default cost: $\psi_\chi(y_t^T) = \max\{0, \psi_\chi^0 + \psi_\chi^y \log(y_t^T)\}$, with $\psi_\chi^y > 0$, which has been used in related literature to match the bond spread dynamics observed in the data (see Bianchi, Hatchondo and Martinez, 2018; Chatterjee and Eyigungor, 2012, for related functional forms on default costs).

All selected parameter values used in the baseline calibration are shown in Table 1. We choose a subset of parameters according to predetermined values and choose the rest of the parameters to match key moments in the data. Data used for moments targeted in the calibration are detailed in Appendix F.3.

In the group of predetermined parameters, we set the coefficient of relative risk aversion to $\sigma = 2$ and the elasticity of substitution between tradable and non-tradable goods to $\xi = 0.5$, which is in the range of values considered in the literature;[16] the share of tradables in the consumption aggregator to $\omega = 0.3$, which implies a ratio of tradable output to total output of around 20%, in line with the data for Spain in the period of analysis; and the labor share from the nontradable sector to $\alpha = 0.75$, following the estimate of Uribe (1997). For unemployment insurance, we set the ratio of the consumption of unemployed households to that of employed households to

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[16]This parameterization implies that the inter- and intratemporal elasticity of substitution are the same, and hence the marginal utility of tradables and that of non-tradables are separable. Another useful implication is that the amount of public spending, according to the Samuelson rule, does not depend on b or y^T.

$\kappa = 0.7$, which is in line with the average expenditure on nondurable goods and services during unemployment estimated by Chodorow-Reich and Karabarbounis (2016) for the United States. In Spain, the monthly benefit amount is 70% of the monthly base over the first 6 months and 50% thereafter, until the unemployment spell reaches 2 years, acoording to indicated by the Servicio Público de Empleo Estatal regulations.

The tradable endowment y_t^T follows a log-normal AR(1) process, $\log y_{t+1}^T = \rho \log y_t^T + \sigma_y \varepsilon_{t+1}$, with $|\rho| < 1$ with $\varepsilon_{t+1}^y \sim i.i.d.\, \mathcal{N}(0,1)$. We estimate the parameters ρ and σ_ϵ for the stochastic process of y_t^T using Spanish national accounts data for the agriculture and manufacturing sectors, log-quadratically detrended. This estimation yields $\rho = 0.78$ and $\sigma_y = 0.029$.

For the parameters related to the debt market, we set the international risk-free rate r equal to 2%, which is roughly the average annual gross yield on German 5-year government bonds; the maturity parameter δ equal to 0.184 to generate an average Macaulay bond duration of 5 years, in line with OECD data for Spain over the period 2000-2010; and the reentry probability θ equal to 0.18 to generate an average autarky spell of 6 years, which is close to the average resumption of financial access reported by Gelos, Sahay and Sandleris (2011) over the period 1980-2000 for 150 developing countries.

Table 1: Calibration

Parameter	Value	Description	Target statistic/Source
Predetermined parameters			
σ	2	Coefficient of risk aversion	Standard business cycle literature
ξ	0.5	Intratemporal elasticity of subst.	Standard business cycle literature
ω	0.3	Share of tradables	Share of tradable GDP (20%)
α	0.75	Labor share in nontradable sector	Uribe and Schmitt-Grohé (2017)
r	0.02	Risk-free rate	Average German 5-year bond return
δ	0.184	Coupon decaying rate	Average bond duration (5 years)
θ	0.18	Reentry probability	Average autarky spell (5.5 years)
κ	0.7	Relative consumption unemployed	Chodorow-Reich & Karabarbounis (2016)
ρ	0.777	AR(1) coefficient of y_t^T	Spanish tradable GDP process
σ_y	0.029	Standard deviation of ε_t	Spanish tradable GDP process
Calibrated parameters			
β	0.91	Discount factor	External debt/GDP (22.8%)
ψ_χ^0	0.33	Utility loss from default (intercept)	Average bond spread (1.05%)
ψ_χ^y	2.42	Utility loss from default (slope)	Volatility of bond spreads (1.4%)
ψ_g	0.02	Weight of g in utility	Relative stdev. of govt. spending to GDP (2)
τ	0.19	Income tax rate	Average govt. spending/GDP (18.1%)
$\bar{w}$	3.1	Minimum wage	Unemployment increase in crisis (10%)

The six remaining parameters are calibrated to match six moments from the data.[17] Targeted moments are detailed in Table 1. The first three moments speak to the amount of default risk in the economy: The average Spanish public external debt-to-GDP ratio of 22.8% and the average and volatility of Spanish bond spreads of 1.05% and 1.4%, respectively.[18] Although all parameters affect all moments in our calibration, these three moments are governed mostly by the discount factor β and the parameters on the default cost function ψ_χ^0 and ψ_χ^y.[19]

The second group of moments is linked to government spending and taxes. We target the ratio of the volatility of government spending to the volatility of output of 2 and the mean Spanish government spending over GDP of 18%. These moments are mainly influenced by the weight of the government good in the utility function, ψ_g, and the income tax rate, τ. Finally, we calibrate $\bar{w}$ to be consistent with the surge in unemployment during the episode of high sovereign spreads. In the data, unemployment in Spain went from 11.3% in 2008 to 21.4% in 2011. Accordingly, we set $\bar{w}$ so that the average increase in unemployment in the 2 years before a default is 10%. This yields $\bar{w} = 3.1$. Appendix Table F.1 shows that our calibrated model approximates the targeted moments fairly well.[20]

4.2   Fiscal Policies over the Business Cycle

In this section, we study how default risk shapes optimal fiscal policy over the business cycle. To do so, we first consider an economy in which we shut down default risk, then show how incorporating default risk changes the nature of the optimal fiscal policy response. We calibrate the two economies to match the same data targets, with the exception of spreads, and which are, of course, zero for the risk-free economy.[21]

Table 2 reports key business cycle moments from the risk-free economy, the baseline model and compares them with their data counterparts.[22] A first takeaway is that in the absence of default

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[17]Computation of simulation statistics is conducted in the standard way (see Appendix D.2).

[18]We note that our calibration target excludes domestically held debt. We follow this approach to capture more precisely the contractionary effects of austerity on aggregate demand. That is, in our model, when the government cuts borrowing it depresses aggregate demand by transferring resources abroad. If we were to include domestic debt, this would understate to some extent the costs of austerity because households would increase their consumption of non-tradable goods.

[19]The calibrated value of the discount factor is $\beta = 0.91$. As is standard in the literature, a relatively low discount factor is needed to rationalize the observed levels of debt. This could capture households' impatience or political economy frictions.

[20]An exception is the volatility of spreads; the model falls short in replicating the volatility observed in the data. As discussed by Aguiar, Chatterjee, Cole and Stangebye (2016), this is a common challenge faced by the canonical sovereign debt model.

[21]Essentially, we choose the same parameter values as in our baseline economy (detailed in Table 1), except for the discount factor and utility of government spending—which we set to match the same average debt-to-GDP and government-spending-to-GDP ratios as in our baseline economy—and the parameters governing the default costs, which are set to large enough values to ensure that the economy never defaults for the targeted debt levels.

[22]Time series for public and private consumption and GDP are log-quadratic detrended.

risk, optimal fiscal policy is countercyclical, with a correlation of -0.81 between government spending and GDP. This model prediction is in sharp contrast to the procyclical behavior of government spending observed for Spain (0.46 in our sample). Table 2 also shows that, thanks to the effective stabilizing role of fiscal policy, the fluctuations in unemployment are small—one order of magnitude smaller that those observed in the data for Spain.

Table 2: Business Cycle Statistics: Data and Models

| | | Model | |
Statistic	Data	Risk-free	Default
Averages (in percent)			
mean(spreads)	1.05	0.00	1.09
mean(debt/y)	22.8	22.4	22.6
mean($p^N g^N/y$)	18.1	18.6	18.2
Correlations with GDP			
corr(GDP,g^N)	0.46	-0.81	0.72
corr(GDP,c)	0.98	1.00	0.98
corr(GDP,spreads)	-0.38	0.00	-0.95
corr(GDP,unemployment)	-0.34	-0.37	-0.97
Volatilities (in percent)			
σ(GDP)	3.5	1.2	4.3
$\sigma(p^N g^N)/\sigma$(GDP)	2.0	1.6	2.0
$\sigma(c)/\sigma$(GDP)	1.1	1.1	1.1
σ(spreads)	1.4	0.0	0.7
σ(unemployment)	4.1	0.6	5.6

Notes: This table reports business cycle statistics for the data and the models with risk-free and risky debt. Bond spreads are computed as the differential between the annual sovereign bond return and the annual risk-free rate. The variables GDP and y denote total output at constant and current prices, respectively.

The last column of Table 2 shows the business cycle statistics for our baseline economy with default risk. The main result is that government spending is procyclical, with a correlation of 0.72 with output. This table shows that the resulting fluctuations in unemployment are also more aligned with the data.

The sharp contrast between the conduct of fiscal policy in the risk-free economy and in the economy with default risk can be illustrated by comparing the policy functions for government spending. As Figure 3 shows, optimal government spending with risk-free debt, depicted by the solid red line, is monotonically decreasing with income. In contrast, optimal government spending with defaultable debt, depicted by the dashed blue line, is non-monotonic within the repayment region. In particular, spending is increasing in y^T for low levels of y^T, and is decreasing in y^T for

Figure 3: Government Spending as a Function of y^T

Notes: This figure shows the optimal government spending as a function of y^T in the risky and risk-free debt models. Debt is set to its average level. The solid red line corresponds to the risk-free debt model and the dashed blue line to the risky model. The dotted vertical line in black corresponds to the default threshold.

high levels of y^T.[23]

To understand these results, Figure 4 depicts two important objects we discuss in the context of the optimal policy tradeoffs in Section 3. Panel (a) shows the fiscal multiplier, defined as the increase in output from a marginal increase in government spending, as a function of tradable endowment. As the figure shows, the fiscal multiplier is positive when income is low and becomes zero once the economy is at full employment.[24] Panel (b) shows the increase in spreads that results from the increase in external debt to finance of one unit of government spending. A crucial property illustrated in the figure is that the marginal financial cost is larger when income is low. Overall, this figure shows that although in bad times the fiscal multiplier is larger, the fact that the financial cost is also larger implies that the government chooses to cut spending and follow a procyclical fiscal policy.

It is important to highlight that departing from the optimal fiscal policy under default risk can entail large welfare costs. To show this, we replace the optimal countercyclical spending with

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[23]Notice also that the amount of spending increases to the left of the default threshold. The reason is that when the government repays and is close to the default threshold, it runs a fiscal surplus and defaulting frees up resources for stimulus.

[24]For empirical evidence on the asymmetry of the fiscal multiplier, see, for example, Born, D'Ascanio, Müller and Pfeifer (2019).

(a) Fiscal Multiplier

(b) Increase in Borrowing Costs
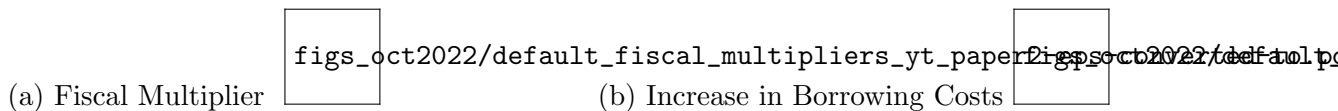
Figure 4: Fiscal Multipliers and Borrowing Costs as a Function of y^T

Notes: This figure shows the fiscal multiplier (left panel) and a measure of the marginal variation in borrowing costs when increasing debt (right panel) as a function of y^T. Fiscal multipliers are computed as the derivative of y_t^N with respect to g_t^N. Current debt is set to 10% above its average level. The marginal increase in borrowing costs is given by $\frac{\partial q}{\partial b'}(b' - (1-\delta)b)$.

a benchmark Samuelson rule that specifies a constant g^N over the business cycle and evaluate the welfare costs from following this rule as opposed to the optimal one. We find that the average welfare cost is 3.5% of permanent consumption.[25]

Following a Samuelson rule instead of the optimal state-contingent policy generates several welfare consequences: it may have adverse effects on the borrowing terms at which the government borrows, which in turn affects the ability to front-load consumption and smooth income shocks over time and, in addition, affects the ability to achieve macroeconomic stabilization. We argue that the latter accounts for the bulk of the welfare losses. Evaluating the value function under the assumption that c^N and g^N are the same (and equal to their optimal values) for both classes of policies, we find that welfare losses become negligible in that case. In addition, the welfare implications associated with the utility loss from default penalties are also quite small. When we abstract from the default penalties when computing the value function, the welfare gains are reduced by about 0.1 percentage points. In contrast to Lucas (1987), macroeconomic stabilization entails significant welfare consequences.

4.3 The Debt Dependence of Optimal Fiscal Policy

In this section, we show that default risk considerations lead to an important state dependency in the optimal fiscal policy. In particular, the government's optimal response to shocks depends crucially on the country's level of debt. To illustrate this debt state dependence, we consider a one-standard-deviation drop in tradable endowment and simulate the model forward under the expected path of income, starting from two initial levels of debt: one that is 25% below the steady-state level ("low debt") and another that is 25% above the steady-state level ("high debt").[26]

Figure 5 shows the results of this exercise. The figure compares macroeconomic variables and spreads under the negative shock with those in the economy without the shock. The dotted black line corresponds to the economy that starts with low debt. In this case, the government chooses an expansionary path for government spending and borrowing (panels (b) and (c), respectively). Facing low default risk, the government resorts to a fiscal stimulus that prevents virtually any increase in unemployment (panel (f)).

In sharp contrast, the solid red line in Figure 5 shows that when initial debt levels are high, the government chooses to contract government spending and reduce debt levels. Because the negative shock triggers an increase in sovereign risk, the government finds it too costly to engage in an expansionary fiscal policy. The increase in spreads that would result from the increase in

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[25]Welfare is computed in total consumption equivalence terms (see Appendix D for details).

[26]For this quantitative exercise, we simulate from $t = 2$ onward along $10,000$ tradable income paths. Naturally, along some paths, default occurs during some periods. To compute the impulse responses, we consider all of the simulations in each period and calculate the cross-sectional median of the variables.

	(a) y^T	(b) Government Spending g^N	(c) Borrowing b_{t+1}
figs_oct2022/yt1_irfs-eps-converted-to.p	figs_oct2022/gn1_irfs-eps-converted-to.p	figs_oct2022/b1_irfs-eps-converted-to.p

	(d) Spreads	(e) c^T	(f) Unemployment
figs_oct2022/r1_irfs-eps-converted-to.p	figs_oct2022/ct1_irfs-eps-converted-to.p	figs_oct2022/h1_irfs-eps-converted-to.p
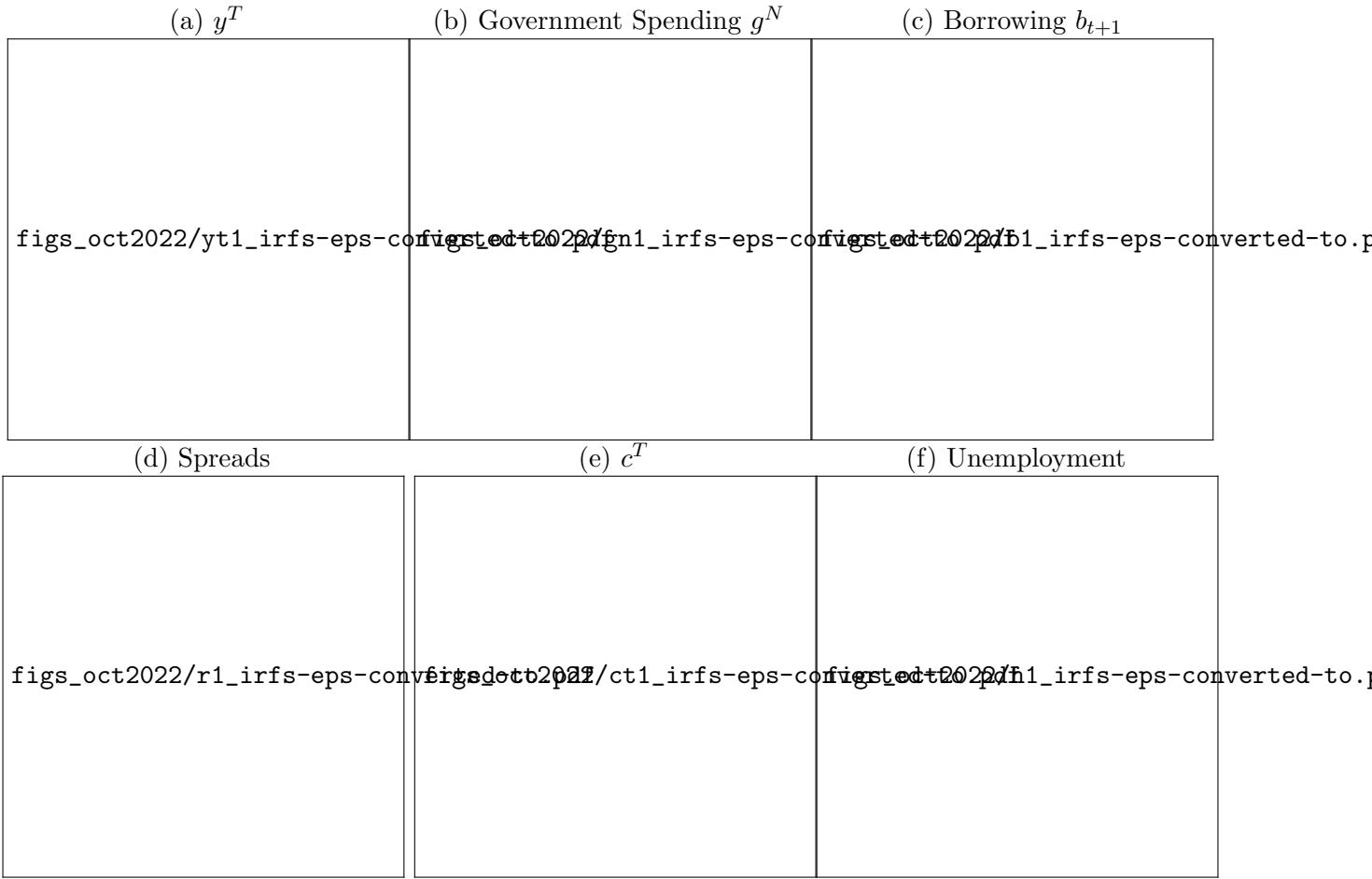
Figure 5: Impulse Responses to y^T for Different Initial Debt Levels

Notes: This figure shows the responses of macro variables to a drop of y^T of one standard deviation from its unconditional mean in period 1. Vertical axis units are median deviations from the unshocked path. Government spending, consumption, and GDP are expressed in percentage deviations, while borrowing, spreads and unemployment are in percentage points. Dashed blue lines correspond to initial debt set to 75% of the steady-state level; solid red lines correspond to initial debt equal to the steady-state level.

borrowing renders the stimulus too costly. This scenario is characterized by a large increase in unemployment (around 8 percentage points) resulting from the contraction in both public and private consumption.[27]

Spain's simulations. The state dependency of our model is also useful in interpreting the recent dynamics of government spending observed in Spain—our calibrated economy—in the run-up to the debt crisis. Figure 6 shows the evolution of Spain's government spending, real GDP, debt/GDP, and bond spreads over the period 2007-2013, in both the model and the data. For the model dynamics, we start from the debt level in 2007 and feed the observed path of tradable

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[27]In Appendix H, we provide a systematic analysis of the state dependence in which we consider the full range of debt and income.

income. To capture the emergency lending received by Spain, we assume the government receives
a 1.5% of GDP lump-sum transfer in 2012 and 2013, which corresponds to the funds provided by
the European Stability Mechanism (ESM).[28]

(a) Real GDP	(b) Government Spending g^N	(c) Debt/GDP
figs_oct2022/GDP_spain-eps-converted-to.pdf	figs_oct2022/gn_spain-eps-converted-to.pdf	figs_oct2022/debt_spain-eps-converted-to.pdf

(d) Spread	(e) Private consumption	(f) Unemployment
figs_oct2022/spread_spain-eps-converted-to.pdf	figs_oct2022/cons_spain-eps-converted-to.pdf	figs_oct2022/unemp_spain-eps-converted-to.pdf
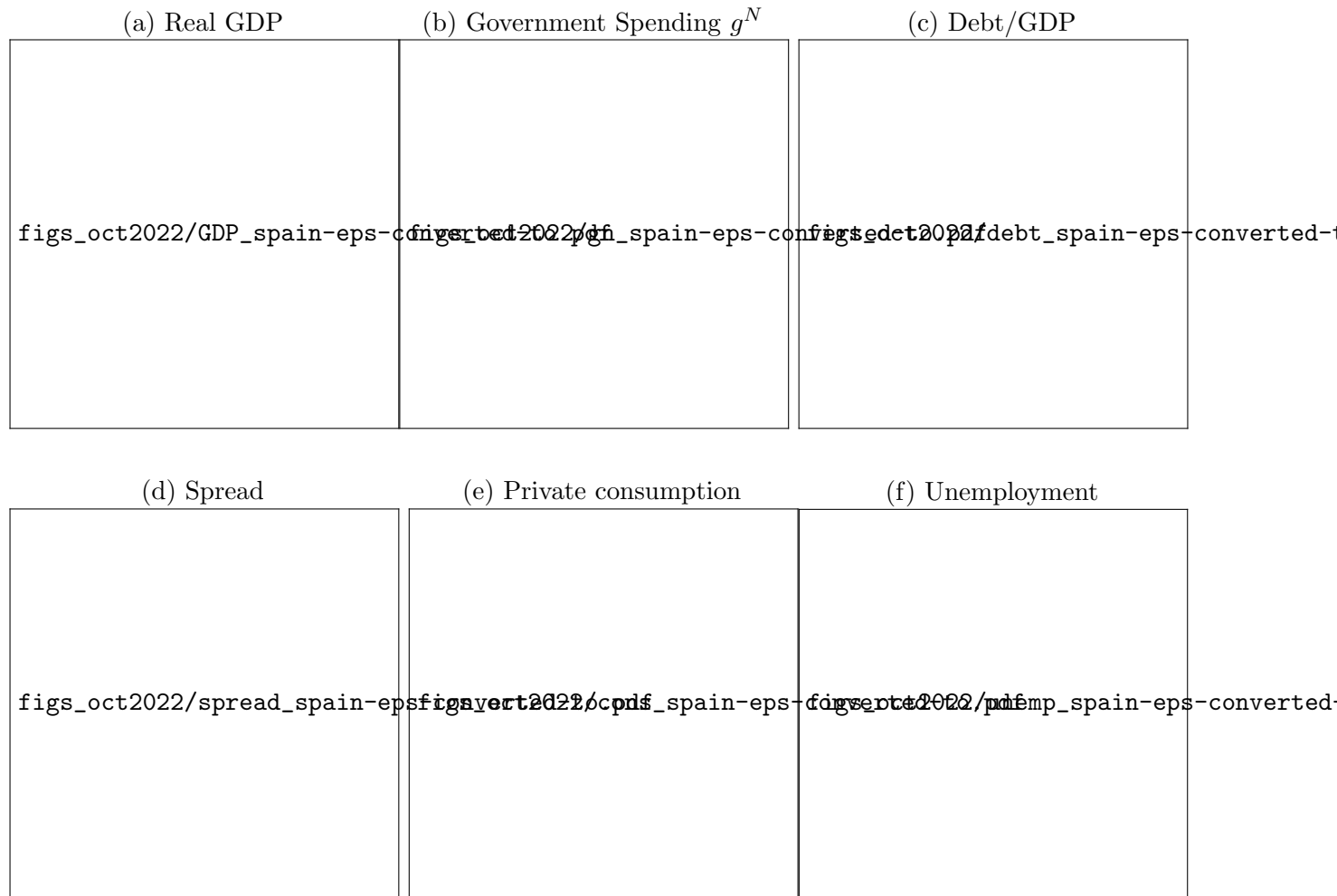
Figure 6: Data and Model: Spain 2007-2013

Notes: This figure shows the time series of macro variables for Spain in the run-up to the the 2012-2013 crisis.
Model simulation starts with the initial external debt in 2007 and fits the observed path of tradable output. For
2012-2013, we assume that Spain receives a total bailout of 3% of GDP. GDP, spending, and consumption are
expressed in % deviations from the trend in the data and % deviations from the mean in the model.

In line with our data, the government responded to the Great Recession with a fairly aggressive
fiscal stimulus (panel (b)). At that time, borrowing costs remained quite modest and government
spending kept rising (see panel (d) and Figure 1). In 2012-2013 there was a new slump in economic
activity, but the situation at that time was quite different. Facing mounting spreads, the Spanish
government decided to cut spending sharply; this, in turn, deepened the recession.

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[28]The promised amount by the ESM was 100 billion euros but only half of it was actually used.

4.4 Extension with Household Borrowing

In the baseline model, we consider a setup in which only the government can access international financial markets. This is the standard assumption in the sovereign debt literature. In this section, we extend the model to allow a fraction γ of "unconstrained", households to save and borrow abroad. We also assume that these households pool their unemployment risk. We index unconstrained households by u. Given these assumptions, we now have to track the aggregate bond position of unconstrained households (a_u) as a state variable, in addition to the government bonds and tradable endowment shock.

When households can save internationally, the government problem (17) features an additional implementability constraint: namely, the government needs to respect the unconstrained households' Euler equation for bonds. Let $\mathcal{C}^{T,u}$ $\mathcal{C}^{N,u}$ denote the continuation policy for tradable and non-tradable consumption for unconstrained households. The government problem is then subject to

$$u_T(c^{T,u}, c^{N,u}) \geq \beta R \mathbb{E} u_T \left[\mathcal{C}^{T,u}(y^{T'}, b', a_u'), \mathcal{C}^{N,u}(y^{T'}, b', a_u') \right], \tag{23}$$

with equality whenever the borrowing constraint on households does not bind.

Under the assumption that preferences are separable in tradables and non-tradables, we obtain the same optimality condition for g^N as in the baseline model. That is, (MSR) still characterizes the trade-off between stimulus and austerity (see details in Appendix C). The government's borrowing choices, however, do affect the amount of households' borrowing, and therefore the level of aggregate demand. Because of the presence of aggregate demand externalities (see, e.g., Schmitt-Grohé and Uribe, 2016), constraint (23) will in general bind for the government. That is, households and the government "disagree" about the intertemporal allocation of consumption. In particular, in a recession, households fail to internalize that if they were to increase borrowing and consumption, employment would increase. Similarly, under full employment, households fail to internalize that if they were to reduce borrowing, this would increase aggregate demand in the future and mitigate recessions. In addition, to the extent that households are not borrowing constrained, they are able to partly offset borrowing choices by the government and potentially offset government stimulus. However, Ricardian equivalence does not hold, given the frictions in taxes and borrowing by the government. Moreover, because public and private goods are imperfect substitutes, government consumption will affect relative prices and firms' labor demand, similar to our baseline model.

The effects of household borrowing on the transmission mechanism of fiscal policy can be analyzed through equation (20), which shows that the fiscal multiplier is higher when households

respond to an increase in g^N by raising c^T.[29] Conversely, if households respond by lowering c^T, the fiscal multiplier becomes smaller. Overall, the effects of higher g^N on c^T are complex and depend on various forces; in particular, intra- and intertemporal substitution effects and aggregate income effects. Higher spending raises p^N, which leads households to substitute consumption toward tradables. At the same time, higher prices today relative to the future lead to an intertemporal substitution toward the future. Finally, the increase in spending raises current household income (through higher labor income and profits) but the accumulation of debt implies a reduction in future income and government transfers.

To examine the effects on the transmission mechanism, we conduct the same numerical counterfactual analysis as in Section 3. We assume that 40% of the agents can borrow externally and use the same parameters as in the baseline. The analysis is presented in Figure 7. The figure displays the savings of unconstrained agents and non-tradable output (the appendix includes other relevant variables; in particular, spreads on unemployment that show the same trade-off as in the baseline model). As can be seen in panel (a), households increase their savings in response to a debt-financed stimulus. Panel (b) shows that we still obtain an increase in the aggregate amount of non-tradable consumption, which implies a multiplier that is still above one (although lower than the baseline).[30]

(a) Household Savings a' (b) Aggregate c^N
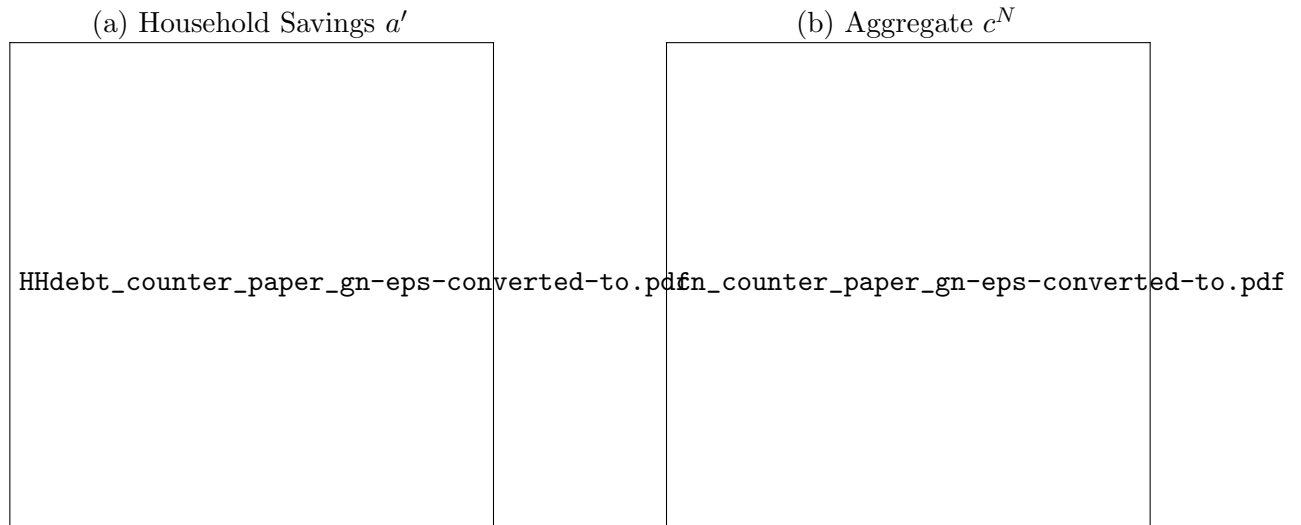
Figure 7: Results with alternative g^N in a model with household borrowing

Notes: See note to Figure 7 for details of the exercise and Appendix C for details of the model with household borrowing. In the figure, we set current tradable income to one standard deviation below its unconditional mean and current government and household debt are set to their respective average levels.

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[29]As we show in Appendix C, equation (20) continues to characterize the effects of fiscal stimulus with the difference that aggregate tradable consumption corresponds to the average of constrained and unconstrained agents (see equation (C.8)).

[30]It is well understood that a fraction of hand-to-mouth agents may raise fiscal multipliers above one (Galí, López-Salido and Vallés, 2007).

Overall, this extension suggests that the main trade-off remains very similar in a version with household borrowing. Figure C.1 in the appendix shows that optimal spending is still characterized by a nonmonotonic policy function. In addition, we obtain a correlation between output and spending, which is roughly the same as in the baseline model.

4.5 Other Extensions and Sensitivity

Fiscal rules. The critical friction that inhibits the government from following a countercyclical fiscal policy is the lack of commitment, which has two dimensions in our model: the inability to commit to repayment decisions and the inability to commit to spending decisions. We argue now that allowing for a limited degree of commitment—namely, a commitment to next period's government spending during repayment—can be quite effective in rendering a stimulus more desirable. In Appendix I we show how, in the midst of a recession, a policy of "fiscal forward guidance" that promises lower government spending once the economy is back to normal can help reduce spreads today and render a stimulus more desirable.[31,32]

Appendix E also explores quantitatively the role of simple fiscal rules that the government follows at all times (see table E.1). Unlike the effectiveness of fiscal programs discussed above, we find that fiscal rules that specify a constant level of spending reduce welfare. The possible gains from committing to low spending turn out to be dwarfed by the costs of the lack of flexibility. Moreover, even though spreads may turn out to be lower in the economy with a constant-spending rule, this occurs primarily because the lack of flexibility creates a form of debt intolerance that causes the government to borrow very little in equilibrium.

Overall, our findings suggest that desirable rules are likely to be highly nonlinear and must be carefully designed to be effective.[33]

Costly tax adjustment. Our baseline analysis features a constant tax rate. A fiscal constraint is indeed critical to inducing a binding government budget constraint—which, together with default risk, gives rise to the austerity channel. It is possible, however, to extend our analysis to allow for a variable tax rate. For tractability, we do not model the primitive reasons why it is

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[31]Like other contributions to the large literature on fiscal rules (see, e.g., Hatchondo, Martinez and Roch, 2021; Chatterjee and Eyigungor, 2015; Hatchondo, Martinez and Sosa-Padilla, 2016; Hatchondo, Roch and Martinez, 2019), we assume that these rules are enforced either by some legal mandate or a supra-national institution. Halac and Yared (2017) and Dovis and Kirpalani (2020) study reputation mechanisms.

[32]The appendix also presents a case in which ill-designed austerity programs can have unintended effects on raising spreads; an empirically relevant case is argued by Born, Müller and Pfeifer (2020). In recent work, Anzoategui (2020) investigates the effects of austerity on spreads using a similar model that incorporates estimated fiscal rules.

[33]We have also explored alternative simple rules in which spending reacts linearly to income and also found little improvements. One promising avenue for future research is to explore fiscal rules based on debt and spread limits, following the work of Hatchondo et al. (2021).

costly to adjust taxes and instead consider a loss from taxation given by $\Phi(\tau_t - \bar{\tau})$, where $\bar{\tau}$ is a reference tax rate, and Φ is a convex function that achieves a minimum at zero.[34] As we show in Appendix B.2, the characterization provided in Section 3 is preserved. The only difference now is that optimality must also satisfy a condition that equates the marginal costs from changing taxes to the marginal value of the tax revenues obtained:

$$\Psi'(\tau_t - \bar{\tau}) = \eta_t \left[y_t^T + p_t^N F(h_t) \right]. \tag{24}$$

An implication of this condition is that in periods in which default risk and the government budget constraint are tighter, it is optimal to raise τ_t, as doing so allows for more space to increase spending. Our quantitative explorations show that the overall austerity results are preserved for realistic parameterizations of Ψ.[35]

In Appendix Table G.1, we also consider an extreme case in which the government has access to lump sum taxes, which corresponds to $\Psi = 0$. In line with our Corollary 1, the government chooses a countercyclical fiscal policy, because a simultaneous increase in taxes and spending helps raise aggregate demand without increasing the exposure to the debt crisis. However, once we calibrate the cost of taxation to match the volatility obtained in the data, the results we obtain are very close the baseline with a fixed tax rate.

Robustness of results. Appendix Table G.1 shows that the main results from the normative analysis are robust to alternative parameterizations of the model. In particular, the optimal fiscal policy is procyclical for alternative discount factors, default costs, debt maturity, degree of unemployment insurance, and tax levels. Economies with a higher discount factor exhibit fiscal policies that are less procyclical. This result suggests that political economy frictions, interpreted as a lower discount factor, drive up the procyclicality of fiscal policy. However, even when raising the discount factor from 0.91 to 0.95, we obtain a correlation between output and spending of 0.65 (vs. 0.75 in the baseline). Governments with lower default costs carry less debt and also exhibit less procyclical fiscal policy.[36] Similarly, economies with longer maturities need to roll over a smaller fraction of the debt and choose less procyclical policies. Inequality considerations also play an important role in determining the optimal policy: Economies with less unemployment insurance put a higher weight on unemployment stabilization and choose less procyclical policies.

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[34]What is crucial for our analysis is that taxes are costly to raise for the government. One can interpret the costs of increasing taxes as originating from deadweight losses or political economy costs. Although including such detailed frictions goes beyond the scope of our paper, they constitute an interesting analysis for future research.

[35]We specify a quadratic cost $\Psi = \Psi_0(\tau - \bar{\tau})^2$ and calibrate $\bar{\tau}$ to match the average spending-to-GDP ratio and Ψ_0 to match a mean absolute deviation of 3% in tax rates, as obtained by Vegh and Vuletin (2015).

[36]Table G.1 also reports the comparison of economies with different default costs when we recalibrate their discount factors so that they have similar debt levels. In this case, the economy with lower default costs faces a higher probability of default for any level of borrowing, which raises austerity considerations and renders the optimal policy more procyclical. Table G.2 also reports similar results in a calibration for Brazil and Greece.

Economies with higher tax rates have to resort to risky external finance to a lesser extent and follow less procyclical fiscal policies. Finally, when income shocks are less persistent, procyclicality is reduced. Intuitively, a less persistent shock implies that a recession today is less likely to be followed by a recession in the future. Therefore, the government has less need for fiscal space in the future and may find it optimal to spend more.[37]

5   Fiscal Responses by Sovereign Risk in the Data

We document that, consistent with the normative predictions of the model, countries with higher sovereign default risk exhibit more fiscal austerity during downturns. In addition, we show that within risky economies, higher initial foreign liabilities are associated with more austerity during recessions. We highlight the fact that the evidence we provide is descriptive and not aimed at being causal. The key takeaway is that the patterns of fiscal policy observed in the data are consistent with how the government resolves the trade-off between stimulus and austerity in our model.

Data description.   Our empirical analysis includes data on national accounts and sovereign risk indicators for a panel of countries around the world for the period 1980 to 2016. We obtain national accounts data from World Development Indicators (WDI), a dataset that reports information from official sources for a large set of countries. We measure economic activity with GDP and government consumption with the variable "general government final consumption expenditure"; we focus our empirical analysis on government consumption because this is the variable for which we conduct our normative analysis in the model. We measure both variables at constant prices and in per capita terms, using data on population from Penn World Tables. Appendix Table J.1 lists 108 countries with at least 15 years of data for these variables. Appendix Table J.2 presents summary statistics of the cyclical behavior of government consumption and GDP around the world. Most countries are characterized by a government consumption that is more volatile than GDP and procyclical. This cyclicality displays a large dispersion across countries, ranging from -0.1 to 0.7, which we exploit in our empirical analysis.

For sovereign risk, we use two measures: historical default rates from Reinhart and Rogoff (2009) and credit ratings from Standard & Poor's (S&P). Table J.3 lists the countries with available data in our sample; it also reports average default rates by country before World War II and the minimum and mode ratings for countries with more than 15 years of available data for the period 1980-2016. As reported in the table, historical default rates exhibit a strong positive

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[37]In Figure G.1 in the appendix, we compare the policy function for spending in the baseline model with the policy in the case of a one-time unanticipated shock. In contrast to the baseline model, for the case of the fully temporary shock, the government responds to a fall in y^T by spending more.

relationship with credit ratings. We complement the measures of sovereign risk with data on net foreign liabilities from Lane and Milesi-Ferreti (2007).[38]

We are interested in characterizing the behavior of government consumption during recessions for countries with different default risks. For this, we identify recession episodes following the algorithm of Calvo, Coricelli and Ottonello (2014), which defines recessions as time windows that contain annual contractions of real per capita GDP (Appendix J.2 provides the details of this algorithm). Following this procedure, we identify a sample of 308 recession episodes in the countries with credit ratings data in our sample, which are listed in Appendix Tables J.4 and J.5. Recessions exhibit a median contraction of economic activity of 1.5% in the first year and a median contraction of 3.3% from peak to trough.

We include in our analysis additional variables the literature has shown to be important determinants of fiscal policy over the business cycle and capable of being correlated with sovereign default risk. First, we examine countries' income levels (e.g., Gavin and Perotti, 1997; Kaminsky et al., 2004; Ilzetzki and Végh, 2008), which we measure with the average GDP per capita PPP adjusted, obtained from WDI.[39] Second, we include political polarization, studied in Ilzetzki (2011) and measured, as in this work, with the index of ethnic fractionalization of Alesina, Devleeschauwer, Easterly, Kurlat and Wacziarg (2003). Third, we consider political agency problems, studied by Alesina, Campante and Tabellini (2008), which we measure, as in their work, with the degree-of-corruption index of Kaufmann, Kraay and Mastruzzi (2006)'s aggregate governance indicators.

Specification. We provide descriptive evidence to characterize the dynamics of government consumption during recessions for countries with different sovereign risk and foreign liabilities by estimating Jordà (2005)-style local projections:

$$\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s}\Delta \log g_{jt-1} + \rho_{2s}\ell_{jt-1} + \mathbf{\Gamma}'_s \text{recession}_{jt} X_{jt-1} + \epsilon_{sjt}, \tag{25}$$

where $s \geq 1$ indexes the forecast horizon; g_{jt} is real government consumption per capita of country j in period t; α_{sj} is a country fixed effect; recession_{jt} is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk_j denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt}

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[38]As shown in Section 4.4, in our model the key variable that determines fiscal policy is the government's debt. In the empirical analysis, we focus on total net foreign liabilities (including both public and private net foreign liabilities) because of data availability in our sample of countries and the period of analysis. In the model-simulated data in Section 4.4, these variables exhibit a strong positive correlation.

[39]Although we include this variable in the analysis to absorb differences in fiscal policies driven by differences in income levels, Ilzetzki (2011) shows that the cyclicality of government consumption, which is the main focus of our analysis, is not significantly different for high-income countries and developing countries.

denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at country level;[40] X_{jt-1} is a vector of controls; and ε_{sjt} is a residual. In our baseline specification, we measure the variable risk_j as either a dummy variable that takes the value of one if country j has a historical default rate above 1% or a dummy variable that takes the value of one if country j ever had an S&P sovereign credit rating below AA, which denotes a very strong capacity to meet its financial commitments and is the minimum rating observed in the U.S.; we consider alternative thresholds in the robustness analysis. For the control vector X_{jt-1} in the baseline model, we include the log of the country's GDP per capita and the interaction of this variable with ℓ_{jt-1}, to absorb differences in fiscal policies during recessions driven by different income levels; we also consider additional variables below. Our main coefficients of interest are β_s and γ_s, which measure the cumulative growth in government consumption s years after a recession for riskless and risky economies, and δ_s, which measures how the cumulative growth of government consumption s years after a recession varies for recessions with different initial net foreign liabilities. We cluster standard errors in two ways to account for correlation within countries and within years. We also estimate (25) with real GDP instead of real government consumption.

Results   Table 3 reports the results from estimating (25) for $s = 0$, which corresponds to estimating the growth in government consumption and GDP relative to their mean in the initial year of a recession episode for countries with different sovereign risk and foreign liabilities. The first row shows the estimate for β_0, which indicates that riskless economies tend to display a fiscal expansion, with growth in government consumption being on average 1-percentage-point higher than its mean, while GDP grows 3 to 4 percentage points below its mean. The second row shows the estimate for γ_0, which indicates that risky governments exhibit more austerity in terms of their government consumption than riskless economies, with a 2-percentage-point growth below that of riskless economies; these economies also experience a more severe output contraction. The third row shows the estimate of δ_0, which indicates that for risky economies, recessions with high initial foreign-liability positions tend to exhibit more fiscal austerity in terms of their government consumption than recessions with low initial foreign liabilities; in particular, having one-standard-deviation higher initial net foreign liabilities over GDP above the mean is associated with a growth of government consumption 3 to 4 percentage points below that of a risky economy with the average level of foreign liabilities in the initial period of a recession episode.[41]

Figures 8 and Appendix Figure J.1 show the dynamics of government consumption and GDP in the years following the initial contraction from recession episodes, obtained by estimating

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[40]We demean the variable ℓ_{jt} at the country level to abstract from permanent differences in foreign-liability positions across countries. See Ottonello and Winberry (2020) for a similar procedure for firms' leverage.

[41]The units of ℓ_{jt} are standardized over the entire sample; thus the units of the estimated coefficient are standard deviations of the ratio of external liabilities over GDP from the sample, which is 0.33.

Table 3: Initial Change in Government Consumption and Output during Recessions by Sovereign Risk and External Liabilities

Dependent variable	(1) Δg_{jt}	(2) Δg_{jt}	(3) Δy_{jt}	(4) Δy_{jt}
recession	0.013**	0.013**	−0.037***	−0.030***
	(0.004)	(0.006)	(0.004)	(0.006)
recession × risk	−0.016**	−0.019**	−0.011*	−0.020***
	(0.007)	(0.008)	(0.006)	(0.007)
recession × risk × ℓ	−0.043***	−0.032**	−0.000	−0.000
	(0.013)	(0.015)	(0.008)	(0.008)
Observations	1,853	1,983	1953	2,082
R^2	0.12	0.12	0.42	0.42
Measure of sov. risk	hist. default	min. rating < AA	hist. default	min. rating < AA

Notes: Results from estimating

$$\Delta \log z_{jt} = \alpha_j + \beta \text{recession}_{jt} + \gamma(\text{recession}_{jt} \times \text{risk}_j) + \delta(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_1 \Delta \log z_{jt-1} + \rho_2 \ell_{jt-1} + \mathbf{\Gamma}' \text{recession}_{jt} X_{jt-1} + \epsilon_{jt},$$

where $z_{jt} \in \{g_{jt}, y_{jt}\}$ is either real government consumption per capita or real GDP per capita of country j in period t; α_j is a country fixed effect; recession$_{jt}$ is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk$_j$ denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector of controls that includes the log GDP per capita of country j and the interaction of this variable with ℓ_{jt-1}. In columns (1) and (3), sovereign risk is measured with a dummy variable that takes a value of one if the historical default rate of country j is above 1 % and zero otherwise (see Section 5 for details); in columns (2) and (4), sovereign risk is measured with a dummy variable that takes the value of one if the country ever had a rating below AA. Standard errors are two-way clustered by country and by year.

(25) for different horizons s, for both measures of sovereign risk.[42] The left and middle panels depict the estimates of β_s and γ_s as a function of s, which indicate tha, after its initial response documented in Table 3, cumulative government consumption growth tends to return to its average, with more persistence for risky economies. The right panels of Figure 8 show that fiscal austerity following recession episodes is particularly persistent and acute for risky economies with initial foreign liabilities.

Robustness and additional analysis Appendix J.3.2 shows that the results that characterize recession episodes are robust to expanding the vector of country-level controls X_{jt-1}, which at the baseline is aimed at absorbing differences in income across countries and the interaction of

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[42]To render these results more tangible, Appendix J.3.1 presents country-level patterns for these dynamics during recession episodes and compares them with their reference risk group.

(a) Sovereign risk measured by historical default probability

(b) Sovereign risk measured by credit ratings
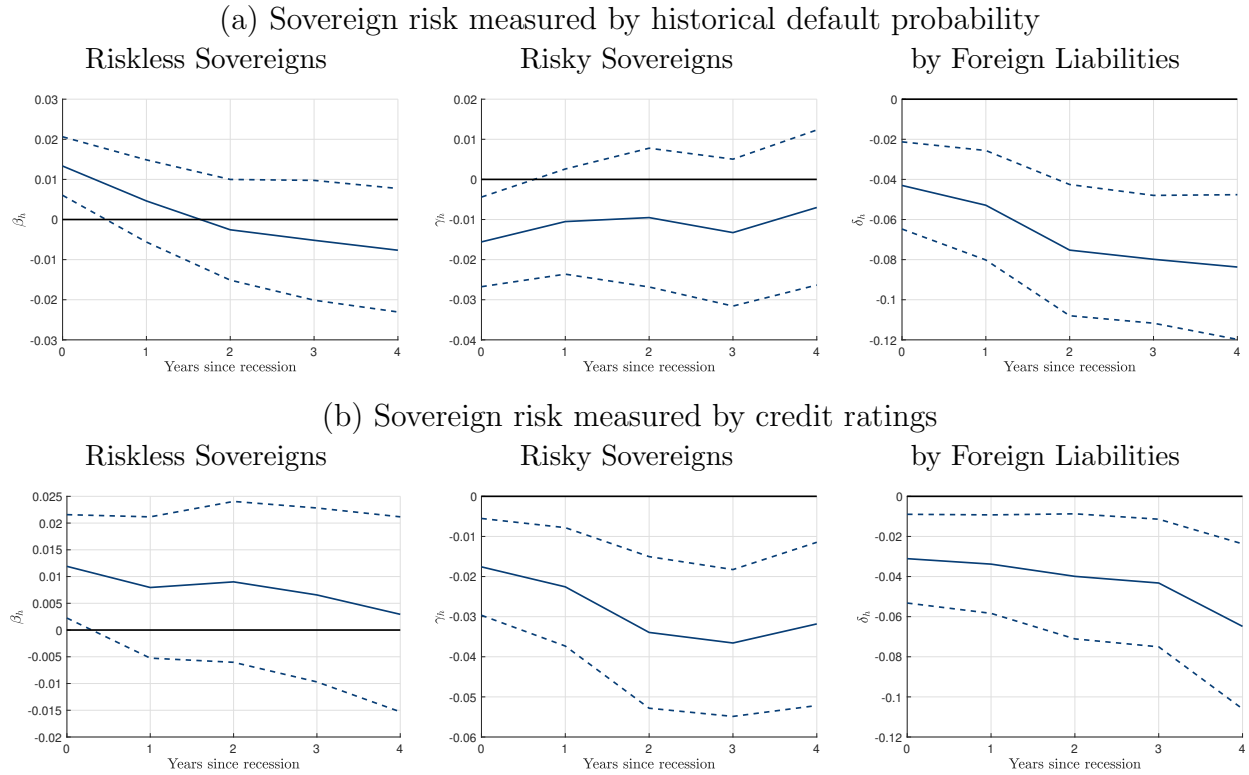
Figure 8: Dynamics of Government Consumption During Recession Episodes by Sovereign Risk and Foreign Liabilities

Notes: Results from estimating

$$\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s}\Delta \log g_{jt-1} + \rho_{2s}\ell_{jt-1} + \mathbf{\Gamma}'_s\text{recession}_{jt}X_{jt-1} + \epsilon_{sjt},$$

where all variables are defined in the notes to Table 3. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands.

this variable with net foreign liabilities. In particular, Appendix Figures J.6 and J.7 show that the differences in sovereign risk from our baseline specification do not capture differences in fiscal cyclicalities for countries with different ethnic fragmentation or corruption, which, as discussed above, have been identified in the literature as important drivers of fiscal procyclicality. Appendix J.3.3 investigates how the results vary with alternative thresholds of credit ratings. Appendix Figure J.9 shows that the differential responses between riskless and risky sovereigns weaken as we lower the bar that defines a riskless economy.

Finally, Appendix J.4 complements the results for recession episodes by documenting the cyclicality of government consumption for countries with different default risk. The main result is that, consistent with our model, countries with higher default risk tend to exhibit a higher sensitivity of government consumption to changes in GDP.

6   Conclusion

We provide a framework that combines Keynesian features with sovereign risk concerns to articulate the fundamental dilemma faced by policymakers in a severe downturn: Should the government increase spending to ease the recession at the expense of higher spreads, or cut spending to reduce exposure to a debt crisis— even if that deepens the recession? Our analysis suggests that a fiscal stimulus may be undesirable, even in the presence of sizeable Keynesian stabilization gains and inequality concerns.

As the global economy emerges from the COVID-19 crisis with record-high sovereign debt levels, the issues we tackle here are likely to inform upcoming policy debates. However, we believe that there are several important areas in which the analysis presented here should be extended. First, we have focused on the role of government spending as a potential countercyclical policy tool while positing a tax rate that is either fixed or subject to an exogenous deadweight loss, calibrated to match the variability in the data. Future research could allow for a richer fiscal constellation and shed further light, for example, on whether austerity should be loaded relatively more on spending or taxes. Second, we have assumed that fiscal policy is conducted by a benevolent government, which shares in particular, the same discount factor as households. An interesting area for future research is to incorporate political economy frictions. Extending the analysis in this dimension would help inform policy discussions on the desirability of fiscal rules and the extent to which they can help manage the fiscal austerity-stimulus trade-off in the presence of sovereign risk.

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Online Appendix to
"Fiscal Stimulus Under Sovereign Risk"

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A Proofs

A.1 Proof of Lemma 1

Proof. The social period utility from private consumption is the average of the utility of employed and unemployed households, weighted by their shares in the population, h_t and $1 - h_t$. That is,

$$\mathcal{U}_t((c_j^T)_{i\in[0,1]}, (c_j^N)_{j\in[0,1]}) = h_t u\left(c_t^{T,e}, c_t^{N,e}\right) + (1 - h_t)u\left(c_t^{T,u}, c_t^{N,u}\right), \tag{A.1}$$

where $c_t^{T,e}$ and $c_t^{N,e}$ denote the consumption of tradable and nontradable goods of employed households and $c_t^{T,u}$ and $c_t^{N,u}$ denote that of unemployed households. From the households' optimality condition (3), we can express tradable consumption for any individual j as

$$c_{jt}^N = c_{jt}^T \left[\frac{1 - \omega}{\omega}(p_t^N)^{-\xi}\right], \tag{A.2}$$

which implies that employed and unemployed agents consume the same ratio of tradables to non-tradables.

Replacing (A.2) in the household's budget constraint, we have

$$c_{jt}^T \left[1 + p_t^N \left(\frac{1 - \omega}{\omega}(p_t^N)^{-\xi}\right)\right] = \mathcal{Y}_t(h_{jt}).$$

Using (7), we arrive at $c_t^{T,u}/c_t^{T,e} = \kappa\, c_t^{N,u}/c_t^{N,e} = \kappa$. Hence, a government unemployment insurance scheme implies a constant ratio between the tradable/non-tradable consumption of unemployed and employed workers. Using this relationship and the form of the utility function, we can write

$$\int_{j\in[0,1]} u(c_j^T, c_j^T)dj = h_t u\left(c_t^{T,e}, c_t^{N,e}\right) + (1 - h_t)\kappa^{1-\sigma} u\left(c_t^{T,e}, c_t^{N,e}\right)$$

$$= u\left(c_t^{T,e}, c_t^{N,e}\right)\left[h_t + (1 - h_t)\kappa^{1-\sigma}\right]. \tag{A.3}$$

By the resource constraint, we have that aggregate consumption must satisfy

$$c_t^T = c_t^{T,e}h + c_t^{T,u}(1 - h)$$

$$= c_t^{T,e}[h + \kappa(1 - h)]. \tag{A.4}$$

1

Substituting (A.4) into (A.3) and using the form of the utility function, we arrive at

$$
\int_{j\in[0,1]} u(c_j^T, c_j^N)dj = u\left(\frac{c_t^T}{h+\kappa(1-h)}, \frac{c_t^N}{h+\kappa(1-h)}\right)\left[h_t + (1-h_t)\kappa^{1-\sigma}\right]
$$
$$
=\frac{h_t + (1-h_t)\kappa^{1-\sigma}}{[h+\kappa(1-h)]^{1-\sigma}}u\left(c_t^T, c_t^N\right)
$$

which is the expression in the lemma we sought to demonstrate.

$\square$

A.2 Proof of Proposition 1

Proof. The proof is by contradiction. Assume, contrary to the statement of the proposition, that there exists an optimal allocation $\{g_t^{N*}, b_t'^*, T_t^*, h_t^*, \chi_t^*\}_{t=0}^\infty$ (henceforth "initial allocation") in which, for some period ℓ, $h_\ell^* < 1$. Given that the allocation features unemployment, the labor market slackness condition implies that wages are equal to the minimum wage

$$
p_\ell^{N*} = \frac{1-\omega}{\omega}\left(\frac{c_\ell^{T*}}{h_\ell^* - g_\ell^{N*}}\right)^{\frac{1}{\xi}} = \bar{w}.
$$

Now consider an alternative allocation with period-ℓ employment given by some $\hat{h}_\ell \in (h_\ell^*, 1)$, government spending given by $\tilde{g}_\ell^N = g_\ell^{N*} + (\tilde{h}_\ell - h_\ell^*)$, lump-sum transfers given by $\tilde{T}_\ell = T_\ell^* - p_\ell^{N*}(\tilde{g}_\ell - g_\ell^{N*})$, and the rest of the variables in the initial allocation. Because of the linear technology, period-ℓ non-tradable consumption is identical in the alternative allocation and in the initial allocation (see equation (11)), which implies that the social period utility from private consumption is at least as good in the alternative allocation as it is in the initial allocation; that is, $u(c_\ell^*, \tilde{h}_\ell - \tilde{g}_\ell)\Omega(\tilde{h}_\ell) \geq u(c_\ell^*, h_\ell^* - g_\ell^{N*})\Omega(h_\ell^*)$ (with equality under perfect unemployment insurance, $\kappa = 1$). Moreover, given that the utility from the public good is higher under the alternative allocation than under the initial allocation (given that $\tilde{g}_\ell^N > g_\ell^{N*}$ and $v(.)$ is increasing), welfare is unequivocally higher under the alternative allocation than under the initial allocation. Finally, we show that the alternative allocation is also feasible, contradicting that the initial allocation is optimal. To see that the alternative allocation is feasible, real wages in this alternative allocation are still equal to the minimum wage; that is, $\frac{1-\omega}{\omega}\left(\frac{c_\ell^{T*}}{\tilde{h}_\ell - \hat{g}_\ell^N}\right)^{\frac{1}{\xi}} = \overline{w}$, which implies that the optimal allocation satisfies the labor market slackness constraint. Given the proposed lump sum taxes, the alternative allocation satisfies the government budget constraint with the borrowing policy of the initial allocation $b_\ell'^*$. Finally, given that in the alternative allocation, c_ℓ^{T*} and $b_\ell'^*$ are the same as in the initial allocation, the resource constraint is also satisfied.

$\square$

A.3 Proof of Corollary 1

The optimal level of spending must be such that the economy is at full employment with $w_t = \bar{w}$. That is, g^N must satisfy

$$\left[\frac{1-\omega}{\omega}\frac{1}{\bar{w}}\right]^{\frac{1}{\xi}} c_t^T + g_t^N = 1. \tag{A.5}$$

Totally differentiating (A.5), we have that $\frac{\partial g^N}{\partial c^T} = -\left[\frac{1-\omega}{\omega}\frac{1}{\bar{w}}\right]^{\frac{1}{\xi}} < 0.$

B Details of the Government Problem

B.1 Baseline model

The government problem in the baseline version of the model consists of choosing a policy for borrowing, government spending, and transfers to maximize welfare subject to resource constraints and the implementability constraints associated with firms' and households' optimization, labor-market rigidities, and market-clearing conditions. The government problem is given by

$$V^R(y^T, b) = \max_{c^T, g^N, b', h \leq 1, T, w} \{u(c^T, F(h) - g^N)\Omega(h) + v(g^N) + \beta\mathbb{E}V(y^{T'}, b')\} \tag{B.1}$$

subject to

$$c^T + \delta b \leq y^T + q(y^T, b')[b' - (1-\delta)b] \tag{B.2}$$

$$\mathcal{P}^N(c^T, h, g^N)g^N + T = q(y^T, b')[b' - (1-\delta)b] + \tau\left[y_t^T + \mathcal{P}^N(c^T, h, g^N)F(h)\right] \tag{B.3}$$

$$T \geq 0, \tag{B.4}$$

$$\mathcal{P}^N(c^T, h, g^N)F'(h) = w \tag{B.5}$$

$$(h-1)(w - \overline{w}) = 0, \tag{B.6}$$

$$w \geq \overline{w}. \tag{B.7}$$

We first show that complementary slackness condition (B.6) is not binding.

Lemma B.1. *The solution to the government's problem (B.1) can be obtained as the solution to*

$$V^R(y^T, b) = \max_{c^T, g^N, b', h \leq 1} \{u(c^T, F(h) - g^N)\Omega(h) + v(g^N) + \beta\mathbb{E}V(y^{T'}, b')\} \tag{B.8}$$

subject to

$$c^T + \delta b \leq y^T + q(y^T, b')[b' - (1-\delta)b] \tag{B.9}$$

$$\mathcal{P}^N(c^T, h, g^N)g^N \geq q(y^T, b')[b' - (1-\delta)b] + \tau\left[y_t^T + \mathcal{P}^N(c^T, h, g^N)F(h)\right] \tag{B.10}$$

$$\mathcal{P}^N(c^T, h, g^N)F'(h) \geq \overline{w}. \tag{B.11}$$

Proof. To see that (B.5)-(B.7) can be combined into (B.19), we first show that (B.6) does not

3

bind. If, at the optimum, the solution if $h = 1$, then (B.6) is automatically satisfied. If $h < 1$, we can see that the government's objective is decreasing in w. Hence, we can set $w = \bar{w}$ and (B.6) is satisfied. Finally, combining (B.3) and (B.4), we obtain (B.18). Note that once we solve for (C.9), we can obtain wages and transfers from (B.4) and (B.5). $\qquad\square$

Using λ, η, and ξ to denote the Lagrange multipliers on the resource constraint, government budget constraint, and labor market implementability constraint, we obtain the following optimality conditions (expressed in sequential form):

$$g^N: \quad v'(g^N) - u_N \Omega(h) + \xi_t F'(h) \frac{\partial \mathcal{P}^N}{\partial g^N} = \eta_t \left(p_t^N + \frac{\partial \mathcal{P}^N}{\partial g^N} (1 - \tau F(h)) \right) \tag{B.12}$$

$$c^T: \quad u_T + \xi_t \frac{\partial \mathcal{P}_t^N}{\partial c_t^T} = \lambda_t \tag{B.13}$$

$$b': \quad (\lambda + \eta_t)(q_t + \frac{\partial q_t}{\partial b_{t+1}} i) = \beta E \frac{\partial V}{\partial b_{t+1}}. \tag{B.14}$$

The envelope condition is

$$V_b^R(y^T, b) = (\lambda + \eta) q(y^T, b')(1 - \delta). \tag{B.15}$$

Replacing (B.14) and (B.13) and using the optimal default decision at $t+1$, we obtain (22), as in Section 3.

B.2 The government's problem with flexible taxes

When the government can choose the tax rate subject to the cost Ψ, the government's problem is

$$V^R(y^T, b) = \max_{c^T, g^N, b', h \leq 1, \tau} \{ u(c^T, F(h) - g^N) \Omega(h) + v(g^N) - \Psi(\tau_t - \bar{\tau}) + \beta \mathbb{E} V(y^{T'}, b') \} \tag{B.16}$$

subject to

$$c^T + \delta b \leq y^T + q(y^T, b')[b' - (1 - \delta)b] \tag{B.17}$$

$$\mathcal{P}^N(c^T, h, g^N) g^N + T \geq q(y^T, b')[b' - (1 - \delta)b] + \tau \left[y_t^T + \mathcal{P}^N(c^T, h, g^N) F(h) \right] \tag{B.18}$$

$$\mathcal{P}^N(c^T, h, g^N) F'(h) \geq \overline{w}. \tag{B.19}$$

We have the following optimality with respect to τ_t:

$$\tau_t: \quad \Psi'(\tau_t - \bar{\tau}) = \eta_t \left[y_t^T + p_t^N F(h_t) \right]. \tag{B.20}$$

The rest of the optimality conditions are the same as in (B.1).

C   Extension with Household Borrowing

C.1   Environment

In this section, we describe the extension of the model in which a fraction of households can borrow externally. There are two types of agents: constrained and unconstrained. A fraction $1 - \gamma$ of constrained agents, indexed by c, cannot access external borrowing markets (as in the baseline model). The remaining γ fraction of unconstrained agents, indexed by u, can borrow internationally in a one-period non-state-contingent bond, subject to a borrowing constraint. In addition, they pool the idiosyncratic unemployment risk, an assumption that ensures that the aggregate bond holdings of unconstrained agents (not the distribution) is the relevant state variable. Aside from these two differences, both types of households have the same per capita average employment, firms' profits, and government taxes and transfers.

The budget constraint of constrained agents is the same as in the baseline model (2). Using subscript u to denote the allocations of unconstrained agents, their budget constraint is given by

$$c_{u,t}^T + p^N c_{u,t}^N + \frac{a_{u,t}'}{R} = (1 - \tau)(y_t^T + w_t h_t^d + \pi_t) + a_u + T_t. \tag{C.1}$$

Optimality implies that the shares of tradable and non-tradable consumption satisfy

$$p_t^N = \frac{1 - \omega}{\omega} \left(\frac{c_c^T}{c_c^N} \right)^{\frac{1}{\xi}} = \frac{1 - \omega}{\omega} \left(\frac{c_u^T}{c_u^N} \right)^{\frac{1}{\xi}}. \tag{C.2}$$

Due to homotheticity, both agents consume the same ratio of tradadable to non-tradable consumption. On the other hand, their levels may differ depending on the savings decisions of unconstrained agents. The optimal savings of unconstrained agents yields the following bond Euler equation in a state in which their borrowing constraint is not binding:

$$u_T(c_{u,t}^T, c_{u,t}^N) \geq \beta R \mathbb{E} \left[u_T(c_{u,t+1}^T, c_{u,t+1}^N)) \right], \tag{C.3}$$

with equality if $a' > \bar{a}$, where $\bar{a}$ denotes the borrowing limit.

Firms' problem is given by (5) and labor market rigidity is the same as in the baseline model. The government's budget constraint continues to be given by (9).

C.2   Equilibrium

We continue to denote by c^N and c^T the aggregate consumption in the economy. That is,

$$c^T = \gamma c_u^T + (1 - \gamma) c_c^T, \tag{C.4}$$
$$c^N = \gamma c_u^N + (1 - \gamma) c_c^N. \tag{C.5}$$

Market clearing in non-tradables therefore implies (11). A competitive equilibrium, for a given set of government policies, is then defined as follows.

Definition C.1 (Competitive Equilibrium)**.** Given initial debt b_0 and ζ_0 and sequences of exogenous processes $\{y_t^T, \vartheta_t\}_{t=0}^\infty$, government policies $\{g_t^N, b_{t+1}, \chi_t, T_t, e_t\}_{t=0}^\infty$, and credit market access

$\{\zeta_t\}_{t=0}^{\infty}$, a *competitive equilibrium* is a sequence of allocations $\{(c_{u,t}^T, c_{u,t}^N, (c_{c,t}^T, c_{c,t}^N, h_{jt})_{j \in [0,1]}, h_t^d\}_{t=0}^{\infty}$ and prices $\{P_t^N, P_t^T, W_t, q_t\}_{t=0}^{\infty}$ such that (i) each household maximizes their welfare; $(ii)\{h_t^d\}_{t=0}^{\infty}$ solves the firm's problem; (ii) government policies satisfy the budget constraints and ζ_t satisfies its law of motion; (iii) bond-pricing equation (10) holds; (iv) the market for non-tradable goods clears (11); and (v) labor market allocations and wages satisfy conditions (12)-(14).

C.3 Fiscal Transmission with Household Borrowing

To analyze the transmission mechanism, we can again combine households' and firms' optimality to obtain

$$\frac{1-\omega}{\omega} \left(\frac{c_t^{T,u}}{c_t^{N,u}} \right)^{\frac{1}{\xi}} F'(h_t) = w_t, \tag{C.6}$$

$$\frac{1-\omega}{\omega} \left(\frac{c_t^{T,c}}{c_t^{N,c}} \right)^{\frac{1}{\xi}} F'(h_t) = w_t. \tag{C.7}$$

Assuming that the wage rigidity constraint binds and $\alpha = 1$, we can combine these two equations to obtain

$$h_t = g_t^N + \left(\frac{1-\omega}{\omega} \frac{1}{\bar{w}} \right)^{\xi} (c_t^{T,c} + c_t^{N,u}). \tag{C.8}$$

C.4 The government's problem with household borrowing

We present here the derivation of the optimal conditions of the government's problem when households have access to international capital markets. Notice that now household savings affect default decisions, and so the bond price is also a function of a'. We consider for simplicity an economy in which all households are unconstrained, $\gamma = 1$. Using that the complementary slackness condition in the labor market does not bind, as in Lemma B.1, the government problem can be written as

$$V^R(s, b, a_u) = \max_{g^N, b', a'_u, h \leq 1} \{u(c^T, F(h) - g^N) + v(g^N) + \beta \mathbb{E} V(y^{T'}, b', a'_u)\} \tag{C.9}$$

$$c^T + \delta b \leq y^T + q(y^T, b', a'_u)[b' - (1-\delta)b] + a_u - \frac{a'_u}{R} \tag{C.10}$$

$$\mathcal{P}^N(c^T, h, g^N)g^N \leq q(y^T, b', a'_u)[b' - (1-\delta)b] + \tau \left[y_t^T + \mathcal{P}^N(c^T, h, g^N)F(h) \right] \tag{C.11}$$

$$\mathcal{P}^N(c^T, h, g^N)F'(h) \geq \bar{w}, \tag{C.12}$$

$$u_T(c^T, F(h) - g^N) = \beta R \mathbb{E} \left[u_T \left(\mathcal{C}^T(s', b', a'_u), \mathcal{C}^N(s', b', a'_u) \right) \right] + \mu \tag{C.13}$$

$$a'_u \geq -\bar{a}, \mu \geq 0, \mu(\bar{a} + a'_u) = 0. \tag{C.14}$$

In this problem, the last two lines correspond to the additional implementability constraints emerging from household borrowing. We use Θ_t to denote the multiplier associated with the households' Euler equation (C.13).

Tradeoffs. Let us compare here the first-order conditions with respect to Section 3. We have the following first-order conditions with respect to g^N:

$$g^N: \quad v'(g^N) - u_N\Omega(h) - \Theta u_{TN}(c_T^T, c_t^N) + \xi_t F'(h)\frac{\partial \mathcal{P}^N}{\partial g^N} = \eta_t\left(p_t^N + \frac{\partial \mathcal{P}^N}{\partial g^N}(1 - \tau F(h))\right). \tag{C.15}$$

Notice that equation (C.15) is the same as (MSR) in the text if preferences are separable. In addition, we have

$$c^T: \quad c^T: u_T + \xi_t\frac{\partial \mathcal{P}_t^N}{\partial c_t^T} + \Theta_t u_{TT} = \lambda_t \tag{C.16}$$

$$b': \quad (\lambda + \eta_t)(q_t + \frac{\partial q_t}{\partial b_{t+1}}i) + \beta\mathbb{E}\frac{\partial V}{\partial b_{t+1}} - \beta R\Theta_t\mathbb{E}\left[u_{TT}\frac{\partial \mathcal{C}^T}{\partial b} + u_{TN}\frac{\partial \mathcal{C}^N}{\partial b}\right] = 0. \tag{C.17}$$

Relative to (B.13) and (B.14), these two first-order conditions differ because now the choices for consumption and government borrowing affect the implementability constraint associated with the unconstrained households' Euler equation. It is important to take into account that the multiplier Θ_t could be positive or negative, depending on the sign of the aggregate demand externality.

In addition, we have the envelope condition

$$V_b^R(y^T, b, a_u) = (\lambda + \eta)q(y^T, b', a')(1 - \delta). \tag{C.18}$$

Replacing (C.17) and (B.13), we obtain this intertemporal Euler equation :

$$(u_T(t) + \xi_t\frac{\partial \mathcal{P}_t^N}{\partial c_t^T} + \eta_t + \Theta_t u_{TT}(t))\left(q_t + \frac{\partial q_t}{\partial b_{t+1}}i\right) =$$

$$\beta\mathbb{E}_t[(1 - \chi_{t+1})[(u_T(t+1) + \xi_{t+1}\frac{\partial \mathcal{P}_{t+1}^N}{\partial c_{t+1}^T} + \eta_{t+1} + \Theta_{t+1}u_{TT}(t+1))(1 - \chi_{t+1})(\delta + q_{t+1}(1 - \delta))]$$

$$- \beta R\Theta_t\mathbb{E}\left[u_{TT}\frac{\partial \mathcal{C}^T}{\partial b} + u_{TN}\frac{\partial \mathcal{C}^N}{\partial b}\right]. \tag{C.19}$$

Relative to (22), (C.19) has additional terms whenever $\Theta \neq 0$, since the government internalizes how a change in borrowing alters households' savings decisions.

C.5 Numerical Results

figs_oct2022/default_gn_yt_gn_hhdebt-eps-converted-to
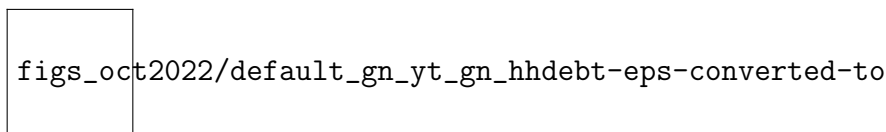
Figure C.1: Government Spending as a Function of y^T in the Extension with Household Borrowing

Notes: This figure shows optimal government spending in the extension of the baseline model with household borrowing, as a function of y^T. Debt is set to its average level. Dashed blue lines correspond to the default model; the dotted vertical lines in black correspond to the default threshold.

(a) Welfare	(b) Unemployment g^N	(c) Aggregate c^N
figs_oct2022/util_counter_paper_gn_hhdebt	figs_oct2022/unemp-counter-paper-gn-hhdebt	figs_oct2022/ctn-counter-paper-gn-hhdebt

(d) p^N	(e) Spreads	(f) Government Borrowing
figs_oct2022/pn_counter_paper_gn_hhdebt-eps-converted-to	figs_oct2022/sp-counter-paper-gn-hhdebt-eps-converted-to	figs_oct2022/debt_counter_paper_gn_hhd

Figure C.2: Welfare, Prices, and Allocations with Alternative Spending

Notes: See note to Figure 7 for details of the exercise and Appendix C for the model with household borrowing. In the figure, we set the current tradable income to one standard deviation below its unconditional mean, and current government and household debt are set to their respective average levels.

D   Numerical Appendix

D.1   Model solution

The model is solved numerically using value function iteration with interpolation. Linear interpolation is used for the endowment and cubic spline interpolation for debt levels. We consider an equidistant grid for tradable endowment of 21 points between 3 standard deviations below and above the unconditional mean. We use 61 gridpoints for debt for the baseline model and 101 for the risk-free debt economy. To compute expectations for continuation values and prices, we use 15 and 11 quadrature points for the endowment realizations, respectively. For each state, conditional on an arbitrary choice of debt, we employ a variant of Brent's method algorithm included in the IMSL library to find the roots of the implementability conditions in the government's problem. To maximize over debt, we then use the UVMIF routine that relies on a quadratic interpolation method. We solve for the optimality conditions under four alternative regimes: with and without a binding wage rigidity constraint and with and without zero lump-sum government transfers. We then compute welfare under the four regimes. Our solution is given by the allocations that deliver the highest utility.

D.2   Simulation Statistics

To compute the business cycle statistics, we run 10,000 Monte Carlo simulations of the model with 10,000 periods each and construct 1,000 subsamples of 32 periods of financial access. The number of periods for each subsample is chosen to roughly match the number of years in our sample period 1980-2012. To avoid dependence on initial conditions, we disregard the first 1,000 periods from each simulation. Also, in our model the borrower regains access to credit with no liabilities after defaulting, whereas in the data countries typically do incure liabilities, and carry a positive amount of debt settled at a restructuring stage. We therefore impose that our candidate subsamples cannot be preceded by reentry episodes for less than 4 years. To anal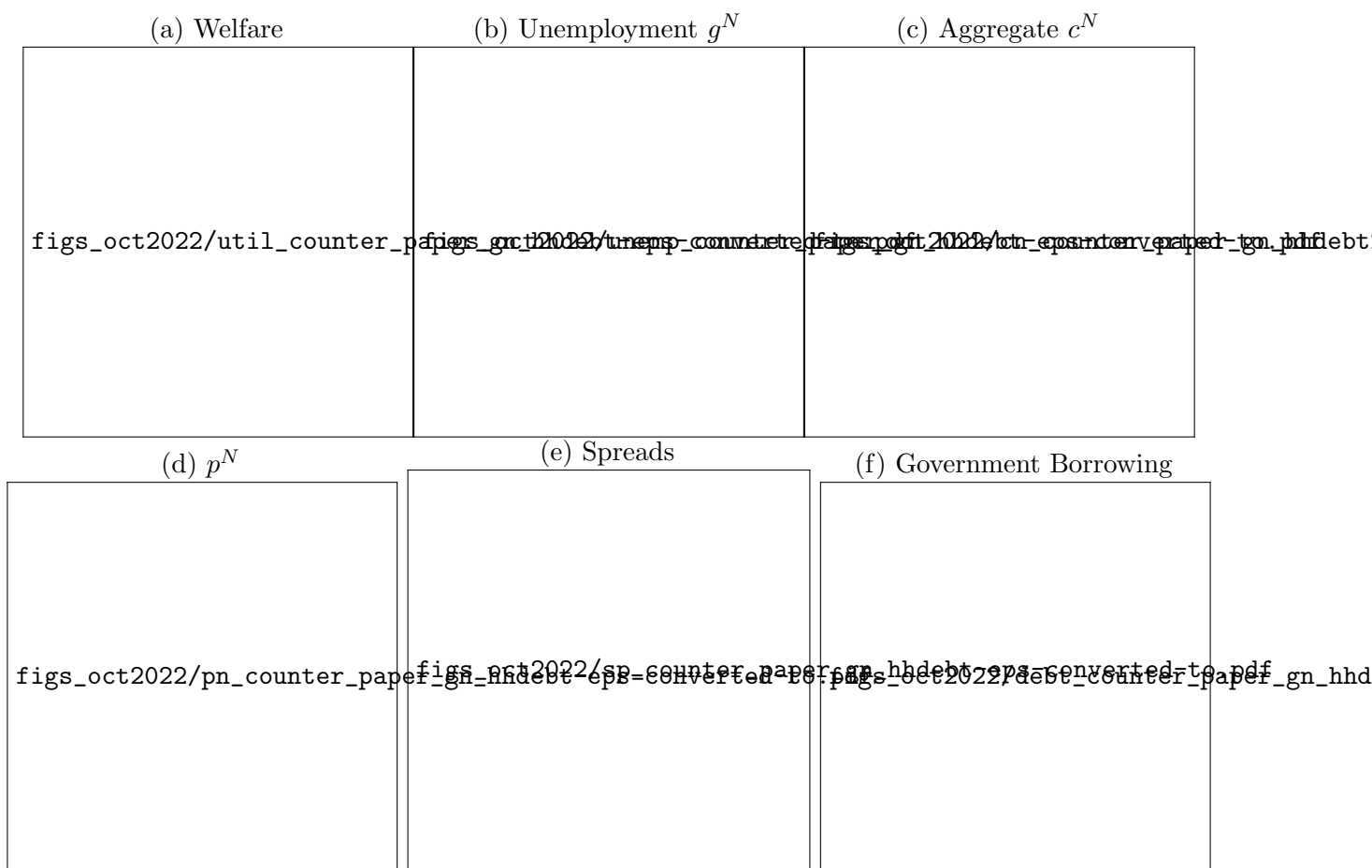yze the economy with no default risk (in the next subsection), we recalibrate the discount factor and the tax rate so that this economy is comparable to the data in terms of external debt and government spending. Also, given the high persistence in the debt dynamics, we run longer simulations for 140,000 periods. After disregarding the initial 100,000 periods, we construct 100,000 subsamples, allowing for $2,000$ periods between consecutive subsample time intervals.

D.3   Computation of welfare gains

We compute conditional welfare gains as the permanent increase in private and public consumption that would leave the household indifferent between living in the economy with a Samuelson rule and switching to the economy with the optimal policy. That is, given a value function V^{SR} of implementing the Samuelson rule, we look for the increase in consumption that is equal to the value of the government under the optimal policy to V^{SR}. For a given initial state and an arbitrary value for the welfare gain, we iterate on the value functions for the Samuelson rule, using the policy functions and default strategies from the baseline Markov equilibrium. Upon convergence, we calculate the sup norm to the difference between the newly computed Samuelson value function and the value function under the optimal policy evaluated at the selected initial

state. If the norm is lower than $1e^{-5}$ in absolute value, we stop and report the welfare gain. If instead it is positive and larger than $1e^{-5}$, we reduce the value of the welfare gain and iterate again on the value function. Otherwise, we increase the welfare gain and iterate again. We repeat this procedure for all the initial states of interest. For unconditional welfare gains, we proceed in a similar fashion, integrating over all states by using an asymptotic distribution of (y^T, b) and ζ, constructed by taking the associated state from the $10,000$th period in each of $10,000$ simulations.

E   Fiscal Rules

In this section we explore quantitatively the implications of of simple fiscal rules for spending. We search for the level of spending that maximizes welfare across the set of policies with constant levels. Table E.1 reports the business cycle statistics and welfare gains for economies with the best rule and compares them with the baseline economy and the one that uses the constant level dictated by the Samuelson rule.

Table E.1:   Fiscal Rules

| Statistic | Baseline | Constant g^N | | Rule $g^N = \alpha_0 + \alpha_1 \log(y^T)$ | |
		Samuelson	Best	$\alpha_1 = +0.1$	$\alpha_1 = -0.1$
Averages (in percent)					
mean(spreads)	1.09	1.85	1.32	1.95	1.76
mean(debt/y)	22.6	21.2	17.2	20.9	21.6
mean($p^N g^N/y$)	18.2	12.7	15.3	12.7	12.6
Correlations with GDP					
corr(GDP,g^N)	0.72	0	0	0.96	$--0.94$
corr(GDP,c)	0.98	1.00	1.00	1.00	1.00
corr(GDP,spreads)	-0.95	-0.94	-0.71	-0.94	-0.94
corr(GDP,unemployment)	-0.44	-1.00	-1.00	-1.00	-1.00
Volatilities (in percent)					
σ(GDP)	4.3	4.3	3.9	4.6	4.1
$\sigma(p^N g^N)/\sigma$(GDP)	2.0	0	0	0.5	0.6
$\sigma(c)/\sigma$(GDP)	1.1	1.3	1.3	1.2	1.4
σ(spreads)	0.7	0.9	1.4	1.0	0.9
σ(unemployment)	5.6	5.2	4.8	5.6	4.8
Welfare losses (in percent)	0	3.263	1.35	3.41	3.15

Notes: This table reports business cycle and welfare statistics for the baseline model and extensions with fiscal rules. Fiscal rules are adopted only when the government repays. The column with best g^N corresponds to the optimal constant level of spending, which is 0.18. For the rules with variable spending, α_0 is set to the Samuelson level of g^N. The variables GDP and y denote total output at constant and current prices, respectively. Welfare losses are expressed as permanent increase in total consumption across all states of nature that renders the government indifferent between staying in the baseline economy or moving to the economy with the fiscal rule, when initial debt is zero and y^T is equal to its unconditional mean.

F Additional Details of Calibration

F.1 Additional Tables and Figures from the Quantitative Analysis

Table F.1: Targeted Moments in Calibration

Parameter	Value	Target statistic	Data	Model
Risky Debt				
β	0.907	External debt/GDP	22.8%	22.6%
ψ_χ^0	0.3277	Average bond spread	1.05%	1.09%
ψ_χ^y	2.42	Volatility of bond spreads	1.4%	0.7%
ψ_g	0.02	Average govt. spending/GDP	18.1%	18.2%
τ	0.19	Volatility of govt. spending/GDP	2.0	2.0
$\bar{w}$	3.068	Increase of unemployment	2.5%	2.5%
Risk-free Debt				
β	0.98037	External debt/GDP	22.8%	22.4%
ψ_g	0.12	Average govt. spending/GDP	18.1%	18.6%

F.2 Model Computations and Data Analogues

The parameter δ is set to match the Macaulay duration of bonds in the data. We compute in the model the duration of a bond with price q and our coupon structure as follows:

$$D = \sum_{t=1}^{\infty} t \frac{\delta}{q} \left(\frac{1-\delta}{1+i_b} \right)^t = \frac{1+i_b}{\delta+i_b},$$

where the constant per-period yield i_b is determined by $q = \sum_{t=1}^{\infty} \delta (\frac{1-\delta}{1+i_b})^t$.

The debt level in the model is computed as the present value of future payment obligations discounted at the risk-free rate r. Given our coupon structure, we thus have that the debt level is given by

$$\frac{\delta}{1 - (1-\delta)/(1+r)} b_t.$$

F.3 Data Series and Sources

The following data were used in the model's calibration for Spain:

1. Tradable endowment process: Estimated using data on the value added in the agricultural and manufacturing sectors at constant prices, log-quadratically detrended, period 1980-2011. Data source: National Accounts in the National Statistics Office (INE).

2. Ratio of tradable output to total output: Average ratio of the value added in the agricultural and manufacturing sectors over total value added in current prices, period 1980-2011. Data source: INE.

3. Ratio of debt to GDP: Total gross debt of the general government held by external creditors, period 1996-2015. Data source: OECD government.

4. Bond spreads: Difference between Spanish and German 5-year sovereign bond yields, period: 2000-2015. Data source: Bank of Spain and Deutsche Bundesbank.

5. Government spending: Ratio of general government final consumption expenditure to GDP, in current prices, period 1996-2015. Data source: WDI.

6. Unemployment: Unemployment rate, period 1996-2015. Data source: INE.

In addition, we calibrated the risk-free rate to match the average annual gross yield on 5-year German government bonds over the period 2000-2015.

G   Sensitivity Analysis

Table G.1:   Sensitivity Analysis

Statistic	mean(spreads)	mean(debt/y)	corr(GDP,g^N)	corr(GDP,spreads)	$\sigma(p^N g^N)/\sigma(\text{GDP})$	$\sigma(\text{unemp.})$
Baseline	1.09	22.6	0.72	-0.95	2.0	5.6
Alternative parameterizations						
Low β ($\beta = 0.867$)	1.85	24.6	0.76	-0.95	1.9	6.5
High β ($\beta = 0.947$)	0.46	18.8	0.64	-0.94	1.9	4.3
Low default cost ($\psi_\chi^0 = 0.307$)	1.60	15.3	0.60	-0.95	2.1	4.7
High default cost ($\psi_\chi^0 = 0.447$)	0.78	31.5	0.82	-0.95	1.9	6.4
10-year maturity	2.2	24.0	0.64	-0.91	2.1	4.8
Less UI ($\kappa = 0.4$)	1.12	11.6	0.43	-0.85	3.0	3.9
Higher UI ($\kappa = 1$)	1.06	25.4	0.74	-0.96	1.9	5.7
Low τ ($\tau = 0.17$)	1.25	22.1	0.91	-0.96	1.7	6.5
High τ ($\tau = 0.21$)	0.97	22.9	0.29	-0.94	3.2	4.2
Lump sum taxes	1.03	26.4	-0.90	-0.83	19.5	0.0
Flexible taxes	1.21	21.9	0.47	-0.95	2.1	5.2
Recalibrations						
Higher public debt (40% of GDP)	1.00	40.3	0.69	-0.89	1.8	5.2
Low default cost ($\psi_\chi^0 = 0.307$)	12.9	22.5	0.88	-0.97	1.9	7.6
High default cost ($\psi_\chi^0 = 0.447$)	0.19	22.7	0.69	-0.93	1.5	4.1

Notes: This table reports business cycle statistics for the baseline and alternative models. In the economy with flexible taxes, the tax-smoothing parameter is set to match the average volatility of tax rates in the data and reference tax rate is calibrated to match average government spending. In the recalibration of the baseline model with low and high default costs, the discount factor β is set to match the average debt-to-GDP in the data. All targeted moments in the recalibration with high public debt are identical to that of the baseline, with the exception of the average debt which is set to 40 percent of GDP (2014 level for Spain). Bond spreads are computed as the differential between the annual sovereign bond return and the annual risk-free rate. The variables *GDP* and y denote total output at constant and current prices, respectively.

Table G.2: Business Cycle Statistics: Data and Model for Greece and Brazil

Statistic	Greece		Brazil	
	Data	Model	Data	Model
Averages (in percent)				
mean(spreads)	1.81	1.60	4.61	4.60
mean(debt/y)	23.0	22.8	21.5	21.5
mean($p^N g^N/y$)	19.0	19.0	19.1	18.8
Correlations with GDP				
corr(GDP,g^N)	0.73	0.36	0.89	0.91
corr(GDP, c)	0.85	1.0	0.96	0.99
corr(GDP,spreads)	0.00	-0.92	-0.16	-0.96
corr(GDP,unemployment)	-0.83	-0.79	-0.79	-1.00
Volatilities (in percent)				
σ(GDP)	3.5	4.4	4.3	5.6
$\sigma(p^N g^N)/\sigma$(GDP)	1.5	1.6	0.7	1.5
$\sigma(c)/\sigma$(GDP)	1.0	1.0	1.3	1.1
σ(spreads)	3.4	1.5	3.4	1.4
σ(unemployment)	1.3	5.0	1.8	7.2

Notes: This table reports business cycle statistics for the data and the baseline model recalibrated for Greece (1995-2010) and Brazil (1996-2019). Bond spreads are computed as the differential between the annual sovereign bond return and the annual risk-free rate. The variables *GDP* and y denote total output at constant and current prices, respectively.

Figure G.1: Role of persistence

Notes: In this figure we compare the policy function of the baseline model with the policy function in response to a one-time unanticipated shock. The figure shows that if the shock is expected to last for one period only, the government responds in a more countercyclical fashion.

Figure H.1: This figure plots (i) the variation in g^N in response to a marginal increase in y^T for all current states of y^T and debt (expressed as percentage of steady-state GDP), shown in shades of blue; (ii) the default region in the state space, shown in light red; (iii) the ergodic distribution of the state vector in the economy, shown by the black markers in the scatterplot (each marker corresponds to a simulation). Darker blue shades are used for higher values.

H   Additional Details on State Dependence

As explained in Section 4.3, the optimal government spending response to a negative shock is highly dependent on debt levels. In Figure 5, we presented the response for two values of debt. Here we present a more systematic analysis of the state dependence.

The state dependence is graphically illustrated in Figure H.1. For all debt and tradable income levels, we compute the variation of spending in response to a marginal increase in tradable income and plot it in a heatmap when repayment is optimal. We use different shades of blue to indicate the size of the variations, ranging from dark blue for large positive variations (of one or higher) to light blue for negative variations (of -1 or less). We also plot in light red the default region. Finally, we include a scatter plot for the ergodic distribution of the state vector (in which each black point corresponds to a different simulation).

Several features stand out in this figure. First, as in other studies, default typically happens for low income and high debt. Second, we can see three clear regions in blue when the government repays. The dark blue region is where austerity is optimal: Spending rises for favorable income realizations and falls for adverse ones. In this austerity region default risk is substantial. For somewhat lower debt or higher income levels, we have an intermediate region with regular blue wherein spending moderately falls as income rises. To the left, for even lower debt or higher income, we have a more Keynesian region, shown in lighter blue. Spending can fall significantly in that region in response to a positive shock. We can see all of the relevant debt "tipping points"; for instance, when current y^T is set to its unconditional mean of 1. Default is optimal when debt is around 30% of steady-state GDP or higher; austerity is optimal for debt levels around roughly 20 and 30%; moderate Keynesian policy is optimal for debt levels roughly around 15% and 20%; and stronger Keynesian policy is prescribed for debt levels below 15%. Is is worth noting that within the Keynesian region shown in lighter blue, the blue shade becomes gradually darker as we move to the left (i.e. reducing debt). This happens because spending variations become smaller and approaches zero as the optimal spending g^N converges to the Samuelson level (region not shown in figure).

Third, the ergodic distribution shows that the economy inhabits the austerity region roughly as much as the Keynesian region. The fact that the absolute variation in spending in the former region is around a third of that in the latter demonstrates the strong correlation between spending and output in the simulations.

17

I Fiscal Programs

In this section, we explore the effects of fiscal programs that are either self-imposed, for example via a fiscal rule, or alternatively dictated by a third party. Specifically, we take as given that some form of commitment to spending is feasible and ask: How should a fiscal program be designed? Our analysis yields three key results. First, fiscal programs can have starkly different implications, depending on the timing of when spending cuts are implemented. Second, a non-state-contingent commitment can improve welfare under a flexible discretionary regime. Third, if the commitment can be made state-contingent, it is optimal to cut spending in intermediate income states.[43]

I.1 Current Spending Cuts

The first exercise we consider is an exogenous one-period cut in current government spending, after which the equilibrium reverts to the Markov equilibrium in the following period. Namely, if the government wishes to remain in good credit standing, it has to follow an exogenously imposed amount of spending. The government can still choose to default, in which case it can freely choose the amount of transfers and spending.

This simple policy reduces the value of repayment by restricting current government choices in good credit standing while the value of default remains unaffected. Clearly, this renders default more attractive, a result we formalize below.

Proposition I.1. *Consider an initial level of debt b and a shock y^T. If the government finds it optimal to default under no fiscal program, it also finds it optimal to default when there is an imposed cut on current government spending. Moreover, there exists a spending cut such that the government defaults with an imposed spending cut but not without it.*

A more subtle aspect of this forced spending cut is the question of when forced austerity is more likely to backfire. To answer this, we examine the spending cut that would push the government to default. Specifically, we compute what would be the amount of current government spending as a fraction of the Samuelson level that would render the government indifferent between repaying and defaulting. The left panel of Figure I.1 shows that when income is low, a low level of austerity is sufficient to precipitate default. For high income, the government does not find default very attractive, and would therefore choose to remain in good credit standing even with substantial cuts imposed on spending. Similarly, as shown in the right panel, the lower the current debt, the less sensitive the repayment decision is to imposed spending cuts.

These findings shed light on the design of fiscal rules, which we will explore in the next section. If the government is close to default, imposing austerity (beyond the optimal amount chosen by the government) can be harmful. Importantly, both the government and investors are ultimately worse off. On the other hand, if the government is relatively further from defaulting, even a moderate spending cut would not trigger default. Moreover, the spending cut reduces debt accumulation and future incentives to default. In this case, investors who hold government bonds would benefit ex post as the market value of the outstanding government debt rises.

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[43]Several countries including Germany and Spain have amended the Constitution to improve the enforceability of fiscal rules. See Hatchondo, Martinez and Roch (2021) for further background evidence. Regarding fiscal programs dicated by third parties, Greece is a prominent recent example. In exchange for a fiscal consolidation in the form of the privatization of government assets, public-sector wage cuts, pension cuts, and higher taxes, the Greek government received several bailout loans from 2010 onward (see Gourinchas, Martin and Messer, 2018).

figs_oct2022/default_welfare_aust_yT-eps-converted-to.pdf figs_oct2022/default_welfare_aust_debt-eps-conver
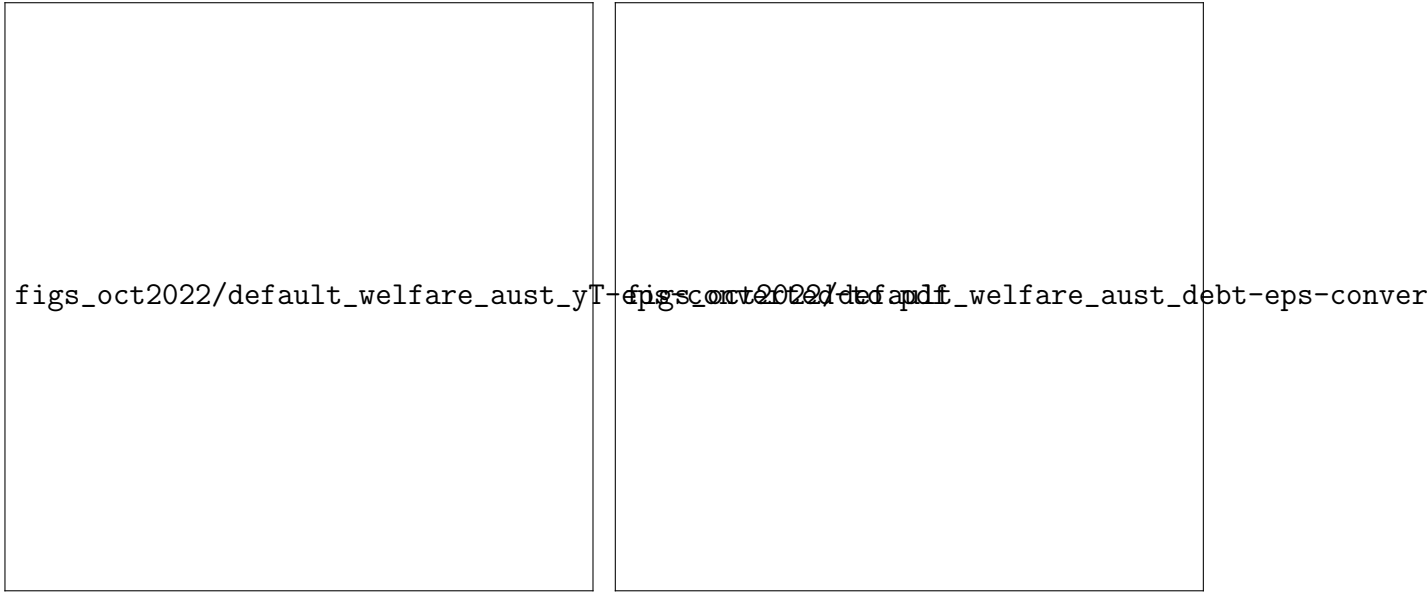
Figure I.1: Effects of Austerity on the Incentives to Default.

Notes: This figure shows the percentage difference relative to the Samuelson level of current public spending that would render the government indifferent between repaying its debt and defaulting, as a function of current y^T, given current debt equal to the average level (left panel), and as a function of debt, given y^T set to its unconditional mean (right panel). From next period on, allocations are assumed to take the equilibrium levels.

I.2 Fiscal Forward Guidance

We now investigate an alternative form of fiscal consolidation based on *future* spending cuts. We refer to this policy as "fiscal forward guidance." We address two questions. First, can spending cuts imposed in the future improve welfare? And second, how should the spending cuts be designed?

The experiment we consider imposes cuts on next-period government spending (g_{t+1}^N). In period t the government continues to choose all available policies, while in the next period, the government chooses borrowing and repayment subject to the restriction whereby the spending cut is implemented. We also assume that lump-sum transfers remain fixed at their optimal levels and that in the period after the consolidation $(t+2)$, the economy reverts to the Markov equilibrium.

We consider two forms of fiscal forward guidance, depending on whether future cuts are predetermined or allowed to be contingent on the state of nature tomorrow. Different from the current spending cuts analyzed above, we will show that a reduction in next-period spending can generate positive effects on the economy. Less spending in the future implies less debt accumulation, which reduces incentives to default in the future and allows the government to borrow more cheaply today—and, in turn, renders stimulus less costly.

The non-state-contingent austerity program specifies a fixed percentage cut in spending relative to the optimal level, regardless of the state of nature tomorrow. On the other hand, the state-contingent austerity program allows for the possibility that spending cuts are contingent on the level of economic activity. In particular, we consider a spending cut that is active only when total income y, given by $y^T + p^N y^N$, is within a subset of future income values. Both the size of the constant spending cut within the subset and the subset itself are selected to maximize welfare.

Figure I.2: Welfare Gains as Function of Size of Spending Cut

Notes: This figure shows the welfare gains for non-state-contingent (dashed blue line) and state-contingent (solid red line) spending cuts next period, as a function of the size of the spending cut. State-contingent spending cuts are implemented if total income $y \equiv y^T + p^N y^N$ lies within the range $[\underline{y}, \overline{y}]$, where $\underline{y}$ and $\overline{y}$ are set to 22% below and 3% above average total income, respectively. Welfare gains are expressed as (percentage) increases in current total consumption under the optimal policy regime to be indifferent to the corresponding austerity measure. The current state features debt equal to 20% above its mean and tradable income given by its unconditional mean.

The advantage of the state-contingent austerity program is that spending cuts can be targeted to the "right" state tomorrow. As it turns out, we find that it is optimal to promise a spending cut only for intermediate values of next-period income (see Appendix Figure I.5). If income is sufficiently low, a spending cut can push the government to default tomorrow (for the reasons explained above), which would increase rather than decrease sovereign spreads today. It is also not optimal to promise a spending cut if income is excessively high tomorrow. The reason is that when income is very high, the interest rate at which the government borrows is closer to the risk-free rate and becomes fairly insensitive to lower debt accumulation. As a result, promising a cut in these states will generate a distortion in the allocation of resources across private and public consumption, with modest gains in terms of lower spreads today.

For each case, we look for the optimal spending cut given the initial conditions considered. We focus on an initial debt value of 20% above the mean and an income equal to its unconditional mean.[44] For the non-state-contingent case, the optimal cut is 3%. For the state-contingent cut, the optimal cut reaches 4%. Under a state-contingent cut, the promised cut is larger because it is implemented only in states in which it is beneficial. Moreover, in line with the mechanisms highlighted above, the income states in which it is optimal to promise the spending cut are between 22% below the unconditional mean of output and 3% above the unconditional mean of total income.

Figure I.2 shows the welfare gains of implementing these austerity programs for a range of spend-

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[44]Appendix Figure I.4 shows how welfare gains vary with the current state for non-state-contingent cuts.

Table I.1: Current and Future Fiscal Austerity

Variable	Current spending cut	Promised non-state-contingent spending cut	Promised state-contingent spending cut
p^N (%)	-0.527	0.111	0.121
debt (%)	-1.227	0.162	0.161
c^T (%)	-1.433	0.304	0.332
unemp (ppts)	1.800	-0.382	-0.420
g^N (%)	-3.000	0.636	0.696
spreads (ppts)	-0.178	-0.103	-0.137
welfare gain (%)	-0.052	0.071	0.083

Notes: Initial responses of key variables and welfare gains for different austerity measures. These measures are a promised spending cut next period in all states (column 1) and a current spending cut (column 2), both of 3%. Column 3 corresponds to a promised spending cut of 4% next period only if total income $y \equiv y^T + p^N y^N$ lies within the range $[\underline{y}, \overline{y}]$, where $\underline{y}$ and $\overline{y}$ are set to 22% below and 3% above average total income, respectively. Welfare gains are expressed as the (percentage) increases in current total consumption that would render households indifferent between remaining under the baseline policy and switching to the alternative. Variations in p^N, debt, c^T, and g^N are reported as percentages relative to optimal baseline levels without any austerity measure. Variations in spreads and unemployment are expressed in percentage points. The current state features debt equal to 20% above its mean and tradable income y^T given by its unconditional mean.

ing cuts. (For the state-contingent cut, we keep the interval for total income at $[-0.22\%, 0.03\%]$ from its mean level.) Welfare gains are measured as the percentage increase in current private consumption that households are willing to give up to implement the austerity program. The dashed blue line shows the welfare gain from non-state-contingent cuts, and the solid red line shows the gain for state-contingent cuts. The maximum welfare gains are, respectively, 0.075% and 0.088% for the non-state-contingent and state-contingent programs. Notice that although both programs require commitment to execute the spending cut, these results show that even a 1-year-ahead commitment can be very effective in providing more scope for stimulus. To the extent that fiscal budgets, once approved, are difficult to change, this assumption does not seem to be very strong.

To shed light on the sources of these welfare gains, in Table I.1 we show the impact of these future austerity programs on today's key macro variables. The table shows that the non-state-contingent spending cut allows the government to borrow more cheaply and facilitates stimulus, which in turn helps to reduce unemployment. In particular, spreads drop by 0.1% despite the increase in borrowing, and unemployment is reduced by almost 0.3 percentage points relative to the no-austerity plan. Notably, relative to the baseline economy, the risk of observing a default in the next period actually rises by 0.1% with the austerity program, but then drops by 1.41% in the following period. Under a state-contingent austerity plan, the government engages in even more stimulus, which further reduces unemployment and achieves higher welfare gains.

To sum up, we find that in the midst of a recession with high sovereign default risk, there is a significant role for an austerity program that involves future spending cuts. An important qualification is that the program cannot be too aggressive, since it risks increasing default incentives and worsening borrowing conditions today. Hence the program must be carefully

designed, given the projections of expected economic activity. In particular, the more protracted the recession, the more delayed the spending cuts should be. Moreover, the desirability of fiscal forward guidance can vary with the initial conditions. The general lesson is that the more sensitive the borrowing costs are, the higher the potential benefits from fiscal forward guidance.

Figure I.3: Welfare gains: optimal policy versus Samuelson rule

Notes: This figure shows the welfare gains in the default model of optimal policy relative to the Samuelson rule. The solid blue line represents average conditional welfare gains as a function of y^T. For each value of y^T, we set debt equal to the average level implied by the ergodic distribution for that y^T. The horizontal dashed black line is the unconditional gain. Welfare gains are expressed in terms of a permanent increase in total consumption.

I.3   Proof of Proposition I.1

Proof. Denote by $V^{R,Austerity}(y^T, b; \bar{g}^N)$ the value of repayment under a fiscal program program that imposes $\bar{g}^N$. By definition, we have $V^{R,Austerity}(y^T, b; 0) = V^R(y^T, b)$. Consider (b, y^T) such that the government finds it optimal to default under no fiscal program. We have $V^R(y^T, b) <$

Figure I.4: Welfare gains from promised non-state-contingent spending cuts

Note: This figure shows the welfare gains from promising non-state-contingent spending cuts next period of 3%, as a function of tradable income y^T (left panel) and as function of debt (right panel). Debt is set to 20% above its average in the left panel and y^T is equal to its unconditional mean in the right panel. Welfare gains are expressed as (percentage) increases in current total consumption under the optimal policy regime to be indifferent with the promised spending cut.

$V^D(y^T)$. We have

$$V^{R,Austerity}(y^T, b; \bar{g}^N) = \max_{b', T \geq 0, h \leq 1} \{u(c^T, F(h) - g^N)\Omega(h) + v(g^N) + \beta \mathbb{E} V(y^{T'}, b') \tag{I.1}$$

subject to

$$c^T = y^T + q(y^T, b')[b' - (1-\delta)b] + \delta b$$

$$\mathcal{P}^N(y^T, h, g^N)\bar{g}^N + \delta b + T = q(y^T, b')[b' - (1-\delta)b] + \tau \left[P_t^T y_t^T + \mathcal{P}^N(y^T, h, \bar{g}^N)F(h) \right]$$

$$\mathcal{P}^N(y^T, h, \bar{g}^N)F'(h) \geq \overline{w}.$$

Comparing (I.1) with (17) in the main text, it follows that $V^{R,Austerity}(y^T, b; \bar{g}^N) \leq V^R(y^T, b)$. Since the value of default under the spending cut is unaffected, we can use that $V^R(y^T, b) < V^D(y^T)$, to show that $V^{R,Austerity}(y^T, b; \bar{g}^N) < V^D(y^T)$, which completes the first part of the proof.

Now consider (b, y^T) such that the government repays under no fiscal program. We have that $V^R(y^T, b) > V^D(y^T)$. Consider a spending cut such that $\bar{g}^N$ is arbitrarily close to zero. Using the Inada condition for the utility of public spending, we have that $\lim_{\bar{g}^N \to 0} V^{R,Austerity}(y^T, b; \bar{g}^N) = -\infty$. By continuity, it follows that there exists $\bar{g}^N > 0$ such that $V^R(y^T, b) > V^D(y^T) > V^{R,Austerity}(y^T, b; \bar{g}^N)$, completing the proof.

$\square$

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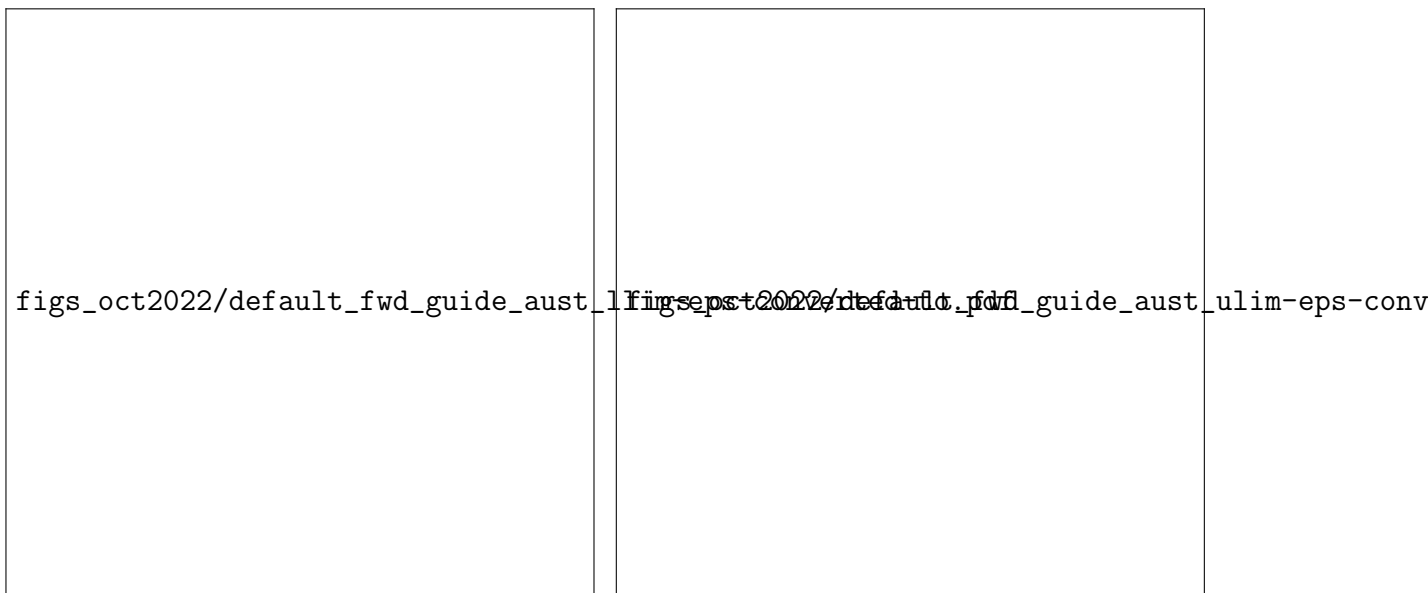
Figure I.5: Welfare gains from Well-designed promised spending cuts

Note: This figure shows the welfare gains from promising spending cuts of 4% for next period whenever total income $y \equiv y^T + p^N y^N$ lies within the range $[\underline{y}, \overline{y}]$. The left panel plots welfare gains as a function of $\underline{y}$ with $\overline{y}$ set to 3% above the average total income. The right panel plots welfare gains as a function of $\overline{y}$ with $\underline{y}$ set to 22% below the average total income. Welfare gains are expressed as (percentage) increases in current total consumption under the optimal policy regime to be indifferent with the promised spending cut. The current state features debt equal to 20% above its mean and tradable income y^T given by its unconditional mean.

J   Appendix of Empirical Analysis

J.1   Additional Figures and Tables

Notes: This table lists the set of countries used in Section 5, which have more than 15 years of data on government consumption, GDP, and sovereign credit ratings for the period 1980-2016.

Table J.1: Countries included in the empirical analysis

Argentina	Cyprus	Iceland	Morocco	Singapore
Australia	Czech Rep.	India	Netherlands	South Africa
Austria	Denmark	Indonesia	New Zealand	Spain
Belgium	Dominican Rep.	Ireland	Norway	Sweden
Belize	Ecuador	Israel	Pakistan	Switzerland
Bolivia	Egypt	Italy	Panama	Thailand
Botswana	El Salvador	Japan	Paraguay	Trinidad and Tobago
Brazil	Finland	Jordan	Peru	Tunisia
Bulgaria	France	Kazakhstan	Philippines	Turkey
Canada	Germany	Korea	Poland	United Kingdom
Chile	Greece	Lebanon	Portugal	United States
China	Guatemala	Luxembourg	Romania	Uruguay
Colombia	Hong Kong	Malaysia	Russia	Venezuela
Costa Rica	Hungary	Mexico	Sierra Leone	

Table J.2: Cyclicality of Government Spending around the World: Summary Statistics

(a) Moments for first-differenced data

	σ_G/σ_Y	$corr(G_t, G_{t-1})$	$corr(G, Y)$
Mean	1.70	0.22	0.29
Median	1.29	0.22	0.29
Standard deviation	1.19	0.28	0.21
95th percentile	4.04	0.63	0.65
5th percentile	0.61	-0.22	-0.05

(b) Moments for HP-filtered data

	σ_G/σ_Y	$corr(G_t, G_{t-1})$	$corr(G, Y)$
Mean	1.63	0.54	0.33
Median	1.22	0.56	0.33
Standard deviation	1.09	0.18	0.26
95th percentile	4.18	0.77	0.74
5th percentile	0.58	0.20	-0.12

Notes: This table shows summary statistics of real per capita government consumption and GDP for the set of countries listed in Table J.1. Panel (a) reports moments computed in the first differences of the log of these variables. Panel (b) reports moments computed on the cyclical component of HP-filtered variables with a smoothing parameter of 100. The variables σ_G/σ_Y, $corr(G_t, G_{t-1})$, and $corr(G, Y)$ denote, respectively, the ratio of the standard deviation of government consumption to the standard deviation of output, the first-order autocorrelation of government consumption, and the correlation between government consumption and output. For more details on these data, see Section 5.

Table J.3: Credit Ratings and Sovereign Default Rates by Country

Country	Minimum rating	Mode rating	Hist. default	Country	Minimum rating	Mode rating	Hist. default
Argentina	Default	B	0.02	Kazakhstan	B	BBB	
Australia	AA	AAA	0	Korea	BB	A	0
Austria	AA	AAA	0.04	Lebanon	CCC	B	
Belgium	AA	AA	0	Luxembourg	AAA	AAA	
Belize	CCC	B		Malaysia	BBB	A	
Bolivia	B	B	0.02	Malta	BBB	A	
Botswana	A	A		Mexico	BB	BBB	0.15
Brazil	B	BB	0.06	Mongolia	B	B	
Bulgaria	B	BBB		Morocco	BB	BB	
Canada	AA	AAA	0	Netherlands	AA	AAA	0.01
Chile	BBB	A	0.03	New Zealand	AA	AA	0
China	BBB	BBB	0.01	Norway	AAA	AAA	0
Colombia	BB	BBB	0.1	Oman	BBB	BBB	
Costa Rica	BB	BB	0.06	Pakistan	Default	B	
Cyprus	CCC	A		Panama	BB	BB	0.03
Czech Rep.	BBB	A		Paraguay	Default	B	0.04
Denmark	AA	AA	0	Peru	BB	BB	0.04
Dominican Rep.	CC	B	0.08	Philippines	BB	BB	
Ecuador	CCC	B	0.13	Poland	BB	BBB	0.07
Egypt	CCC	BB	0.01	Portugal	BB	AA	0.03
El Salvador	B	BB	0.06	Romania	B	BB	0.02
Finland	AA	AAA	0	Russia	Default	BBB	0.03
France	AA	AAA		Singapore	AA	AAA	0
Germany	AAA	AAA	0.03	South Africa	BB	BBB	0
Greece	CC	BBB	0.04	Spain	BBB	AA	0.06
Guatemala	BB	BB	0.08	Suriname	B	B	
Hong Kong	A	A		Sweden	AA	AAA	
Hungary	BB	BBB	0.07	Switzerland	AAA	AAA	
Iceland	BBB	A	0	Thailand	BBB	BBB	0
India	BB	BB		Trinidad and Tobago	BB	A	
Indonesia	Default	BB		Tunisia	BB	BBB	
Ireland	BBB	AA	0	Turkey	B	BB	0.14
Israel	BBB	A		United Kingdom	AA	AAA	0.01
Italy	BBB	AA	0	United States	AA	AAA	0
Jamaica	CCC	B		Uruguay	B	BBB	0.04
Japan	A	AAA	0	Venezuela	CCC	B	0.07
Jordan	B	BB					

corr(minimum rating, mode rating)= .83
corr(minimum rating, historical sovereign external default rate)= .42
corr(mode rating, historical sovereign external default rate)= .54

Notes: This table reports moments of credit ratings for countries and historical sovereign default rates included in the empirical analysis in Section 5. Moments for credit ratings were computed with S&P ratings for the period 1980 to 2016, obtained from Bloomberg. Historical default rates were computed from Reinhart and Rogoff (2009)'s dataset for the period with available data before WWII, using the variable "sovereign external debt crises" from their dataset. This includes outright default on payments of debt obligations incurred under foreign legal jurisdiction, including nonpayment, repudiation, or the restructuring of debt into terms less favorable to the lender than in the original contract. To compute correlations involving credit ratings, we map credit ratings to integers assigning AAA to 1, AA to 2,..., C to 9, and sovereign default to 10.

(a) Sovereign risk measured by historical default probability

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

files_revision_empirical/final/emp_dynam/...

(b) Sovereign risk measured by credit ratings

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

files_revision_empirical/final/emp_dynam/...
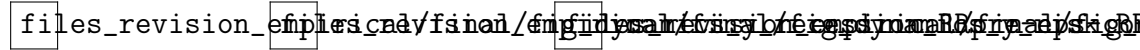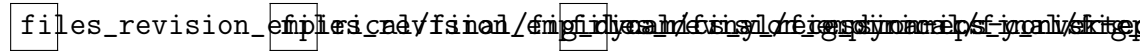
Figure J.1: Dynamics of GDP During Recession Episodes by Sovereign Risk and Foreign Liabilities

Notes: Results from estimating

$$\log y_{jt+s} - \log y_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s}\Delta \log y_{jt-1} + \rho_{2s}\ell_{jt-1} + \mathbf{\Gamma}'_s\text{recession}_{jt}X_{jt-1} + \epsilon_{sjt},$$

where y_{jt} is the real GDP per capita of country j in period t; α_j is a country fixed effect; recession_{jt} is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk_j denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector of controls that includes the log of the average GDP per capita of country j and the interaction of this variable with ℓ_{jt-1}. In Panel (a), sovereign risk is measured with a dummy variable that takes a value of one if the historical default rate of country j is above 1% and zero otherwise (see Section 5 for details); in Panel (b), sovereign risk is measured with a dummy variable that takes the value of one if the country ever had a rating below AA. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands.

J.2 Recession episodes

Using the data on GDP per capita described in Section 5, we identify recession episodes following the algorithm in Calvo et al. (2014), which proceeds as follows:

1. For each country i, identify the first recession episode with the first period in which there is a per capita output contraction, i.e., $t_c(i, 1) \in [1, T_i]$ such that $y_{t_c(i,j)} < y_{t_c(i,j)-1}$ for $j = 1$, where T_i denotes the last year with available data for country i.

2. Define the *peak* of recession episode j as the period immediately preceding the output contraction that identifies the recession episode: $t_P(i, j) \equiv t_c(i, j) - 1$.

3. Define the *recovery point* of recession episode j as the period $t_R(i, j) \geq t_c(i, j)$ in which per capita output recovers its peak level: $y_{t_R(i,j)} \geq y_{t_c(i,j)}$. If there is no recovery point when the data end or there are more than 8 years between peak and recovery point, the regression is excluded from the analysis.

4. Define the *trough* of the recession episode as the period $y_{t_R(i,j)}$ with the minimum level of per capita output between the peak and recovery points.

5. Repeat steps (1)-(3) for $j = 2, 3, ..$ until there are no more output contractions in that country after the last recovery point.

We apply this procedure to countries in the sample listed in Table J.3. For the countries in our sample that were members of the Soviet Union, we exclude their data before 1994 to exclude from our sample recession episodes associated with the transition from soviet to market economies in the early 1990s (and any recessions that occurred during their soviet period). For the rest of the countries, we identify recessions in the period 1980-2016. We obtain a sample of 308 recession episodes, listed in Tables J.4 and J.5, that report the peak and trough of each recession and the change in real GDP per capita in the first year of the recession from peak to trough.

Table J.4: Sample of Recession Episodes (Part I)

Country	Peak	Trough	GDP change Initial	P-T	Country	Peak	Trough	GDP change Initial	P-T
Argentina	1980	1982	-8.6	-15.8	Chile	2008	2009	-3.5	-3.5
Argentina	1983	1985	-1.0	-11.3	Colombia	1987	1989	0.0	-0.6
Argentina	1986	1990	-0.2	-19.5	Colombia	1990	1991	-1.5	-1.5
Argentina	1994	1995	-5.3	-5.3	Colombia	1992	1993	-1.2	-1.2
Argentina	1998	2002	-5.5	-25.3	Colombia	1995	1996	-1.2	-1.2
Argentina	2008	2009	-7.8	-7.8	Colombia	1997	2002	-2.4	-9.4
Argentina	2011	2012	-3.1	-3.1	Colombia	2000	2002	-1.2	-1.6
Australia	1982	1983	-4.8	-4.8	Colombia	2008	2009	-0.6	-0.6
Australia	1986	1987	-0.6	-0.6	CostaRica	1984	1991	-4.1	-6.8
Australia	1990	1992	-3.0	-4.9	CostaRica	1987	1991	-1.2	-4.9
Australia	2000	2001	-0.5	-0.5	CostaRica	1993	1996	-0.6	-5.0
Australia	2005	2006	-0.2	-0.2	CostaRica	1998	2002	-0.4	-0.9
Austria	1980	1981	-0.3	-0.3	CostaRica	2008	2009	-3.6	-3.6
Austria	1992	1993	-1.1	-1.1	Cyprus	1990	1991	-4.0	-4.0
Austria	2002	2003	-0.2	-0.2	Cyprus	1992	1993	-3.9	-3.9
Austria	2008	2009	-4.4	-4.4	Cyprus	1995	1997	-2.3	-3.2
Belgium	1980	1981	-0.4	-0.4	Cyprus	2002	2003	-0.4	-0.4
Belgium	1992	1993	-1.7	-1.7	Cyprus	2007	2014	-0.4	-22.6
Belgium	2002	2003	-0.2	-0.2	Czech Rep.	1996	1998	-0.4	-0.5
Belgium	2007	2013	-0.8	-5.7	Czech Rep.	2008	2009	-5.9	-5.9
Belgium	2010	2013	-0.3	-2.3	Czech Rep.	2011	2013	-1.1	-1.7
Belize	1980	1986	-3.3	-23.0	Denmark	1987	1988	-0.2	-0.2
Belize	1993	1998	-3.8	-19.1	Denmark	1992	1993	-0.7	-0.7
Belize	2000	2002	-1.2	-1.8	Denmark	2001	2003	-0.1	-0.3
Bolivia	1991	1992	-2.3	-2.3	Denmark	2006	2009	0.0	-7.4
Bolivia	1998	2003	-3.4	-8.6	Denmark	2011	2012	-0.6	-0.6
Botswana	1991	1994	-2.5	-7.1	Dominican Rep.	1980	1982	-0.4	-3.2
Botswana	1997	1998	-3.1	-3.1	Dominican Rep.	1983	1986	-3.1	-9.8
Botswana	1999	2001	-1.4	-4.1	Dominican Rep.	1987	1988	-1.9	-1.9
Botswana	2003	2004	-0.1	-0.1	Dominican Rep.	1989	1991	-9.1	-11.8
Botswana	2008	2009	-10.8	-10.8	Dominican Rep.	1993	1994	-1.4	-1.4
Brazil	1980	1983	-8.8	-19.2	Dominican Rep.	2000	2001	-1.3	-1.3
Brazil	1986	1992	-0.4	-16.0	Dominican Rep.	2002	2004	-3.2	-4.9
Brazil	1995	1996	-1.0	-1.0	Dominican Rep.	2008	2009	-1.8	-1.8
Brazil	1997	2003	-2.7	-6.5	Ecuador	1981	1996	-4.4	-29.3
Brazil	2000	2003	-1.4	-2.5	Ecuador	1988	1996	-3.8	-14.3
Brazil	2002	2003	-1.4	-1.4	Ecuador	1997	2000	-0.8	-11.3
Brazil	2008	2009	-2.1	-2.1	Ecuador	2002	2003	-0.6	-0.6
Bulgaria	1998	1999	-4.3	-4.3	Ecuador	2006	2007	-1.2	-1.2
Bulgaria	2008	2009	-2.3	-2.3	Ecuador	2008	2009	-2.7	-2.7
Canada	1981	1982	-5.3	-5.3	Egypt	1980	1981	-1.3	-1.3
Canada	1985	1986	-0.2	-0.2	Egypt	1985	1989	-2.9	-6.5
Canada	1988	1992	-0.9	-9.4	Egypt	1990	1994	-3.5	-4.7
Canada	1995	1996	-0.5	-0.5	Egypt	1992	1994	-1.2	-1.3
Canada	2000	2001	-0.2	-0.2	Egypt	2000	2003	-0.3	-2.4
Canada	2002	2003	-0.2	-0.2	El Salvador	1995	1996	-0.5	-0.5
Canada	2006	2009	-0.1	-6.4	El Salvador	2008	2009	-4.0	-4.0
Canada	2011	2012	-0.5	-0.5	Finland	1989	1993	-0.2	-12.6
Chile	1981	1983	-13.7	-20.5	Finland	2007	2009	-0.2	-9.2
Chile	1989	1990	0.0	0.0	Finland	2011	2015	-2.3	-6.0
Chile	1998	1999	-2.9	-2.9	France	1992	1993	-1.5	-1.5

Notes: This table details the sample of recession episodes used in the empirical analysis of Section 5 (reported in Tables J.5 and J.6). *Initial* and *P-T* refer to the contraction in real GDP per capita in the first year of the recession episode and from the recession peak to trough. GDP changes are expressed in percentages.

Table J.5: Sample of Recession Episodes (Part II)

| Country | Peak | Trough | GDP change | | Country | Peak | Trough | GDP change | |
			Initial	P-T				Initial	P-T
France	2001	2003	-0.17	-0.6	Italy	1992	1993	-1.0	-1.0
France	2007	2009	-0.97	-4.9	Italy	2001	2003	-0.4	-1.3
France	2011	2013	-0.78	-1.2	Italy	2004	2005	-0.1	-0.1
Germany	1981	1982	-0.07	-0.1	Italy	2007	2009	-2.0	-8.0
Germany	1992	1993	-2.18	-2.2	Italy	2011	2014	-3.0	-6.3
Germany	2001	2003	-0.26	-1.1	Japan	1973	1974	-4.4	-4.4
Germany	2008	2009	-5.19	-5.2	Japan	1992	1993	-0.4	-0.4
Germany	2012	2013	-0.03	0.0	Japan	1997	1999	-1.6	-2.2
Greece	1985	1987	-0.3	-3.3	Japan	2001	2002	-0.3	-0.3
Greece	1989	1990	-1.77	-1.8	Japan	2007	2009	-1.2	-6.5
Greece	1991	1993	-1.11	-4.4	Jordan	1980	1999	-2.6	-56.8
Greece	2007	2013	-0.94	-25.6	Jordan	1992	1999	-6.1	-18.0
Guatemala	1992	1994	-0.83	-1.5	Jordan	2002	2003	0.0	0.0
Guatemala	1995	1997	-1.6	-1.8	Kazakhstan	2008	2009	-2.6	-2.6
Guatemala	1998	2005	-0.73	-9.7	Korea	1979	1980	-4.6	-4.6
Hong Kong	1981	1982	-0.37	-0.4	Korea	1997	1998	-7.0	-7.0
Hong Kong	1984	1985	-1.8	-1.8	Korea	2008	2009	-0.1	-0.1
Hong Kong	1988	1989	-0.37	-0.4	Lebanon	1988	1989	-42.8	-42.8
Hong Kong	1994	1996	-1.02	-2.9	Lebanon	1991	1992	-0.6	-0.6
Hong Kong	1997	1999	-8.36	-8.5	Lebanon	1996	1997	-3.7	-3.7
Hong Kong	2000	2001	-1.05	-1.1	Lebanon	1998	2006	-3.1	-27.2
Hong Kong	2008	2009	-3.27	-3.3	Luxembourg	1980	1981	-1.1	-1.1
Hong Kong	2011	2012	-0.05	-0.1	Luxembourg	1991	1992	-0.8	-0.8
Hungary	2008	2009	-6.15	-6.2	Luxembourg	1994	1996	-1.4	-2.8
Hungary	2011	2012	-0.85	-0.9	Luxembourg	2002	2003	-0.4	-0.4
Iceland	1981	1983	-0.33	-4.9	Malaysia	1984	1987	-6.2	-10.9
Iceland	1987	1993	-2.71	-13.2	Malaysia	1997	1998	-11.9	-11.9
Iceland	1994	1995	-1.35	-1.4	Malaysia	2000	2001	-3.8	-3.8
Iceland	2001	2002	-1.42	-1.4	Malaysia	2007	2009	-0.4	-6.3
Iceland	2007	2010	-2.17	-15.0	Malta	1981	1985	-0.8	-3.9
India	1981	1982	-1.22	-1.2	Malta	2000	2001	-0.8	-0.8
India	1983	1984	-0.83	-0.8	Malta	2003	2004	-0.7	-0.7
India	1986	1987	-0.47	-0.5	Malta	2008	2009	-3.6	-3.6
India	1990	1991	-2.98	-3.0	Mexico	1981	1988	-5.0	-24.9
Indonesia	1981	1983	-2.37	-2.8	Mexico	1991	1992	-0.4	-0.4
Indonesia	1984	1985	-1.79	-1.8	Mexico	1994	1995	-9.1	-9.1
Indonesia	1997	1999	-15.54	-16.9	Mexico	1998	1999	-0.3	-0.3
Ireland	1982	1983	-1.69	-1.7	Mexico	2000	2003	-3.2	-6.4
Ireland	1985	1986	-0.65	-0.7	Mexico	2007	2009	-1.8	-9.4
Ireland	2002	2003	-0.38	-0.4	Morocco	1982	1983	-3.4	-3.4
Ireland	2007	2010	-7.79	-14.5	Morocco	1986	1987	-4.3	-4.3
Ireland	2011	2012	-0.51	-0.5	Morocco	1988	1990	-1.0	-1.3
Israel	1981	1984	-1.58	-3.8	Morocco	1991	1993	-5.5	-9.4
Israel	1987	1989	-0.56	-3.8	Morocco	1994	1995	-8.2	-8.2
Israel	1990	1991	-1.68	-1.7	Morocco	1996	1997	-4.1	-4.1
Israel	1992	1993	-2.25	-2.3	Morocco	1998	2000	-1.3	-1.7
Israel	1995	1999	-0.29	-3.4	Morocco	2013	2014	-0.3	-0.3
Israel	2000	2003	-4.15	-10.1	Netherlands	1992	1993	-0.1	-0.1
Israel	2007	2009	-1.32	-4.6	Netherlands	2001	2003	-1.1	-1.8
Israel	2011	2012	-1.62	-1.6	Netherlands	2008	2009	-4.6	-4.6
Israel	2013	2015	-0.09	-0.6	Netherlands	2011	2013	-1.7	-2.5

Notes: This table details the sample of recession episodes used in the empirical analysis of Section 5 (reported in Tables J.4 and J.6). *Initial* and *P-T* refer to the contraction in real GDP per capita in the first year of the recession episode and from the recession peak to trough. GDP changes are expressed in percentages.

Table J.6: Sample of Recession Episodes (Part III)

| Country | Peak | Trough | GDP change | | Country | Peak | Trough | GDP change | |
			Initial	P-T				Initial	P-T
New Zealand	1981	1982	-0.8	-0.8	South Africa	1981	1983	-5.4	-11.8
New Zealand	1986	1992	-0.5	-12.9	South Africa	1984	1999	-5.8	-34.3
New Zealand	1996	1998	-0.2	-1.1	South Africa	1996	1999	-0.8	-4.1
New Zealand	2007	2010	-3.0	-5.9	South Africa	2008	2009	-4.0	-4.0
Norway	1981	1982	-0.4	-0.4	Spain	1980	1981	-1.6	-1.6
Norway	1987	1988	-1.2	-1.2	Spain	1992	1993	-1.9	-1.9
Norway	2002	2003	-0.2	-0.2	Spain	2002	2004	-0.3	-0.5
Oman	1981	1982	-0.1	-0.1	Spain	2007	2013	-1.8	-13.1
Oman	1985	1988	-6.0	-16.8	Sweden	1989	1993	-0.6	-8.6
Oman	1989	1995	-7.8	-17.1	Sweden	2007	2009	-2.1	-8.7
Oman	1998	1999	-0.4	-0.4	Sweden	2011	2013	-1.8	-2.2
Oman	2001	2007	-4.4	-18.3	Switzerland	1981	1983	-2.3	-2.6
Pakistan	1981	1984	-0.4	-2.2	Switzerland	1990	1996	-3.1	-9.2
Pakistan	1985	1987	-1.1	-1.3	Switzerland	2001	2003	-1.2	-2.5
Pakistan	1988	1991	-1.2	-3.3	Switzerland	2007	2009	-0.3	-4.8
Pakistan	1992	2002	-3.4	-15.3	Thailand	1996	1998	-5.0	-14.3
Pakistan	2007	2012	-2.4	-8.2	Thailand	2008	2009	-1.7	-1.7
Panama	1982	1984	-8.8	-10.4	Thailand	2010	2011	-0.1	-0.1
Panama	1985	1989	-0.9	-24.7	Trinidad and Tobago	1982	1993	-13.1	-41.6
Panama	1993	1996	-1.3	-3.7	Trinidad and Tobago	1991	1993	-2.9	-5.3
Panama	1998	2002	-0.2	-6.2	Trinidad and Tobago	2008	2009	-5.3	-5.3
Panama	2008	2009	-2.0	-2.0	Trinidad and Tobago	2010	2011	-1.3	-1.3
Paraguay	1981	1986	-6.9	-19.1	Tunisia	1980	1984	-0.1	-7.2
Paraguay	1989	1993	-1.2	-6.1	Tunisia	1985	1986	-6.3	-6.3
Paraguay	1995	2002	-3.0	-24.4	Tunisia	1987	1989	-4.4	-7.1
Paraguay	2004	2005	-1.1	-1.1	Tunisia	1990	1991	-0.6	-0.6
Paraguay	2008	2009	-6.5	-6.5	Tunisia	1992	1995	-2.0	-3.8
Paraguay	2011	2012	-3.9	-3.9	Tunisia	2001	2002	-0.3	-0.3
Peru	1981	1985	-4.9	-21.7	Turkey	1981	1982	-1.1	-1.1
Peru	1987	1992	-13.4	-37.9	Turkey	1984	1985	-0.04	-0.04
Peru	1995	1996	-0.6	-0.6	Turkey	1987	1989	-1.4	-4.6
Peru	1997	2001	-3.3	-6.6	Turkey	1990	1991	-2.6	-2.6
Peru	2008	2009	-1.4	-1.4	Turkey	1993	1994	-7.7	-7.7
Peru	2013	2014	-0.3	-0.3	Turkey	1997	1999	-0.9	-7.1
Philippines	1989	1995	-2.1	-14.2	Turkey	2000	2001	-8.7	-8.7
Philippines	1997	2002	-4.9	-8.0	Turkey	2007	2009	-1.6	-8.5
Philippines	2000	2002	-1.4	-2.0	United Kingdom	1990	1992	-1.7	-1.8
Philippines	2008	2009	-2.1	-2.1	United Kingdom	2007	2011	-2.3	-8.2
Portugal	1982	1984	-1.0	-3.4	United States	1981	1982	-3.8	-3.8
Portugal	1992	1993	-2.6	-2.6	United States	1989	1991	-0.2	-2.5
Portugal	2001	2003	-0.2	-1.9	United States	2000	2002	-1.0	-1.1
Portugal	2007	2009	-0.2	-3.3	United States	2006	2009	-0.1	-6.6
Portugal	2010	2013	-1.4	-4.7	Uruguay	1981	1984	-10.9	-23.0
Romania	1996	1998	-3.8	-4.9	Uruguay	1988	1990	-0.2	-1.2
Romania	2008	2009	-5.4	-5.4	Uruguay	1994	1995	-2.9	-2.9
Russia	1997	1998	-4.9	-4.9	Uruguay	1998	2002	-3.0	-16.5
Russia	2008	2009	-7.9	-7.9	Uruguay	2014	2015	-0.3	-0.3
Singapore	1984	1986	-3.1	-3.8	Venezuela	1986	1987	-1.6	-1.6
Singapore	1997	1998	-7.6	-7.6	Venezuela	1988	1989	-13.0	-13.0
Singapore	2000	2001	-6.1	-6.1	Venezuela	1992	1996	-4.1	-14.3
Singapore	2007	2009	-5.9	-11.3	Venezuela	1997	2003	-3.6	-32.2
Singapore	2011	2012	-0.5	-0.5	Venezuela	2008	2010	-6.2	-10.4

Notes: This table details the sample of recession episodes used in the empirical analysis of Section 5 (reported in Tables J.4 and J.5). *Initial* and *P-T* refer to the contraction in real GDP per capita in the first year of the recession episode and from the recession peak to trough. GDP changes are expressed in percentages.

J.3 Additional Analysis of Fiscal Responses during Recession Episodes
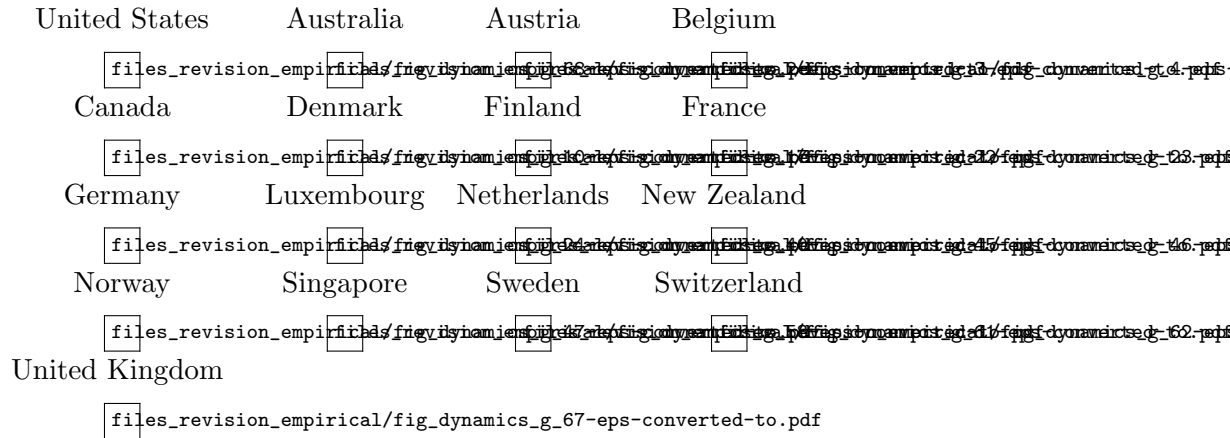
J.3.1 Country-level results

Figure J.2: Country-level results for riskless countries

Notes: In each panel, the marked black line shows the results of estimating, for country j, the regression $\log g_{jt+h} - \log g_{jt-1} = \alpha_{hj} + \beta_{hj}\text{recession}_{jt} + \rho_{jh}\Delta \log g_{jt-1} + \epsilon_{hjt}$, where g_{jt} is real government consumption per capita of country j in period t. The blue line shows the estimated coefficient β_h, associated with the dynamics of government consumption for riskless sovereigns (measured by credit ratings), in the baseline regression (25); dashed lines report 90% error bands. For more details, see Section 5.
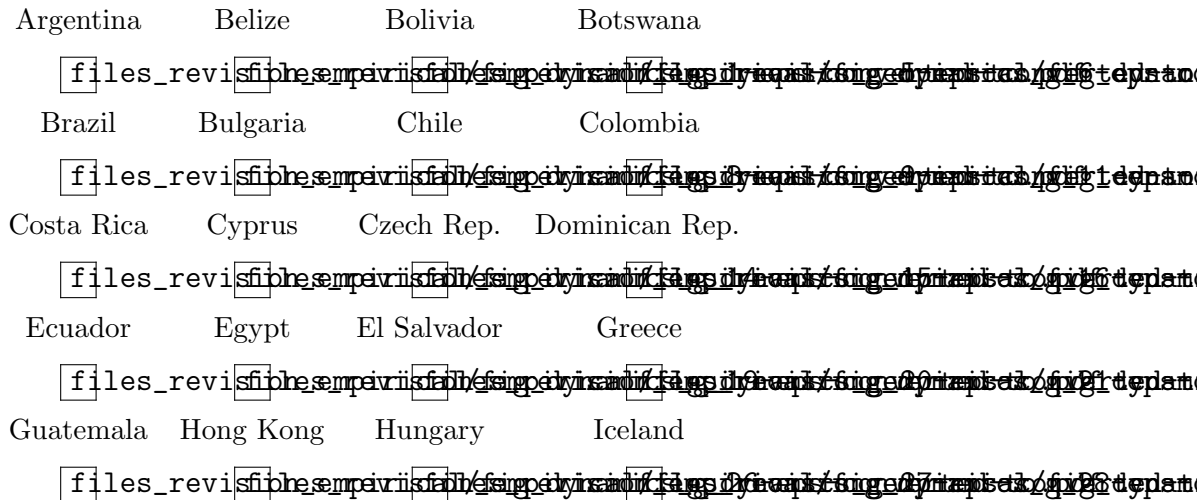

Figure J.3: Country-level results for risky countries (Part I)

Notes: In each panel, the marked black line shows the results of estimating, for country j, the regression $\log g_{jt+h} - \log g_{jt-1} = \alpha_{hj} + \beta_{hj}\text{recession}_{jt} + \rho_{jh}\Delta \log g_{jt-1} + \epsilon_{hjt}$, where g_{jt} is real government consumption per capita of country j in period t. The blue line shows the estimated coefficient γ_h, associated with the dynamics of government consumption for risky sovereigns (measured by credit ratings), in the baseline regression (25); dashed lines report 90% error bands. For more details, see Section 5.
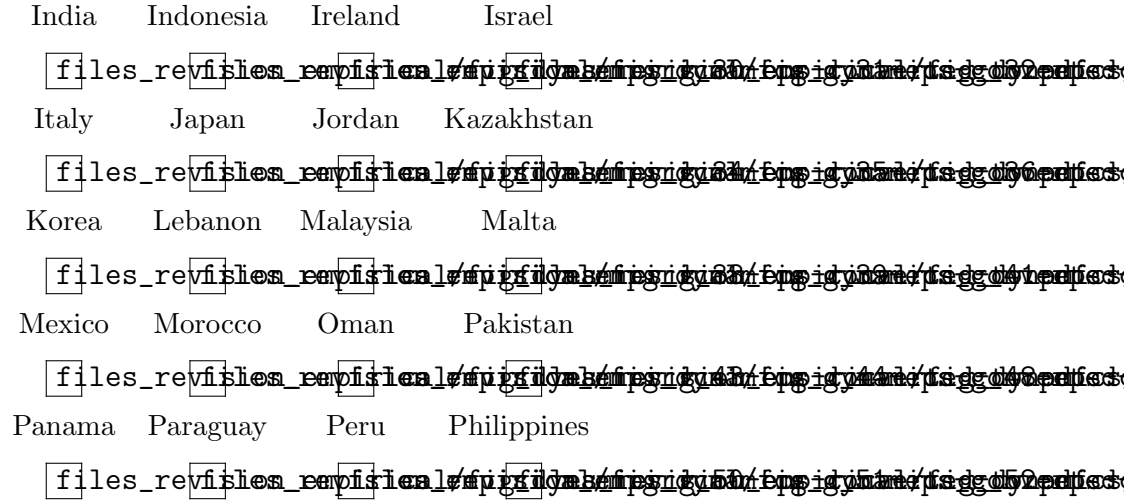
India   Indonesia   Ireland   Israel

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Italy   Japan   Jordan   Kazakhstan

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Korea   Lebanon   Malaysia   Malta

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Mexico   Morocco   Oman   Pakistan

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Panama   Paraguay   Peru   Philippines

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Figure J.4: Country-level results for risky countries (Part II)

Notes: In each panel, the marked black line shows the results of estimating, for country j, the regression $\log g_{jt+h} - \log g_{jt-1} = \alpha_{hj} + \beta_{hj}\text{recession}_{jt} + \rho_{jh}\Delta \log g_{jt-1} + \epsilon_{hjt}$, where g_{jt} is real government consumption per capita of country j in period t. The blue line shows the estimated coefficient γ_h, associated with the dynamics of government consumption for risky sovereigns (measured by having credit ratings), in the baseline regression (25); dashed lines report 90% error bands. For more details, see Section 5.
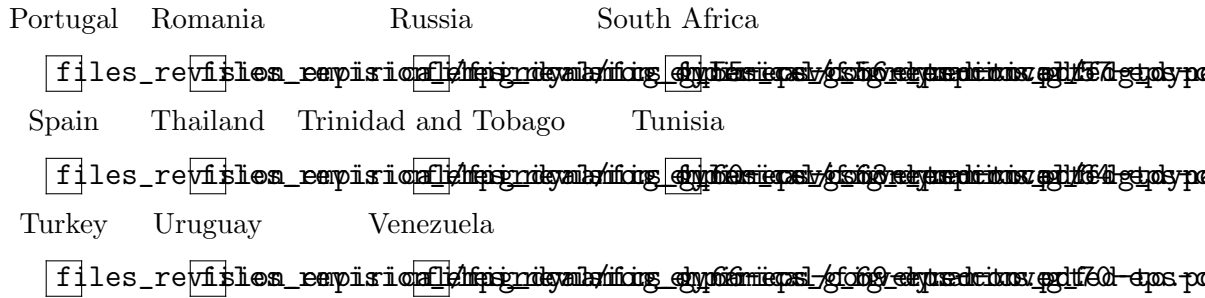
Portugal   Romania   Russia   South Africa

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Spain   Thailand   Trinidad and Tobago   Tunisia

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Turkey   Uruguay   Venezuela

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Figure J.5: Country-level results for risky countries (Part III)

Notes: In each panel, the marked black line shows the results of estimating, for country j, the regression $\log g_{jt+h} - \log g_{jt-1} = \alpha_{hj} + \beta_{hj}\text{recession}_{jt} + \rho_{jh}\Delta \log g_{jt-1} + \epsilon_{hjt}$, where g_{jt} is real government consumption per capita of country j in period t. The blue line shows the estimated coefficient γ_h, associated with the dynamics of government consumption for risky sovereigns (measured by credit ratings), in the baseline regression (25); dashed lines report 90% error bands. For more details, see Section 5.

J.3.2 Robustness to additional control variables

(a) Sovereign risk measured by historical default probability
Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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(b) Sovereign risk measured by credit ratings
Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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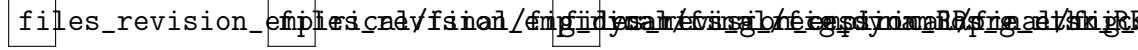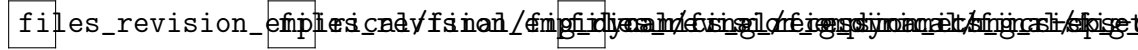
Figure J.6: Dynamics of Government Consumption During Recession Episodes by Sovereign Risk and Foreign Liabilities, controlling for Ethnic Fractionalization

Notes: Results from estimating $\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1}) + \rho_{1s}\Delta \log g_{jt-1} + \rho_{2s}\ell_{jt-1} + \boldsymbol{\Gamma}_s' \text{recession}_{jt}X_{jt-1} + \epsilon_{sjt}$, where g_{jt} is real government consumption per capita of country j in period t; α_j is a country fixed effect; recession_{jt} is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk_j denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector X_{jt-1} that includes the log of the average GDP per capita of country j, the index of ethnic fractionalization from Alesina et al. (2003), and the interaction of these variables with ℓ_{jt-1}. In Panel (a), sovereign risk is measured with a dummy variable that takes a value of one if the historical default rate of country j is above 1% and zero otherwise (see Section 5 for details); in Panel (b), sovereign risk is measured with a dummy variable that takes the value of one if the country ever had a rating below AA. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands.

(a) Sovereign risk measured by historical default probability

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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(b) Sovereign risk measured by credit ratings

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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Figure J.7: Dynamics of Government Consumption during Recession Episodes by Sovereign Risk and Foreign Liabilities controlling for Corruption
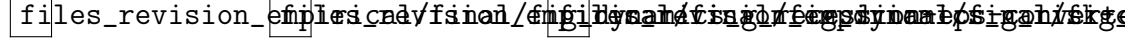
Notes: Results from estimating

$$\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s (\text{recession}_{jt} \times \text{risk}_j) + \delta_s (\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s} \Delta \log g_{jt-1} + \rho_{2s} \ell_{jt-1} + \mathbf{\Gamma}'_s \text{recession}_{jt} X_{jt-1} + \epsilon_{sjt},$$

where g_{jt} is real government consumption per capita of country j in period t; α_j is a country fixed effect; recession_{jt} is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk_j denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector X_{jt-1} that includes the log of the average GDP per capita of country j, the degree of corruption index of Kaufmann et al. (2006), and the interaction of these variables with ℓ_{jt-1}. In Panel (a), sovereign risk is measured with a dummy variable that takes a value of one if the historical default rate of country j is above 1% and zero otherwise (see Section 5 for details); in Panel (b), sovereign risk is measured with a dummy variable that takes the value of one if the country ever had a rating below AA. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands.

J.3.3 Results for alternative measures of credit ratings

(a) Risk classification based on minimum ratings

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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(b) Risk classification based on mode ratings

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

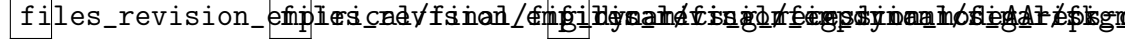`files_revision_empirical/final/figures/ffe_dynamics_gov_rec_risk`

Figure J.8: Dynamics of Government Consumption during Recession Episodes by Sov. Risk and Foreign Liabilities for Alternative Measures of Risk (Part I)

Notes: Results from estimating

$$\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s}\Delta \log g_{jt-1} + \rho_{2s}\ell_{jt-1} + \mathbf{\Gamma}'_s \text{recession}_{jt} X_{jt-1} + \epsilon_{sjt},$$

where g_{jt} is real government consumption per capita of country j in period t; α_j is a country fixed effect; recession_{jt} is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk_j denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector of controls that includes the log of the average GDP per capita of country j and the interaction of this variable with ℓ_{jt-1}. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands. In Panel (a), a country is classified as riskless if it always has an AA or above credit rating. In Panel (a), a country is classified as riskless if its mode rating is AA or above.

(a) Threshold for riskless sovereign: AA or above

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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(b) Threshold for riskless sovereign: A or above

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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(c) Threshold for riskless sovereign: BBB or above

Riskless Sovereigns   Risky Sovereigns   by Foreign Liabilities

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Figure J.9: Dynamics of Government Consumption during Recession Episodes by Sov. Risk and Foreign Liabilities for Alternative Measures of Risk (Part II)

Notes: Results from estimating

$$\log g_{jt+s} - \log g_{jt-1} = \alpha_{sj} + \beta_s \text{recession}_{jt} + \gamma_s(\text{recession}_{jt} \times \text{risk}_j) + \delta_s(\text{recession}_{jt} \times \text{risk}_j \times \ell_{jt-1})$$
$$+ \rho_{1s}\Delta \log g_{jt-1} + \rho_{2s}\ell_{jt-1} + \mathbf{\Gamma}'_s\text{recession}_{jt}X_{jt-1} + \epsilon_{sjt},$$

where g_{jt} is real government consumption per capita of country j in period t; α_j is a country fixed effect; recession$_{jt}$ is a dummy variable that takes the value of one if country j has a recession starting in period t and zero otherwise; risk$_j$ denotes a dummy variable that takes a value of one if country j has sovereign default risk and zero otherwise; ℓ_{jt} denotes the ratio of net foreign liabilities to GDP of country j in period t demeaned at the country level, standardized over the entire sample; and X_{jt-1} is a vector of controls that includes the log of the average GDP per capita of country j and the interaction of this variable with ℓ_{jt-1}. Standard errors are two-way clustered by country and by year. Dashed lines report 90% error bands. In Panel (a), a country is classified as riskless if it always has an AA or above credit rating; in Panel (b) if it always has A or above; and in Panel (c) if it always has BBB or above.

J.4 Fiscal Cyclicality and Sovereign Risk

In this section, we study how differences in fiscal adjustment during recessions by sovereign risk documented in Section 5 translate to differences in the cyclicality of government consumption. For this, we estimate the regression

$$\Delta \log g_{jt} = \alpha_j + \beta \Delta \log y_{jt} + \gamma(\Delta \log y_{jt} \times \text{risk}_j) + \rho \Delta \log g_{jt-1} + \mathbf{\Gamma}' \Delta \log y_{jt} X_j + \epsilon_{jt}. \quad \text{(J.1)}$$

Our main coefficients of interest are β and γ, which measure the relationship between government consumption changes and GDP changes without and with sovereign risk. We interpret these estimated coefficients as descriptive statistics on the link between government consumption and GDP over the business cycle for different countries, which can be linked to models in which both output and government consumption are endogenous, as in our theoretical model.[45][46]

Tables J.7 and J.8 present the results from estimating variants of (J.1). The first column of J.7 shows the estimated β in an empirical model that only includes the variable $\Delta \log y_{jt}$, which indicates a positive coefficient of 0.4, consistent with the view that most countries around the world exhibit procyclical fiscal policies. The second column shows a stronger association in the relationship between changes in government consumption and GDP for countries with sovereign risk, whose estimated coefficient is substantially larger than that of riskless sovereigns. The rest of the columns in Table J.7 introduce alternative controls interacted with changes in GDP. In some of these cases, such as for GDP, it is naturally challenging to distinguish between risk and income levels, because the vast majority of riskless economies are also high-income economies. However, the estimated coefficients in Table J.7 are fairly stable across specifications, which suggests that economies with high risk tend to exhibit a larger sensitivity of government consumption to GDP than riskless economies. Table J.8 shows that we obtain similar results for alternative measures of default risk. As in the case of recession episodes, the differences between riskless and risky governments weaken as we lower the bar to define a riskless economy.

It is worth noting that the procyclicality of riskless governments' consumption reported in Tables J.7 and J.8 suggests that the benefits of Keynesian stimulus over the cycle might be smaller than those featured by the model. A possible reason for this is that the model focuses on an economy under a fixed exchange-rate regime; in the data, riskless governments tend to use more active tools of monetary stabilization that render the use of fiscal tools less pressing, and potentially closer to the Samuelson rule.

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[45]This type of empirical model has been used in the literature to study fiscal procyclicality (e.g., Gavin and Perotti, 1997). For instrumental variable strategies aimed at identifying the effect of GDP changes in fiscal policy, see Galí and Perotti (2003); Jaimovich and Panizza (2007); Ilzetzki and Végh (2008); and Alesina et al. (2008) among others.

[46]We have also investigated the role of foreign liabilities that affect the relationship between changes in government consumption and GDP for risky economies. We find that higher external liabilities are associated with a higher sensitivity of government consumption to GDP for risky economies; however these differences are not statistically significant.

Table J.7: Government Consumption Cyclicality by Sovereign Risk

	(1)	(2)	(3)	(4)	(5)
Output	0.39***	0.15***	0.22***	0.18***	0.20***
	(0.05)	(0.04)	(0.06)	(0.05)	(0.06)
Output × sovereign risk		0.30***	0.20*	0.24***	0.22***
		(0.08)	(0.10)	(0.06)	(0.10)
Output × X_j			-0.09	0.09	-0.08
			(0.07)	(0.05)	(0.05)
Observations	2,387	2,168	2,168	2,168	2,164
R^2	0.17	0.18	0.18	0.18	0.18
X_j			Income	Ethnic fract.	Corruption

Notes: This table shows the results of estimating different specifications of

$$\Delta \log g_{jt} = \alpha_j + \beta \Delta \log y_{jt} + \gamma(\Delta \log y_{jt} \times \text{risk}_j) + \rho \Delta \log g_{jt-1} + \mathbf{\Gamma}' \Delta \log y_{jt} X_j + \epsilon_{jt},$$

where g_{jt} is real government consumption per capita of country j in period t; y_{jt} is real GDP per capita; α_j is a country fixed effect; risk_j denotes a dummy variable that takes a value of one if the historical default rate of country j is above 1% and zero otherwise (see Section 5 for details); and X_j is a country-level control. Column (3) includes the log of the average GDP per capita of country j; column (4) the index of ethnic fractionalization from Alesina et al. (2003); and column (3) the degree of corruption index of Kaufmann et al. (2006). Standard errors are two-way clustered by country and by year.

Table J.8: Government Consumption Cyclicality by Sovereign Risk for Alternative Measures of Risk

	(1)	(2)	(3)	(4)
Output	0.15***	0.14***	0.09***	0.17***
	(0.04)	(0.05)	(0.04)	(0.05)
Output × sovereign risk	0.30***	0.30***	0.33***	0.27***
	(0.08)	(0.07)	(0.07)	(0.07)
Observations	2,168	2,387	2,387	2,387
R^2	0.18	0.18	0.18	0.18
Measure of sov. risk	hist. default	min. rating < A	min. rating < AA	mode rating < AA

Notes: This table shows the results from estimating different specifications of

$$\Delta \log g_{jt} = \alpha_j + \beta \Delta \log y_{jt} + \gamma(\Delta \log y_{jt} \times \mathrm{risk}_j) + \rho \Delta \log g_{jt-1} + \epsilon_{jt},$$

where g_{jt} is real government consumption per capita of country j in period t; y_{jt} is real GDP per capita; α_j is a country fixed effect; risk_j denotes a measure of default risk that varies across specifications; and X_j is a country-level control. Column (1) measures risk with a dummy variable that takes a value of one if the historical default rate of country j is above 1% and zero otherwise (see Section 5 for details); column (2) with a dummy variable that takes the value of one if the country ever had a rating below A; column (3) with a dummy variable that takes the value of one if the country ever had a rating below AA; and column (4) with a dummy variable that takes the value of one if the country has a mode rating below AA. Standard errors are two-way clustered by country and by year.