Fiscal Policy, Sovereign Risk, and Unemployment *

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Abstract

How should fiscal policy be conducted in the presence of default risk? We address this question using a sovereign default model with nominal rigidities. An increase in government spending during a recession stimulates economic activity and reduces unemployment. Because the government lacks commitment to future debt repayments, expansionary fiscal policy increases sovereign spreads, making the fiscal stimulus less desirable. We analyze the optimal fiscal policy and study quantitatively whether austerity or stimulus is optimal during an economic slump.

Keywords: sovereign debt, optimal fiscal policy, downward nominal wage rigidity.
JEL Codes: E62, F34, F41, F44, H50.

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1 Introduction

Much of the debates on fiscal policy during the Great Recession and the Eurozone crisis have centered on whether fiscal stimulus is desirable when there are concerns about public debt sustainability. One view argues that high unemployment calls for expansionary government spending (e.g., Krugman, 2015). On the other hand, the austerity view (e.g. Barro, 2012) argues that, with high levels of debt, expansionary government spending can increase further borrowing costs and the probability of a sovereign default crisis .

Motivated by this austerity-versus-stimulus debate, we present a model in which debt-financed government spending can mitigate an economic slump, but the resulting surge in borrowing increases vulnerability to a sovereign debt crisis. We study the optimal fiscal policy and show how the government trades off the stimulus benefits of expanding government spending with the costs from higher sovereign spreads.

We study optimal fiscal policy in a sovereign default model (Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008) extended with downward wage rigidity, as in Schmitt-Grohé and Uribe (2016). We consider a small open economy with a tradable and a nontradable sector and a fixed exchange rate regime, or equivalently an economy member of a currency union. Lacking the ability to depreciate the exchange rate, the economy faces the possibility of involuntary unemployment. When the economy faces adverse shocks to tradable income, this depresses aggregate demand and puts downward pressure on the price on nontradables. Because the wage is sticky, this reduces labor demand and generates unemployment.

An increase in government spending in nontradable goods raises the relative price of nontradables and stimulates labor demand, thereby reducing unemployment. If the government cannot raise taxes, the fiscal expansion has to be financed by increasing debt, leading to higher spreads on the government bonds to compensate foreign investors for the risk of default. Is it then optimal for the government to raise spending, given the increased burden of sovereign debt and rising borrowing costs? This is the key question we address in our analysis.

Conducting a quantitative study calibrated to the recent Euro Area debt crisis, we study both the positive and normative implications of fiscal policy. On the positive side, we show that the fiscal multipliers are highly non-linear in the severity of the recession. On the normative side, we show that the optimal size of government purchases depends critically on the sovereign debt level. When the stock of debt is relatively low, government spending displays a strongly countercyclical role. As debt increases, and the government becomes more exposed to a sovereign default, the optimal response becomes more austere.

Related Literature. Our paper bridges two strands of the literature. First, our paper builds on the sovereign debt literature (Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008). Cuadra, Sanchez, and Sapriza (2010) show that fiscal policy is optimally procyclical in a canonical sovereign debt model. Because spreads are higher in recessions, the government finds it optimal to contract spending and reduce tax rates, and do the opposite during expansions. In Arellano and Bai (2016), the government faces rigidities of fiscal revenues, which can either trigger the need for fiscal austerity programs or lead to government default. Balke and Ravn (2016) study optimal time consistent policy in a model featuring unemployment due to search and matching frictions. However, because these papers do not consider nominal rigidities, they do not incorporate the stabilization benefits behind fiscal stimulus, and hence do not feature the trade-off we analyze in this paper. Na, Schmitt-Grohé, Uribe, and Yue (2014) introduce downward wage rigidity in a canonical sovereign debt model. Differently from us, they focus on rationalizing why depreciations of the exchange rate and defaults tend to occur together in the data, and they do not consider fiscal policy.[1] Our paper is the first, to our knowledge, to study fiscal policy in an environment with Keynesian features and sovereign default risk, articulating the trade-off between austerity and stabilization policy, and to study the implications for optimal fiscal policy.

Second, our paper also relates to a large literature that studies the role of government spending as a macroeconomic stabilization tool. One stream of this literature has analyzed how, when there are constraints on monetary policy, either because of a zero lower bound or a fixed exchange rate regime, countercyclical fiscal policy becomes desirable. Examples in this literature include Eggertsson (2011), Christiano, Eichenbaum, and Rebelo (2011), Werning (2011), Gali and Monacelli (2008), and Farhi and Werning (2017). Our central contribution to this literature is to introduce the possibility of sovereign default, and study the implications for optimal fiscal policy.

Another stream of this literature has analyzed how increases in sovereign spreads can translate into higher borrowing costs for the private sector and negatively affect economic activity. Important examples include Corsetti, Kuester, Meier, and Muller (2013,2014),

[1] Recently, Anzoategui (2017) has estimated fiscal rules for the Eurozone and evaluated counterfactuals using a similar environment to our paper.

and Bocola (2016). Our main contribution to this literature is to study optimal fiscal policy in an environment that includes both the costs of sovereign default risk and the Keynesian benefits of fiscal stimulus.

Our paper is also related to the empirical literature on fiscal multipliers (for a recent survey see Ramey (2011)). This literature estimates a wide set of fiscal multipliers. Fiscal multipliers in our model can be closer to zero or bigger than one, depending on the initial states and whether they are financed with debt or taxes.

The paper is organized as follows. Section 2 presents the model and defines the competitive equilibrium. Section 3 presents the quantitative analysis of the model calibrated to the Spanish economy. It also evaluates the welfare implications under the different policy schemes. Section 4 presents empirical evidence, and Section 5 concludes.

2 Model

This section describes the model economy in which fiscal policy will be studied. We consider a two-sector small open economy within a currency union populated by a representative risk-averse household, a representative firm, and a government. The economy receives a stochastic endowment of tradable goods and has access to decreasing-returns-to-scale technology operated by the firm to produce nontradable goods using labor. The household is hand-to-mouth, consumes tradable and nontradable goods, and inelastically supplies labor in competitive markets. The labor market is characterized by a downward nominal wage rigidity, which can give rise to involuntary unemployment as in Schmitt-Grohé and Uribe (2016), and Na, Schmitt-Grohé, Uribe, and Yue (2014).

The government is benevolent, and decides external borrowing, taxes, and public spending on nontradable goods. The government cannot choose monetary policy, assumed to be determined by a fixed exchange-rate regime. Public spending provides utility to the household. Due to the presence of nominal wage rigidity and the fixed exchange rate, public spending can help reduce unemployment in the labor markets by affecting relative prices. The government, however, has a limit of its tax capacity and can only finance surges in public spending with costly external borrowing. In particular, external borrowing consists of one-period bonds, traded with risk-neutral competitive foreign lenders, whose promised payoff is non-state-contingent; the government does not have commitment to repay and can default on these bonds, generating a utility cost to the households and temporary exclusion from international credit markets.

2.1 Households

Households' preferences over private and public consumption are given by

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

where c_t denotes private consumption 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 expectation operator conditional on the information set available at time t.

The consumption good is assumed to be a composite of tradable (c^T) and nontradable goods (c^N), with a constant elasticity of substitution (CES) aggregation technology:

$$c = C(c^T, c^N) = [\omega(c^T)^{-\mu} + (1-\omega)(c^N)^{-\mu}]^{-1/\mu},$$

where $\omega \in (0, 1)$ and $\mu > -1$. The elasticity of substitution between tradable and nontradable consumption is therefore $1/(1 + \mu)$.

Each period households receive tradable endowment y_t^T, and profits from the ownership of firms producing nontradable goods ϕ_t^N. We assume that y_t^T is stochastic and follows a stationary first-order Markov process. Households inelastically supply $\overline{h}$ hours of work to the labor markets. Due to the presence of the wage rigidity (discussed in detail in the next subsections), households will only be able to sell $h_t \leq \overline{h}$ hours in the labor markets. The actual hours worked h_t is determined by firms' labor demand and taken as given by the households. As usual in the sovereign debt literature (see, for example, Aguiar and Gopinath, 2006 and Arellano, 2008), we assume that households are hand-to-mouth and that the government can distribute proceedings from external borrowing to the households using lump-sum taxes or transfers τ_t, expressed in tradable units. Households' sequential budget constraint, expressed in terms of tradables, is therefore given by

$$c_t^T + p_t^N c_t^N = y_t^T + \phi_t^N + w_t h_t - \tau_t, \tag{2}$$

where p_t^N denotes the relative price of nontradables in terms of tradables, w_t denotes the wage rate in terms of tradable goods.

The households' problem consists of choosing c_t^T and c_t^N to maximize (1) given the sequence of prices $\{p_t^N, w_t\}$, endowments $\{y_t^T\}$, profits $\{\phi_t^N\}$, and taxes $\{\tau_t\}$. The optimality condition of this problem yields the equilibrium price of nontradable goods as a function of the ratio between tradable and nontradable consumption:

$$p_t^N = \frac{1-\omega}{\omega}\left(\frac{c_t^T}{c_t^N}\right)^{\mu+1}. \tag{3}$$

That is, the relative price of nontradables is equal to the marginal rate of substitution between tradables and nontradables.

2.2 Firms

Firms are competitive and have access to a decreasing-returns-to-scale technology to produce nontradable goods with labor:

$$y_t^N = F\left(h_t\right), \tag{4}$$

where y_t^N denotes output of nontradable goods in period t, $F(.)$ is a continuous, differentiable, increasing and concave function. Firms' profits each period are then given by

$$\phi_t^N = p_t^N y_t^N - w_t h_t. \tag{5}$$

The optimal choice of labor h_t equates the value of the marginal product of labor and the wage rate, all expressed in tradable units,

$$p_t^N F'\left(h_t\right) \quad = \quad w_t. \tag{6}$$

2.3 Government

The government determines public spending, borrowing, and repayment decisions to maximize households' lifetime utility. The government lacks commitment to all future policies.

We consider long-term debt, as in Arellano and Ramanarayanan (2012), Hatchondo and Martinez (2009), and Chatterjee and Eyigungor (2012). A bond issued in period t promises an infinite stream of coupons that decreases at an exogenous constant rate δ. 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 can be represented by the following law of motion:

$$b_{t+1} = (1 - \delta)b_t + i_t, \tag{7}$$

where b_t is the stock of bonds due at the beginning of period t, and i_t is the stock of new bonds issued in period t. The government can trade this long-term bond with atomistic international lenders not only to smooth consumption and allocate it optimally over time, but to boost employment through the keynesian channel as well. Debt contracts cannot be enforced and the government may decide to default at any point of time.

The government's sequential budget constraint each period in which it has access to debt markets is given by

$$p_t^N g_t^N - \delta b_t = \tau_t - q_t i_t, \tag{8}$$

where q_t is the equilibrium price of the bond. The budget constraint indicates that tax revenues and new debt issuance have to finance public spending and the repayment of outstanding debt obligations.

Default costs and tax limit. Government's default entails two punishments. First, the government switches to financial autarky and cannot borrow for a stochastic number of periods. While excluded from credit markets, the government runs a balanced budget, i.e. $p_t^N g_t^N = \tau_t$. Second, there is a utility loss $\psi_{\chi,t}$, which we assume to be increasing in tradable income. We think of this utility loss as capturing various default costs related to reputation, sanctions, or misallocation of resources. It can also be thought of representing the adverse political or institutional repercussions of defaulting in a currency union, which might be particularly relevant for our countries of interest, the peripheral EU members.[2]

To capture the presence of distortionary taxes, we assume that the government has a limit on its ability to tax given by

$$\tau_t \leq \overline{\tau}, \tag{9}$$

where $\overline{\tau} > 0$.

Timing and Notation. Let χ_t be the default decision, which takes value 1 if the government decides to default at time t, and 0 otherwise. Also, ζ_t is a variable that takes

[2]Our choice of a utility loss both from taxes and default, rather than an output cost, is also motivated by the fact that with the former the marginal rate of transformation between tradable and nontradable goods is not altered when the economy defaults and switches to autarky.

value 1 if the government cannot issue bonds in period t, and zero otherwise. Throughout the paper, we will say that the economy is under repayment if $\zeta_t = 0$, and in autarky if $\zeta_t = 1$.

At the beginning of each period with access to financial markets, and after the shock to the tradable endowment is realized, the government has the option to default on the outstanding debt carried from last period. If the government honors its debt contracts, it can issue new bonds and remains with access to financial market next period. If instead the government defaults, it switches to financial autarky and cannot borrow that period. While in autarky, in each period with probability θ, the government regains access to financial markets, in which case it starts over with zero outstanding debt. Let χ_t be a random variable that captures the fact that the government exits financial autarky, taking a value of 1 in that event, and zero otherwise.

The law of motion for ζ_t is then as follows:

$$\zeta_t = (1 - \chi_t)\zeta_{t-1} + \chi_t(1 - \zeta_{t-1}) \tag{10}$$

If at time $t-1$, the government could issue bonds ($\zeta_{t-1} = 0$), then $\zeta_t = \chi_t$. If instead it was in financial autarky ($\zeta_{t-1} = 1$), then $\zeta_t = (1 - \chi_t)$, reflecting the fact that the government would only be able to borrow at time t if it recovers access to financial markets.

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 risk-less security paying a net interest rate r. By a no-arbitrage condition, equilibrium bond prices are then given by

$$q_t = \frac{1}{1+r}\mathbb{E}_t[(1 - \chi_{t+1})(\delta + (1 - \delta)q_{t+1})]. \tag{11}$$

Equation (18) indicates that in equilibrium an investor has to be indifferent between selling a government bond in period t at price q_t and keeping the bond until next period bearing the risk of default. In case of repayment next period, the payoff is given by the coupon δ plus the market value q_{t+1} of the non-maturing fraction of the bonds. In case of default, the price q_{t+1} is equal to zero since we assume no recovery of defaulted bonds.

Equation (18) will play a critical role when we turn to the optimal fiscal policy. If lenders anticipate a fiscal policy in the future that will make default more likely, they will demand lower bond prices, or equivalently higher bond returns, to compensate for a higher default risk. Similarly, if the government wants to run a debt-financed stimulus, this will be increasing future default probability and reducing the bond price today.

2.5 Equilibrium

In equilibrium the market for nontradable goods clears:

$$c_t^N + g_t^N = F(h_t). \tag{12}$$

For the labor markets, it is assumed that nominal wages have a lower bound $\bar{w}$, by which $W_t \geq \bar{w}$ for all t, following Schmitt-Grohé and Uribe (2016).[3] Given that the economy is under a currency peg and assuming that the law of one price holds for tradable goods and that the price of foreign tradable goods is constant and normalized to one, the wage rigidity can be expressed as

$$w_t \geq \bar{w}, \tag{13}$$

where w_t is the real wage and $\bar{w}$ is the wage lower bound, both in terms of the tradable good.

Actual hours worked cannot exceed the inelastically supplied level of hours:

$$h_t \leq \overline{h}. \tag{14}$$

Labor market equilibrium implies that the following slackness condition must hold for all dates and states:

$$(w_t - \bar{w})\left(\overline{h} - h_t\right) = 0. \tag{15}$$

This condition implies that when the nominal wage rigidity binds, the labor market can exhibit involuntary unemployment, given by $\overline{h} - h_t$. Similarly, when the nominal wage rigidity is not binding, the labor market must exhibit full employment.

Combining the equilibrium price equation (3) with resource constraint (12), the rela-

[3] In Schmitt-Grohé and Uribe (2016), $\bar{w}$ depends on the previous period wage. For numerical tractability, we take $\bar{w}$ as an exogenous (constant) value.

tive price p_t^N can be expressed as

$$p_t^N = \mathcal{P}^N(c_t^T, h_t, g_t^N) = \frac{1-\omega}{\omega}\left(\frac{c_t^T}{F(h_t) - g_t^N}\right)^{\mu+1} \tag{16}$$

Using the households' budget constraint (2) and the definition of the firms' profits and market clearing condition (12), the resource constraint of the economy can be rewritten as

$$c_t^T = y_t^T + (1-\zeta_t)[\delta b_t - q_t i_t] \tag{17}$$

A competitive equilibrium given government policies in our economy is then defined as follows:

Definition 1 (Competitive Equilibrium)**.** *Given initial debt b_0 and ζ_0, an exogenous process $\{y_t^T, \chi_t\}_{t=0}^{\infty}$, government policies $\{g_t^N, b_{t+1}, \chi_t, \tau_t\}_{t=0}^{\infty}$, a competitive equilibrium is a sequence of allocations $\{c_t^T, c_t^N, h_t\}_{t=0}^{\infty}$ and prices $\{p_t^N, w_t, q_t\}_{t=0}^{\infty}$ such that:*

1. *Allocations solve household's and firms' problems at given prices.*
2. *Government policies satisfy the government budget constraint (8), and the law of motion for ζ satisfies equation (10).*
3. *Bond pricing equation (18) holds.*
4. *The market for nontradable goods clears.*
5. *The labor market satisfies conditions (13)-(15).*

2.6 Optimal Government Policy

We consider the optimal policy of a benevolent government with no commitment, that chooses public spending, external borrowing, and taxes to maximize households welfare, subject to the implementability conditions. We focus on the Markov recursive equilibrium in which all agents choose sequentially.

Every period the government enters with access to financial markets, it evaluates the lifetime utility of households if debt contracts are honored against the lifetime utility of households if they are repudiated. Given current (y^T, b), the government problem with access to financial markets can be formulated in recursive form as follows:

$$V(y^T, b) = \max_{\chi \in \{0,1\}} \{(1-\chi)V^r(y^T, b) + \chi V^d(y^T)\}, \tag{P}$$

where $V^r(y^T, b)$ and $V^d(y^T)$ denote, respectively, the value of repayment, given by the Bellman equation

$$V^r(y^T, b) = \max_{g^N, b', h, \tau \leq \overline{\tau}} \{u\left(C\left(c^T, F(h) - g^N\right)\right) + v(g^N) + \beta \mathbb{E}\left\{V(y^{T'}, b')\}|y^T\right\} \tag{P^r}$$

subject to

$$\begin{aligned} c^T + q(y^T, b')i &= y^T + \delta b \\ \tau &= \mathcal{P}^N(c^T, h, g^N)g^N + \delta b - q(y^T, b')i, \\ \mathcal{P}^N(c^T, h, g^N)F'(h) &\geq \bar{w}, \\ (\mathcal{P}^N(c^T, h, g^N)F'(h) - \bar{w})(h - \overline{h}) &= 0, \end{aligned}$$

and the value of default, given by:

$$\begin{aligned} V^d(y^T) = \max_{g^N, h, \tau \leq \overline{\tau}} \{ & u\left(C\left(y^T, F(h) - g^N\right)\right) + v(g^N) - \psi_\chi(y^T) \\ & + \beta \mathbb{E}\left\{(1-\theta)V^d(y^{T'}) + \theta V(y^{T'}, 0)|y^T\right\}\} \end{aligned} \tag{P^d}$$

subject to

$$\begin{aligned} \tau &= \mathcal{P}^N(y^T, h, g^N)g_t^N, \\ \mathcal{P}^N(y^T, h, g^N)F'(h) &\geq \bar{w}, \\ (\mathcal{P}^N(y^T, h, g^N)F'(h) - \bar{w})(h - \overline{h}) &= 0. \end{aligned}$$

where $q(y^T, b')$ denotes the bond price schedule, taken as given by the government.[4]

Let $s = (y^T, \zeta)$ and let $\{\chi(b, s), \hat{c}^T(b, s), \hat{g}^N(b, s), \hat{\tau}(b, s), \hat{b}(b, s), \hat{h}(b, s)\}$ be the optimal policy rules associated with the government problem. A Markov perfect equilibrium is then defined as follows.

Definition 2 (Markov perfect equilibrium)**.** *A Markov perfect equilibrium is defined by*

[4] The bond price q_t depends on the stock of bonds b_{t+1} carried into next period and the endowment y^T, since these two variables affect the government's incentives to default.

value functions $\{V(y^T,b), V^r(y^T,b), V^d(y^T)\}$*, policy functions* $\{\chi(b,s), \hat{c}^T(b,s), \hat{g}^N(b,s), \hat{\tau}(b,s), \hat{b}(b,s), \hat{h}(b,s)\}$*, and a bond price schedule* $q(y^T,b)$ *such that*

1. *Given the bond price schedule, policy functions solve problems (*P*), (*P^r*), and (*P^d*),*

2. *The bond price schedule satisfies the bond pricing equation,*

$$q(y^T,b') = \frac{1}{1+r}\mathbb{E}[(1-\chi')(\delta + (1-\delta)q(y^{T\prime},b''))|y^T]. \tag{18}$$

where

$$\begin{aligned} b'' &= \hat{b}(b',s') \\ \chi' &= \chi(b',s') \end{aligned}$$

with $s' = (y^{T\prime}, 0)$*.*

2.7 Fiscal Policy Trade-offs

The choice of government spending faces a trade-off between the benefits of reducing unemployment and the inefficiencies associated with its financing. This trade-off can be illustrated with the first-order conditions of the government problem. The optimality condition with respect to g^N yields

$$\underbrace{v'(g_t^N) - u_N(c_t^N)}_{\text{Samuelson}} + \underbrace{\xi_t F'(h_t)\frac{\partial \mathcal{P}_t^N}{\partial g_t^N}}_{\text{Stimulus}} - \underbrace{\eta_t \left(p_t^N + g_t^N \frac{\partial \mathcal{P}_t^N}{\partial g_t^N}\right)}_{\text{Austerity}} = 0,$$

where ξ_t denotes the Lagrange multiplier associated with the wage rigidity, and η_t that of the government budget constraint. At the optimum, the government has to be indifferent between spending one additional unit, which provides a direct marginal utility benefit of $v'(g_t^N)$, and the marginal costs. In a model without nominal rigidities or distortionary taxes, the marginal costs would be simply given by the resources given up for private consumption, $u_N(c_t^N)$, as indicated by the Samuelson rule. However, the presence of downward wage rigidity implies that higher spending will increase output when the economy has slack on the labor markets, isolated in the second term.

The last term isolates the marginal cost from the increase in spending in the tightening of the government budget constraint. An increase spending tightens the budget constraint by p^N, which is the direct cost of the extra unit of public goods, plus the effect of the increase in spending on the inframarginal units of spending, which is the second term in the austerity term. The overall marginal utility effects are given by this increase in spending times the Lagrange multiplier on the government budget constraint.

Default plays a crucial role in the model to shape the austerity term by linking the Lagrange multiplier on government budget constraint to the bond price schedule through the Euler equation with respect to debt.

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

This bond Euler equation says that the government equates the marginal cost from borrowing today and spending in public goods to the marginal cost of cutting spending tomorrow and repaying the debt. If the government raises one more units of bonds it obtains a price q net of how the increase in borrowing reduces the bond price of the inframarginal units of borrowing. The more the bond price declines with the increase in government borrowing, the higher is the Lagrange multiplier on the government budget constraint, everything else constant. As a result, when default risk is elevated, stimulus become more costly.

To further illustrate this trade-off, Figure 1 shows how the equilibrium allocations change with a one-period deviation in the level of government spending from its optimal level.[5] The tradable endowment is set to its unconditional mean and the current debt level is given by the mean of its asymptotic distribution in the calibrated model. In each panel, the red dot indicates the level of the variable of interest at the optimal level of government spending.

As Figure 1 shows, the relative price of nontradable goods is an increasing function of g^N. In turn, this translates into higher employment. As employment rises, so does the private nontradable consumption.[6] Since additional spending is only financed with debt, tradable consumption increases as well. As a result, the fiscal multiplier is larger than one.

[5]To conduct this exercise we used the calibrated economy of Section 3.

[6]Eventually, as full employment is achieved, further increases of g^N start crowding out c^N.

On the cost side, the last panel of Figure 1 shows that increasing government spending above the optimal level leads to a sharp decline in bond prices, reflecting the higher risk of future default associated with higher debt levels. In addition to the rising borrowing costs, a higher likelihood of defaulting also entails larger expected welfare losses associated to it. As it can be seen from the equilibrium allocations under optimal policy, such costs deter the government from providing sufficient stimulus to attain full employment.

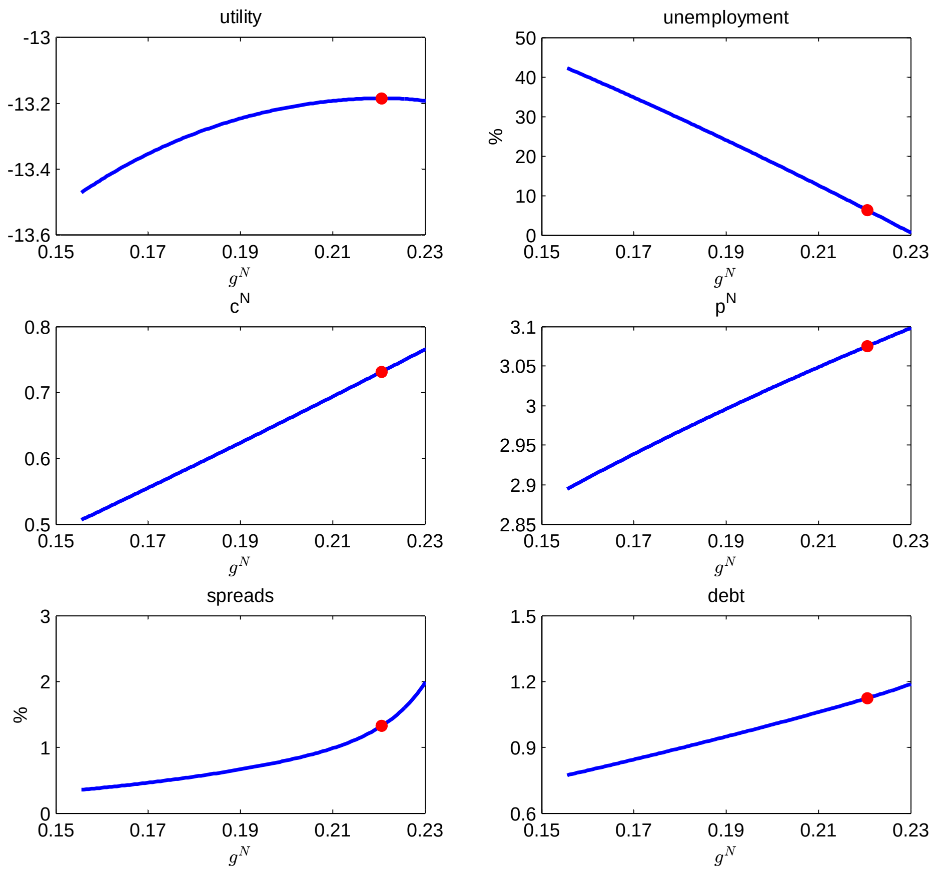

Figure 1: Utility, prices and allocations under repayment for alternative values of current g^N.

Note: Blue lines correspond to repayment levels of utility, unemployment, nontradable consumption, relative price of nontradable goods, spreads, and debt, as function of current government spending, given current tradable endowment equal to its unconditional mean and average debt level. Red dots indicate equilibrium levels given optimal government spending.

3 Quantitative Analysis

3.1 Calibration

To characterize the aggregate dynamics under the optimal fiscal policy we calibrate the model to match key moments in the data at an annual frequency for the Spanish economy over the period 1996-2015. The model is solved numerically using value function iteration with interpolation.[7]

Functional Forms. We assume constant relative risk aversion (CRRA) utility functions for private and public consumption:

$$u(c) = (1-\psi_g)\frac{c^{1-\sigma}}{1-\sigma},$$
$$v(g) = \psi_g \frac{g^{1-\sigma_g}}{1-\sigma_g},$$

scaled by the relative weights $(1-\psi_g)$ and ψ_g, respectively. Also, we consider an isoelastic form for the production functions in nontradable sector:

$$F(h) \;=\; h^{\alpha}, \qquad \alpha \in (0,1).$$

For the direct utility cost of default given by $\psi_\chi(y^T)$, we follow Bianchi, Hatchondo, and Martinez (2016) and assume the following form:

$$\psi_\chi(y_t^T) = \max\{0, \psi_\chi^0 + \psi_\chi^y \log(y_t^T)\}, \tag{19}$$

with $\psi_\chi^y > 0$. A similar specification but for output costs has been shown by Chatterjee and Eyigungor (2012) to be crucial for matching bond spreads dynamics, in particular reproducing spreads volatility.

We assume that the tradable endowment y_t^T follows a log-normal AR(1) process,

$$\log y_{t+1}^T = \rho \log y_t^T + \sigma_y \varepsilon_{t+1},$$

[7] Linear interpolation is used for the endowment and cubic spline interpolation for debt levels. 71 gridpoints are used for endowment and debt in the solution algorithm. To compute expectations, 15 quadrature points are used for the endowment realizations. The results presented in this section are for a version of the model with $\tau_t = \overline{\tau}$. The version of the model with $\tau_t \leq \overline{\tau}$ are work in progress.

with $|\rho| < 1$, and where the shock $\varepsilon^y_{t+1} \sim i.i.d.\, \mathcal{N}(0,1)$.

Parameter Values. All selected parameter values used in the baseline calibration are shown in Table 1. The parameters ρ and σ_ϵ for the stochastic process of y^T_t are estimated using log-quadratically detrended data on the value-added in the agricultural and manufacturing sectors for Spain. Time series at an annual frequency for real output in these sectors (and overall economy), as well as for unemployment, are taken from the National Accounts in the National Statistics Office (INE) of Spain. The estimation yields $\rho = 0.777$ $\sigma_y = 0.029$.

The maturity parameter δ is set to generate an average bond duration of 5 years, in line with the data.[8] The debt level $\bar{b}_t$ 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 $\bar{b}_t = \frac{\delta}{1-(1-\delta)/(1+r)} b_t$.

The coefficient of relative risk aversion of private consumption is set to 2, which is standard in the literature. Similarly, the coefficient of risk aversion of public consumption σ_g is also set to 2. The value of the parameter μ implies a Cobb-Douglas specification for the consumption aggregator and an elasticity of substitution between tradable and nontradable consumption of 1, only slightly above the range of values typically used in other studies. The share of tradables in the consumption composite implies a ratio of tradable output-to-total output of around 0.25, in line with the data.

The international risk-free rate r is equal to 2 percent, which is roughly the average annual gross yield on German 5-year government bonds over the period 2000-2015. Data on bond yields for Germany and Spain has been taken from Deutsche Bank and Banco de España, respectively. The reentry probability θ is set to generate an average autarky spell of 5 years, which is very close to the average 4.7 years until resumption of financial access reported by Gelos, Sahay and Sandleris (2011) over the period 1980-2000 for 150 developing countries.

The households' inelastic supply of hours to work is normalized to 1. The labor share in the production of nontradable goods is 0.75, which is the estimate found by Uribe

[8] The Macaulay duration of a bond with price q and our coupon structure is given by

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

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

Table 1: Parameters Selected Directly

Parameter	Value	Description
σ	2	Coefficient of risk aversion, private consumption
σ_g	2	Coefficient of risk aversion, public consumption
$1+\mu$	1	Inverse of intratemporal elasticity of substitution
ω	0.3	Share of tradables
α	0.75	Labor share in nontradable sector
r	0.02	Risk-free rate
θ	0.24	Reentry probability
$\overline{h}$	1	Inelastic supply of hours worked
ρ	0.777	AR(1) coefficient of productivity y_t^T
σ_y	0.029	Standard deviation of ε_t
Parameters set by simulation		
β	0.902	Subjective discount factor
ψ_g	0.006	Weight of public consumption in utility function
ψ_χ^0	0.33	Utility loss from default (intercept)
ψ_χ^y	1.78	Utility loss from default (slope)
$\bar{w}$	3.09	Lower bound on wages
$\overline{\tau}$	0.93	Tax level

(1997) for Argentina.

The five remaining parameters are calibrated to match five moments from the data: the time discount factor β, the scalar pre-multiplying the government spending term in the utility function ψ_g, the two parameters determining the utility loss of default, ψ_χ^0 and ψ_χ^y, and lower bound on wages, $\overline{w}$.

The discount factor β is chosen to match the average external debt-GDP ratio.[9] This yields $\beta = 0.902$, which is within the range of values used in the sovereign default literature (see, for example, Aguiar and Gopinath, 2006 and Chatterjee and Eyigungor (2012)). The limit on taxes is is calibrated to replicate the average government spending observed in the data for Spain from 1996 to 2015, which amounts to 18.3 percent of total output. The lower bound on wages $\bar{w}$ is set to generate an unemployment rate of 10 percent on average in the simulations, which is lower than the 15 percent observed for Spain during the period in consideration.[10] Finally, the parameters ψ_χ^0 and ψ_χ^y are chosen to mimic the mean and volatility of spreads in the data. For the reasons described in Aguiar et.

[9]For external debt, we use total gross debt of the general government held by external creditors, as a fraction of GDP, available at the OECD Government Statistics database.

[10]In our calibration, the economy spends roughly 6 percent of the time with full employment.

al (2016), the model falls short of replicating the volatility of spreads in the data, so we choose the value of ψ^y_χ that delivers the maximum volatility of spreads in our simulations.

3.2 Model Statistics

Table 2 reports the moments of our baseline model, and under the same economy without default risk.[11] To compute the business cycle statistics, we run 100,000 Monte Carlo (MC) simulations of the model with 100,000 periods each, and construct 200 sub-samples of 32 periods of financial access.[12] In order to have a measure of total real output in our model, we compute $\hat{y}$ as the sum of tradable and nontradable output, where the latter is multiplied by the *average* relative price of nontradables in the simulations (in contrast, y is computed using the current p^N in each period).

As is standard in the literature (e.g. Aguiar and Gopinath, 2006; Arellano, 2008), the model can replicate several features regarding the reoccurrence of default events, the high variability of bond spreads and their comovement with economic activity and debt flows, and the volatility of consumption relative to output.

The new key prediction of the model is a procyclical government spending (0.3), close to that observed in the data (0.46). The procyclical fiscal policy in our model is driven by default risk, as the economy with risk-free debt displays a significantly countercyclical fiscal policy, reflecting the Keynesian benefits of fiscal policy.

Our model also generates a positive correlation between government spending and the real exchange rate. In line with the data, expansions of government spending usually come along with a real appreciation.

To disentangle the mechanisms driving the optimal fiscal policy, Table 2 also reports the moments of an economy when the government has access to a commitment technology, and borrows at the risk-free debt. In this case, relative to our baseline model, optimal policy would be countercyclical (-0.52 correlation of government spending with output) because the government does not need to be austere. As the welfare costs associated with

[11] In particular, in this alternative economy, the costs of default are assumed to be infinite, so debt is risk-free. We maintain the rest of the parameters across economies unchanged, except for the discount factor, which is set so both economies have the same debt levels.

[12] To avoid dependence on initial conditions, we disregard the first 1,000 periods from each simulation. Also, while in our model the borrower regains access to credit with no liabilities after defaulting, in the data countries typically do so carrying 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 four years.

Table 2: Business Cycle Statistics: Data and Model

Statistic	Data	Baseline Model	Risk-free Debt
mean(spreads) (%)	1.05	1.12	0
mean($\bar{b}/y$)	22.8	20.3	23.7
mean(y^T/y)	20.2	20.3	20.3
mean($p^N g^N/y$)	18.1	18.3	18.5
mean(T/y)	14.6	18.8	18.9
mean(h)	0.83	0.93	0.95
cor(g^N, y)	0.46	0.30	$-.52$
cor(g^N, RER)	0.77	0.35	0.56
cor(y, RER)	0.31	0.96	0.27
cor(y, c)	0.98	0.99	0.98
cor(y,spreads)	-0.38	-0.93	-0
$\sigma(p^N g^N)/\sigma(\hat{y})$	2.0	0.9	6.0
$\sigma(c)/\sigma(\hat{y})$	1.1	1.0	1.2
σ(spreads) (%)	1.4	0.7	0

the financing of government spending are lower, fiscal policy is more often used as an active stabilization tool allowing the government to sustain higher levels of employment on average. Government spending therefore becomes higher and more volatile.

3.3 Policy Functions

This section analyzes the policy functions of the calibrated economy under the optimal fiscal policy. Figure 2 shows the decision rules for unemployment, the real exchange rate, government spending, external debt, nontradable and tradable consumption, wages and spreads as a function of the current debt level. The dashed red and and solid blue lines in each panel correspond to a low and a high realization of the tradable endowment y^T, respectively.[13] The discontinuity point is to the default threshold: allocations and prices to the left of it (lower debt) are plotted for repayment; to the right of it (higher debt) they are plotted for autarky.

Figure 2 shows an interesting pattern for optimal government spending, which is highly

[13] More specifically, the low (high) realization corresponds to the one unconditional standard deviation below (above) the unconditional mean of y^T.

dependent on the current debt position. Let us focus on the blue lines, which correspond to the high income realization. There are three different regions in this Figure. The first region to the right is the default region. Here, high levels of debt imply that the government finds it optimal to default, and has more resources available to spend in public goods. For levels of debt below, the government enters the repayment region and spending is reduced discretely relative to the autarkic level. This occurs because the government uses some of its available resources to make the coupon payments. (While the government is able to borrow, it reduces overall its debt issuance, given the steep spread schedule.) In this second region, government spending is *decreasing* in the current level of debt. This decrease in spending for higher levels of debt is the outcome of opposing Keynesian and austerity forces. On one hand, as current debt is increased, there is more need for active stabilization by the government. Higher levels of debt are associated with lower levels of aggregate demand, which in turn lead to a more depreciated real exchange rate and higher unemployment. That is, the Keynesian channel is stronger as current debt is increased. On the other hand, higher current levels of debt are associated with higher new debt levels, and hence higher spreads. Since bond proceedings fall (depressed bond prices, higher coupon repayments and lower debt issuance), more taxes are required. As a result, we observe a growing need for austerity as it becomes more costly to do expansionary fiscal policy. Overall, we find that the second effect dominates, and the government spends *less* when debt increases. Put it differently, the higher is the debt, the stronger is the austerity channel relative to the Keynesian channel. For low levels of debt, the economy enters a third region, characterized by full employment. At this current debt level, government spending is sufficiently large that brings the economy to full employment. In this region, the wage rigidity constraint is still binding, though. Consequently, given full employment, the real exchange rate is held constant over this interval. It is the active stabilization policy that keeps the economy at full employment. The optimal size of government spending becomes increasing in the level of debt. As debt is reduced, less stimulus is needed to keep the economy at full employment. Hence, in order to avoid crowding out of private consumption, government spending is optimally cut. It is worth pointing out that for savings levels (not shown in the figure), the market wage would increase above the sticky wage. Also, in that case p^N would jump and government spending would become even more increasing in debt given the absence of Keynesian benefits.

Figure 2 also shows the impact of tradable endowment on the level of government spending and the overall economy. The role of the tradable endowment is twofold. First, as emphasized in standard models of default, a low income shock leads to higher incentives to default in the future and a deterioration of borrowing opportunities. Facing adverse income shocks, the government raises taxes and cuts spending (see Cuadra, Sanchez, and Sapriza, 2010). Second, as tradable income falls, this leads to a decline in aggregate demand setting in motion a recession in the nontradable sector. Since preferences are homothetic and there is an infinitely elastic demand for tradables, the price of nontradable goods needs to fall to clear the excess supply of nontradable goods that results from the decline in income. Due to the downward wage rigidity, the decline in the price of nontradables leads to increases in the real wage measured in units of nontradables, and firms contract labor demand.

An increase in government spending in nontradable goods contributes to offset the reduction in private demand, thereby mitigating the deflationary spiral and the increase in unemployment. Does government spending increase or decrease when the tradable endowment falls? The answer to this question depends on which of the three regions the economy is in. If the economy is in default for both levels of endowment realizations, government spending is higher for the high income shock. At low levels of income, the government needs to collect more distortionary tax revenue for the same level of spending, which is costly. As debt level falls below 0.7, the economy repays for the positive shock, and remains in default for the adverse income shock. Here, the government spends more in case of a negative income shock. For the reasons described above, as the government stops repaying debt, there are more resources devoted for spending. As debt is reduced further, to the point that repayment is optimal for the adverse shock as well, and as long as unemployment prevails for both income realizations, the government spends more with higher income, in line with the austerity prescription. Interestingly, the difference between the two levels of spending for the two different shock shrinks as debt is reduced. Eventually, the Keynesian channel dominates and spending is larger for lower levels of income. To shed further light on this, we will be conducting impulse responses to endowment shocks in Section 3.4.

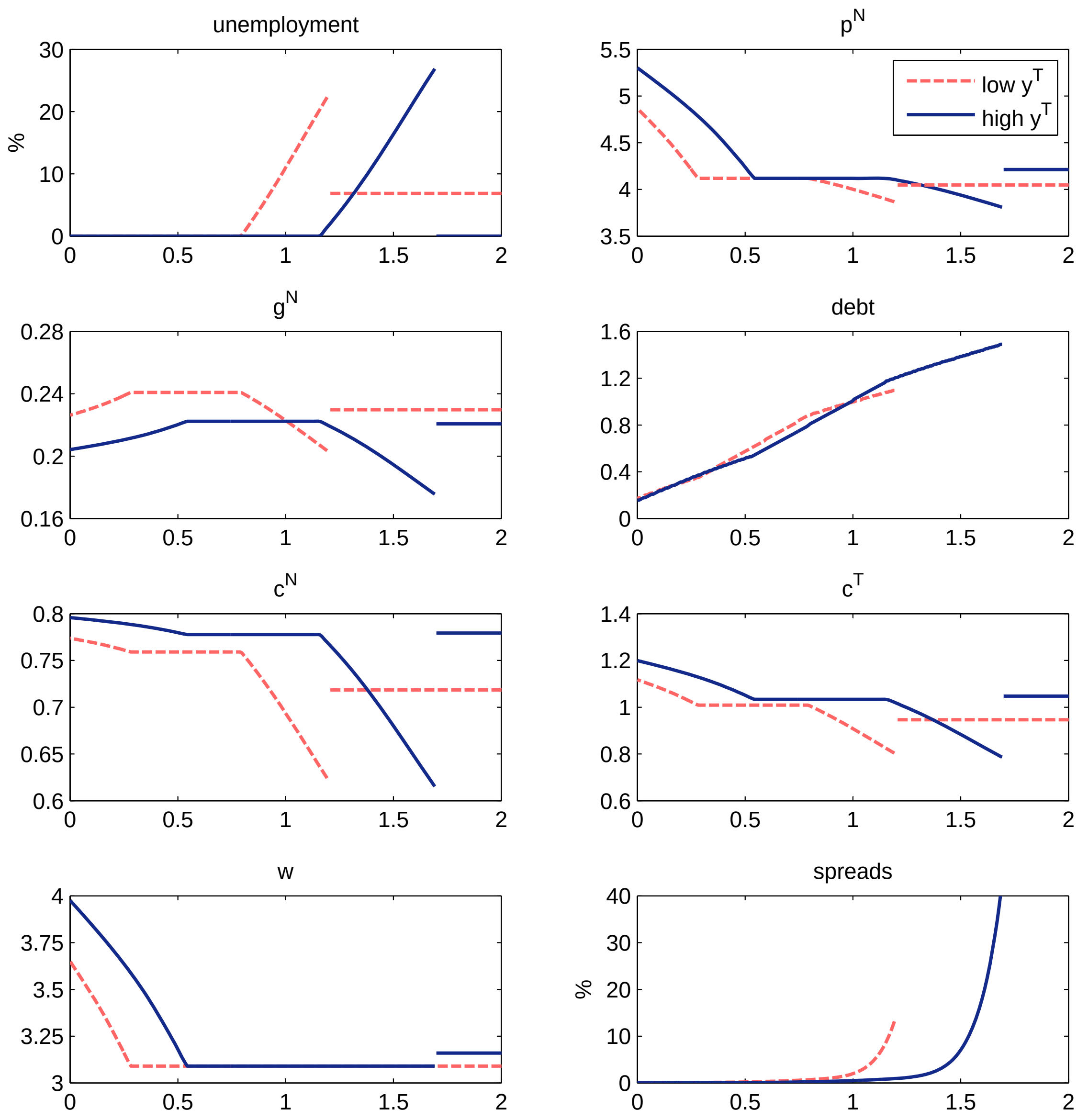

Figure 2: Policy Functions with Optimal Government Spending, as Function of Current Debt b.

Note: Dashed red lines correspond to the low y^T realization and solid blue lines correspond to the high y^T realization.

3.4 Impulse Responses

In this section, we investigate the response of the economy to a negative income shock, and show how the optimal size of government purchases depends critically on the sovereign debt level.

We examine the model dynamics after a negative shock to endowment y^T hits the economy. To do so, we initiate our economy from the repayment state with steady-state y^T level and two different debt levels, and consider a (one-time) shock ε_1 of size σ_y at time 1 and no additional shocks thereafter.[14] We then report in Figure 3 the simulated responses of unemployment, relative price of nontradables, government spending, debt, spreads, tradable consumption, and nontradable consumption, for 20 periods after the shock. The two levels of debt considered are $0.5b_0$ ("low debt") and $1.5b_0$ ("high debt"), where b_0 is the ergodic mean of debt. For each initial debt level, we plot a different line in Figure 3.

As shown in the figure, a decrease in tradable endowment leads to a decline in consumption of both tradables and nontradables for all initial values of debt. Tradable consumption falls due to the wealth effect. Given that preferences are homothetic, households' demand for nontradables declines, pushing down the relative price p^N. Due to the downward wage rigidity, the decline in the price of nontradables increases the real wage measured in units of nontradables. Firms reduce labor demand and unemployment rises. Moreover, spreads go up reflecting higher incentives for future default.

A key finding illustrated in Figure 3 is that the optimal response of the government to a negative income shock depends critically on the level of debt. When the stock of debt is initially high, the government contracts sharply the amount of government spending, following the austerity prescription. Because the negative shock triggers an increase in sovereign spreads, the government finds it more costly to engage in an expansionary fiscal policy and reduces debt levels. As analyzed above, eventhough the Keynesian stabilization motive is stronger in this case, the austerity channel dominates, and the government cuts spending severely.

When the stock of initial debt is low, government spending increases in response to a negative shock, following the standard keynesian prescription. Facing lower spreads, the

[14] We find this exercise more informative that computing standard impulse responses after simulating our model for a large number of different random sequences of y^T since in our environment default would typically occur for some income paths influencing the dynamics of the model in the subsequent periods.

government sharply increases borrowing to finance the stimulus and is able to mitigate unemployment.

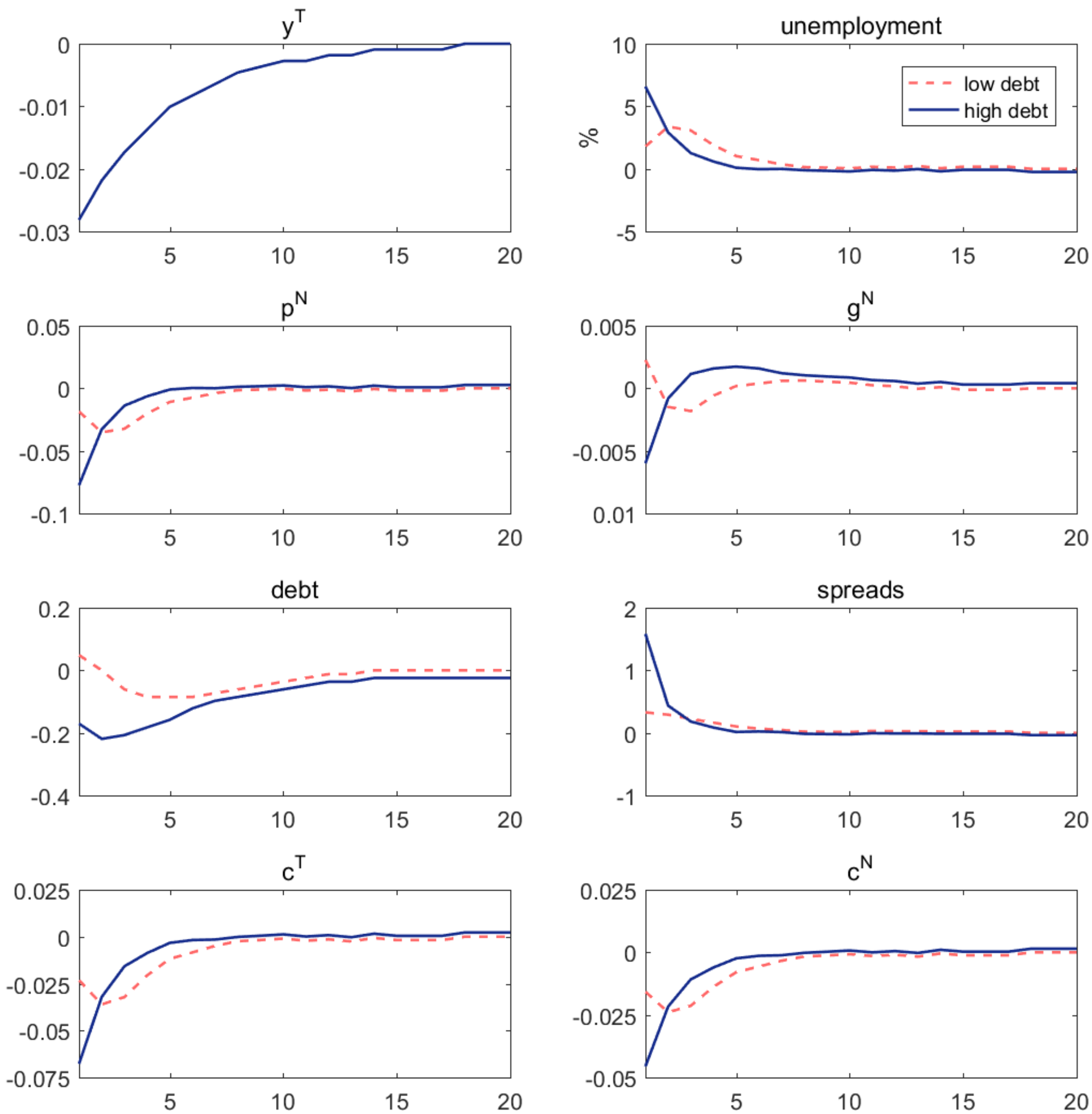

Figure 3: Responses of Key Variables to One-Time Negative Shock to y^T.

Note: given an initial state (y^T, b), responses of tradable endowment, unemployment, relative price of nontradables, government spending, debt, spreads, tradable consumption, and nontradable consumption, when y^T decreases one standard deviation in period 1. Responses are computed as absolute deviations from levels when y^T is set to its unconditional mean in all periods. The initial y^T equals its unconditional mean.

3.5 Dynamics around Default Events

To better understand the role of default in our economy and its interaction with fiscal policy, we show next the evolution of key macro variables around the default announcements. To that end, we pick 1,000 default announcements in our Monte Carlo simulations that were preceded by at least 6 periods of access to financial markets and that were followed by at least 4 periods of financial autarky. We then compute the equilibrium levels in those periods for tradable income, tradable and nontradable private consumption, taxes, employment, government spending, bond spreads, debt level, and relative price of nontradables. Figure 4 displays the dynamics of the cross-sectional medians of these variables in a 9-period window around the default announcements. Default occurs in period 0.

As shown in the top panel, default episodes are preceded by a decreasing sequence of income realizations, which hits the bottom in the period of the announcement. Tradable consumption falls by around 10 percent over the periods prior to the default. When the government defaults in period 0, it makes available some tradable resources that prevent tradable consumption from falling further along with income. Similarly, as aggregate demand drops, nontradable consumption decreases and the real exchange rate depreciates. As wages cannot adjust downward, unemployment climbs 9 percentage points.

During the debt crises, with typically high indebtness levels and sizable borrowing costs, the government decides to moderately reduce its debt position, which cannot prevent bond spreads from rising even further as the state of the economy deteriorates. Despite the downward pressure on the relative price p^N, the government finds it optimal to follow the austerity prescription and cuts government spending. After the default event, as tradable income recovers, so do private and public consumption.

To illustrate the optimality behind the default choice, Figure 5 depicts the dynamics of key variables under the assumption that the government would be forced to repay.[15] Given the inability of the government to raise taxes, repayment can only be obtained by sharply contracting government spending. This contraction of government spending in turn would imply a large increase of unemployment, from 12 percent in the default scenario, to over 20 percent in the scenario in which the government is forced to repay. In our framework default decisions have therefore a Keynesian motive, namely, preventing the massive increase of unemployment that would imply to repay high debt levels.

[15] During this counterfactual, we assume the government being forced to repay is not incorporated to bond prices.

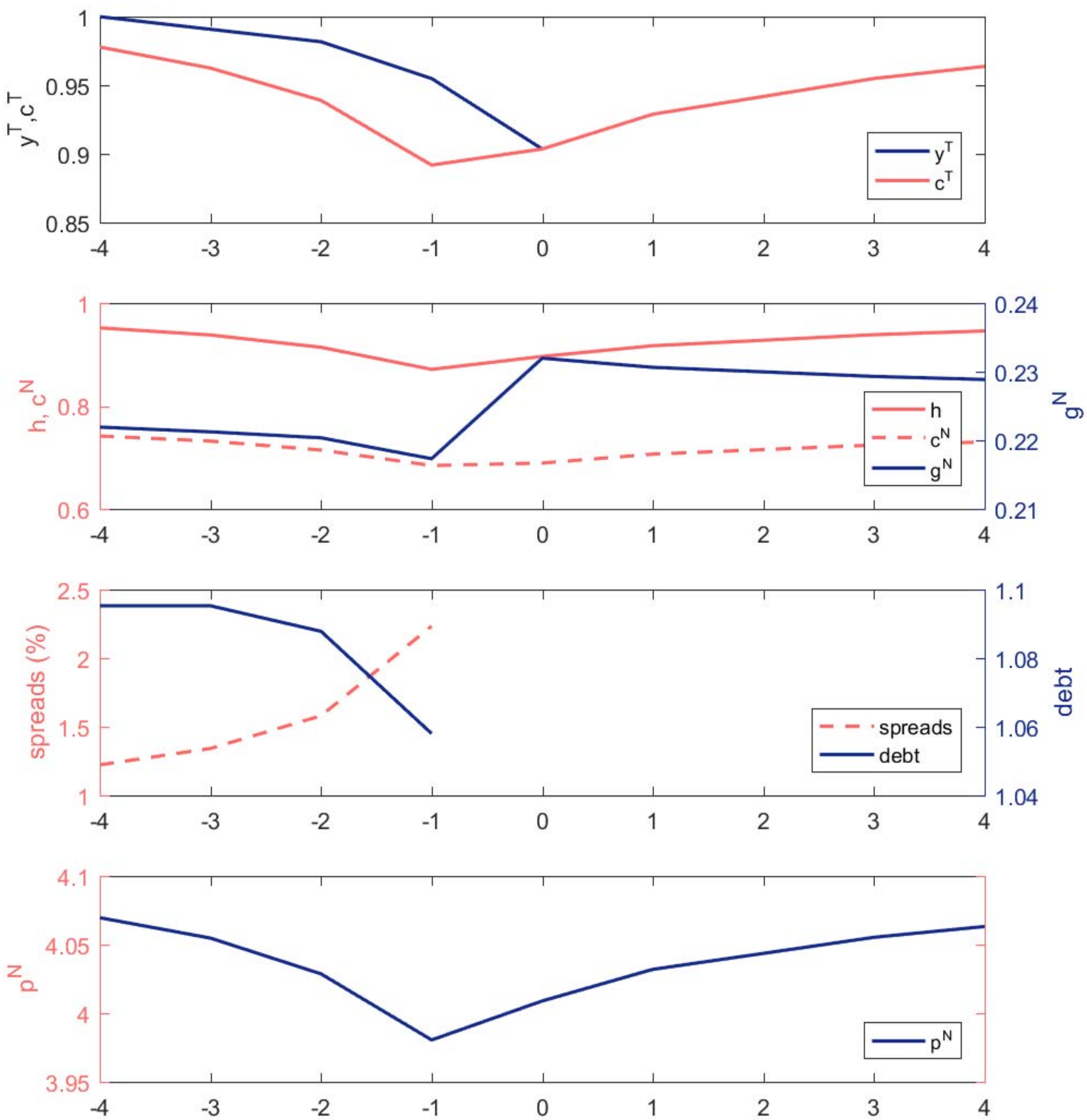

Figure 4: Dynamics around default events.

Note: Cross-sectional medians of levels of y^T, c^T, h, c^N, g^N, bond spreads, debt, and p^N around default announcements. Default occurs in period 0.

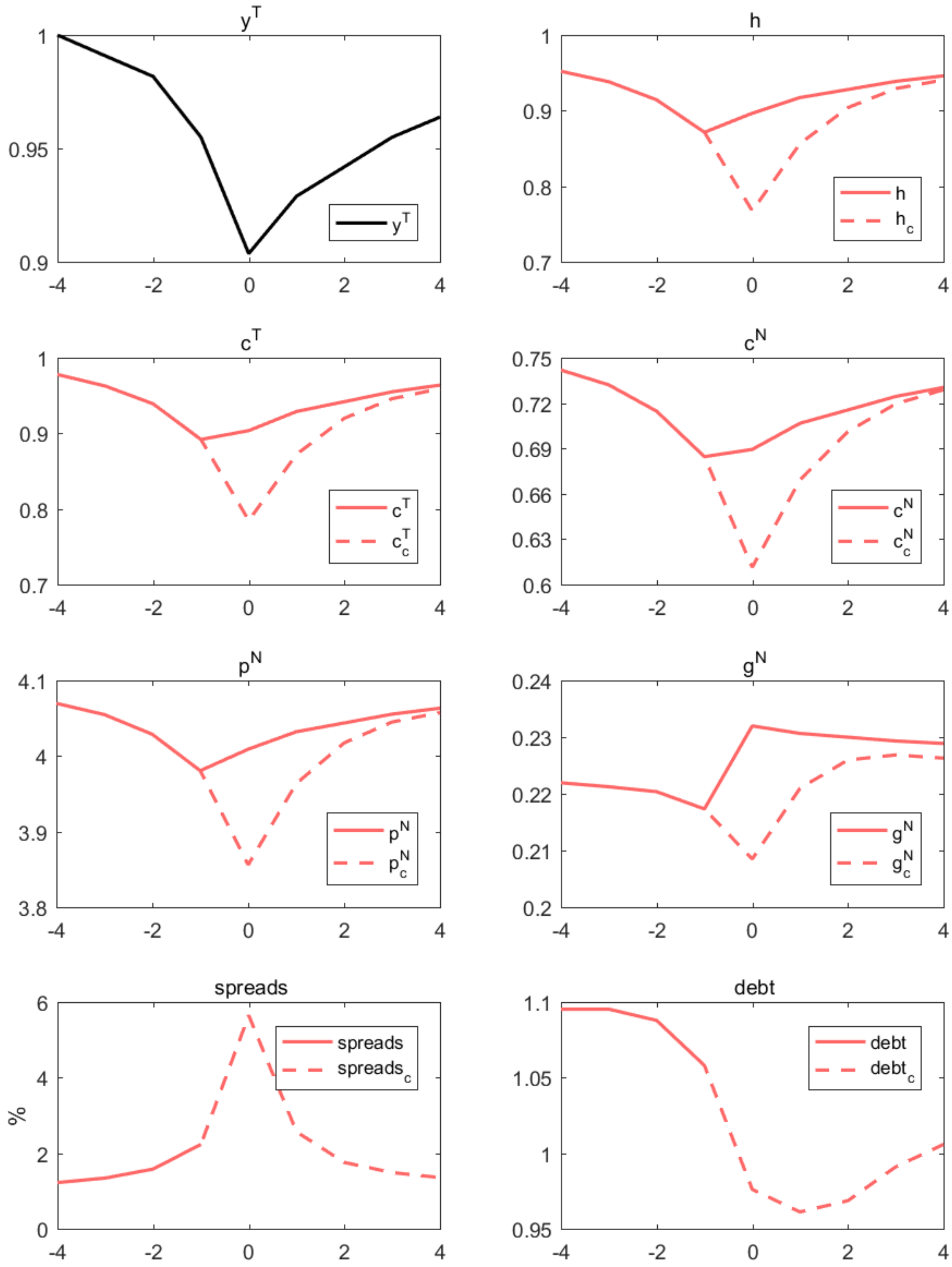

Figure 5: Counterfactual Dynamics around Default Events.

Note: Cross-sectional medians of levels of y^T, c^T, τ, h, c^N, g^N, bond spreads, debt, and p^N around default announcements. Default occurs in period 0.

4 Empirical Evidence

The model has two main testable implications. First, in recessions, governments should contract more spending when debt is high. Second, recessions should be more severe when debt is high. In this section we document that these predictions are consistent with data from the cross-section of a sample of recession episodes in emerging economies. We expand the analysis to several countries – rather than only analyzing our calibrated economy– to be able to analyze a larger set of recession episodes. We focus on emerging economies because these are countries integrated to international credit markets that typically have default risk.[16]

We follow the event-study approach around recession episodes, following standard practices in the empirical literature (see, for example Calvo, Coricelli, and Ottonello, 2014). We define a recession episode as a contraction of annual output (real per-capita GDP), obtaining a sample of 105 recession episodes. We then study the dynamics of government spending and output in a window around the recession episode. This window goes from the period displaying the maximum cyclical component of output preceding the recession event (recession peak) to the period after the recession event in which output recovers its trend level (recession recovery). The recession trough is the period between the peak recovery points displaying the minimum level of the cyclical output. We then sort episodes according to their external debt levels (net foreign liabilities) at the recession peak, and classify episodes into those with an initial debt level above the mean (high-debt episodes) and those with initial debt level below the mean (low-debt episodes).

Figure 6 depicts the dynamics of government spending, external debt, and output for high- and low-debt recession episodes. Results indicate that whereas during low-debt episodes government spending is relatively flat from the recession peak-to-trough, it contracts by 5 percent for high-debt episodes. It is worth mentioning that output contracts more in high-debt episodes, suggesting that Keynesian motives to expand government spending should be higher in these episodes. Figure 6 also shows that external debt is relatively flat in the recession peak-to-trough in high-debt episodes, whereas it significantly

[16] In particular, we focus on economies that are part JP Morgan's Emerging Market Bond Index (EMBI), which is a measure typically used in the literature to capture middle-income economies integrated in global capital markets. Countries included in the sample are Argentina, Brazil, Bulgaria, Chile, Colombia, Croatia, the Czech Republic, the Dominican Republic, Ecuador, El Salvador, Hungary, Indonesia, Ivory Coast, Lebanon, Malaysia, Mexico, Morocco, Nigeria, Panama, Peru, the Philippines, Poland, Russia, South Africa, South Korea, Thailand, Tunisia, Turkey, Ukraine, Uruguay, and Venezuela.

increases in low-debt episodes. This evidence is consistent with government adjusting government spending to reduce default risk, as suggested by our theoretical framework.

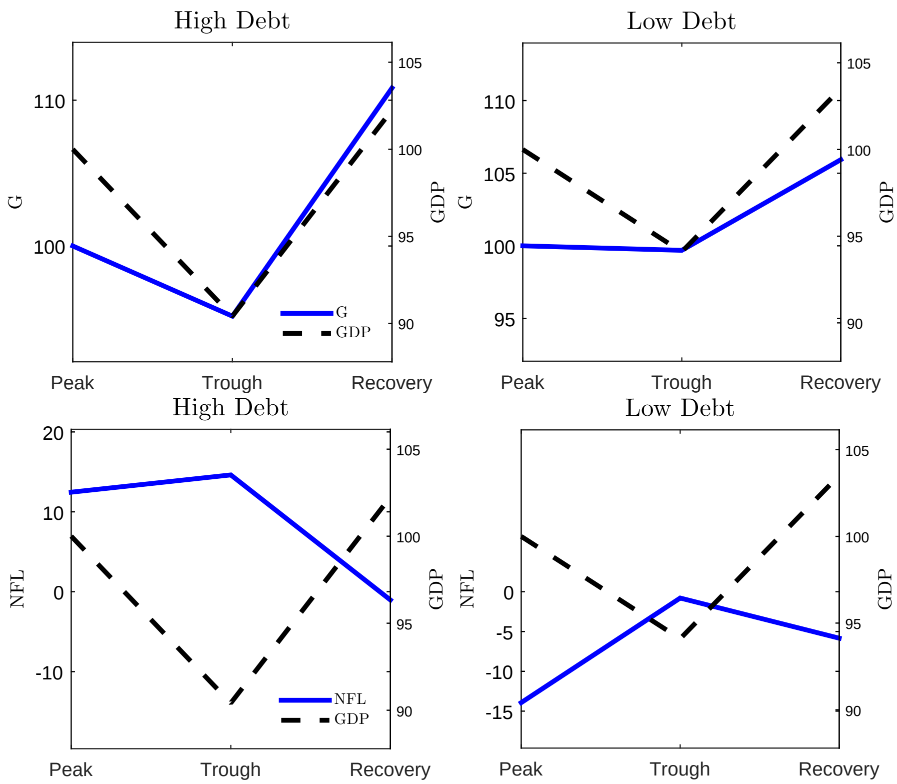

Figure 6: Fiscal Policy during Recession Episodes.

Note: G: real government spending per person in woking age, peak level =100; data source: WDI. GDP in real terms per person in woking age, peak level=100; data source: WDI. NFL: net foreign liabilities over GDP; data source: Lane and Milesi-Ferreti (2007) dataset. Includes 105 recession episodes in emerging economies.

5 Conclusion

We studied the positive and normative implications of fiscal policy in a sovereign default model with nominal rigidities. The presence of wage rigidity creates a role for stabilization policy during recessions. Sovereign default risk, however, makes it costly to run a debt-financed stimulus.

We show that the stabilization effects of fiscal policy are highly non-linear in the severity of the recession. When the level of unemployment is high, fiscal multipliers are large. On the normative side, the optimal amount of government spending depends critically on the sovereign debt level. When the stock of debt is relatively low, recessions call for strong stabilization policy. As debt increases and the government becomes more exposed to a sovereign default, the optimal response becomes more austere.

In work in progress, we are considering aspects of commitment in the conduct of optimal fiscal policy and in the design of fiscal rules.

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