Expansionary Fiscal Consolidation Under Sovereign Risk*

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Abstract

We study how debt limits can be expansionary in economies that face sovereign risk. We develop a sovereign default model with capital accumulation, long-term debt, and fiscal rules. The model features two distortions: debt dilution and a pecuniary externality of private investment on default incentives. The optimal debt limit increases capital accumulation due to lower sovereign risk, generating an economic expansion in the long-run. Welfare gains are a result of a significant reduction in spreads due to expectations about future borrowing and investment. We present evidence of a positive relation between debt limits and investment, and a negative one between debt limits and spreads; which are consistent with the predictions of the model.

Keywords: Fiscal rules, Sovereign debt, Expansionary fiscal consolidation.

JEL Codes: F34, F41

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1 Introduction

The economic downturn from the pandemic and its consequent fiscal needs led to historically high levels of public debt. In the aftermath of COVID-19, most economies face the challenge of restoring their fiscal health while attempting to strengthen their economic recovery. In contrast to advanced economies, this challenge is particularly difficult for emerging economies, who pay significant and increasing sovereign spreads (see Kose, Ohnsorge, Nagle, and Sugawara (2020)). The supportive fiscal expansions from the pandemic are not sustainable and prospects of debt crises loom in the horizon of many emerging economies. However, an ambitious fiscal consolidation plan that drastically reduces the level of debt poses a conundrum for these economies. On one hand, it could lead to a sharp growth deceleration in the short-run; but, on the other, healthy public finances could lead to lower spreads and higher economic activity in the long-run. This trade-off, which is less prevalent in advanced economies, gives rise to the question of whether adopting fiscal rules that limit debt accumulation can lower sovereign spreads and, in turn, boost aggregate investment.

We study emerging economies that face high sovereign risk, which distorts capital accumulation in the long-run. Debt reduction in these economies can be desirable because it ameliorates these distortions. This is in contrast with most of the literature on expansionary fiscal consolidation, which focuses on rich economies and short-run "Keynesian" and "Ricardian" effects of fiscal policy (see for instance Giavazzi and Pagano (1990), Alesina and Ardagna (2009), and Guajardo, Leigh, and Pescatori (2014); we discuss the differences between our paper and this line of work in the literature review below).

We develop a sovereign default model of a small-open economy with capital accumulation, long-term debt, and fiscal rules. Domestic households make aggregate investment decisions and lack access to international financial markets. There is a benevolent government that makes optimal borrowing and default decisions on behalf of the households. The government has to finance a fixed stream of expenditure in each period, for which it can levy a proportional income tax and issue debt (up to a limit). We model fiscal rules as an upper bound to the debt-to-GDP ratio, following the benchmark analysis by Hatchondo, Martinez, and Roch (2022). Whether the debt limit binds depends, then, on both the history of government borrowing and the history of capital accumulation.

There are two distortions that arise from default risk in this economy. The first, is the debt dilution problem studied by Hatchondo, Martinez, and Sosa-Padilla (2016) due to the presence of long-term debt. The second, is a result of the interaction between private investment and default incentives. When the government defaults, there is an exogenous dead-weight cost to productivity, so high default risk lowers expected returns to capital and depresses aggregate investment. In addition, households do not internalize how low investment increases default incentives and further limits the government's ability to rollover its debt. Potential welfare gains from imposing a debt limit come from how lower default risk ameliorates these two externalities, which is the main focus of our quantitative analysis.[1]

We calibrate the model using data for Indonesia, a representative emerging economy that has committed to a debt rule since 2004.[2] Our main quantitative exercise consists of calculating welfare gains from implementing a limit to the debt-to-GDP ratio and computing its optimal level. The optimal debt limit yields positive welfare gains and is lower than the average debt level in the less-constrained economy. We then study average dynamics of the main macro-aggregates in the model in the transition after the introduction of the fiscal rule.

Since the economy starts with a debt level higher than what the fiscal rule allows, there is a costly fiscal consolidation transition, in which GDP, investment, and consumption decrease to finance the debt reduction. Importantly, sovereign spreads drop on impact as a response to the implementation of the fiscal rule and continue to further decline as the economy deleverages and increases its stock of capital. In the long-run, the economy converges to an ergodic distribution that features higher average GDP, capital, and consumption, as well as lower spreads and debt. Overall, higher consumption and lower spreads in the long-run are the main source of the positive welfare gains that we find, despite the painful adjustment period at the beginning of the transition. It is important to stress that our model does not consider other channels through which default risk can affect production, such as the balance-sheet effects in Bocola (2016) or lower entry and higher exit of firms as documented by Chaumont, Melkadze, and Vardishvili (2023). These additional chan-

[1] There are other mechanisms through which default risk affects production, which we discuss in detail in the literature review below. Our modeling choice allows us to model default risk endogenously and focus on the role of aggregate capital accumulation.

[2] Following the Asian Financial Crisis of 1997-1998, Indonesia implemented a successful fiscal consolidation plan that paved the way for economic recovery. Even though the fiscal rules implemented in 2004 were part of a comprehensive fiscal consolidation plan and other structural reforms, the adoption of a debt rule in Indonesia can be associated with lower public debt, lower sovereign spreads, and higher private investment.

nels would reduce the initial economic downturn given the large initial drop in spreads—which is driven by expectations of future policy. This would increase the overall welfare gains of debt limits that we find.

Empirically, we provide evidence that supports the key predictions of the model. Using a panel of 27 emerging market economies, we sort countries into two categories: "debt rule" and "no debt rule". While both sets of countries have experienced an increase in private investment since 2000, we show that the surge in private investment is most notable for countries with a debt rule. Moreover, we estimate a panel fixed-effect regression to show that the positive correlation between debt rules and private investment is robust to various specifications. Interestingly, we find that the coefficient associated to the debt rules becomes statistically insignificant once we consider high-income countries, which is consistent with the model in the sense that debt rules affect investment because of the distortionary effect that large spreads have on expected capital returns, which are more prevalent in low and middle-income economies. Finally, we document a negative and statistically significant correlation between debt rules and sovereign spread that sheds light on the role of fiscal rules in creating confidence in financial markets.

Related literature.—This paper relates to the literature that studies whether fiscal consolidation is expansionary or contractionary. Most work in this literature is centered around the juxtaposition of two mechanisms through which fiscal consolidation affects output in the short-run. On one hand, there is the idea based on text-book Keynesian intuition that fiscal consolidation is likely to contract aggregate demand. On the other, is the Ricardian argument that if private agents expect fiscal discipline in the future they will revise upwards their estimate of their permanent income, which will in turn increase current and planned consumption, resulting in an economic expansion following a fiscal consolidation. Giavazzi and Pagano (1990) present evidence from the cases of Ireland and Denmark in the 1980s, when a large scale fiscal contraction was associated with a strong output expansion. In a discussion of their work, Blanchard (1990) develops a simple model to reconcile both ideas and derives two conditions under which fiscal consolidation can be expansionary: low myopia by private agents and the economy being close to the brink of requiring aggressive tax increases due to increasing debt. Our model accommodates both channels of fiscal discipline discussed by these papers: a contraction in the demand for real resources from the government and an increase in households' permanent income through lower expected taxation. However, our model also includes the effects of sovereign risk on investment, an important channel for emerging economies that is absent from these papers.

More recently, Alesina and Ardagna (2009) estimate that fiscal adjustments on the spending side rather than on the tax side are less likely to create recessions. Guajardo, Leigh, and Pescatori (2014) challenge these findings by constructing a dataset that differentiates changes in fiscal policy motivated by a desire to reduce the budget deficit (fiscal consolidation) from those that are responding to prospective economic conditions (cyclical responses). They find that fiscal consolidation has contractionary rather than expansionary effects on output. We differ from these empirical papers in two important dimensions. First, these papers focus on OECD countries, which are mostly rich developed economies. We focus on emerging economies that feature sizeable sovereign spreads. Second, these papers estimate short-run effects of fiscal consolidation, while we study both its effects in the short-run and in the long-run.

We also relate to the literature that studies the effects of default risk on production and investment. Mendoza and Yue (2012) develop a general equilibrium model of sovereign default with production that uses a mix of domestic and imported intermediate inputs, the latter financed with working capital. Upon default, the economy loses access to financial markets and, with this, producers lose access to imported materials, which implies a less efficient mix of intermediate inputs. Their model generates an endogenous drop in TFP following a default, a feature that is key for our results. We, however, assume that this drop is exogenous to simplify the exposition and solution of our model. Bocola (2016) documents how default risk hampers financial intermediation by tightening the funding constraint of domestic banks who hold government debt. He develops a model of banks who hold domestic government debt in which default risk contracts credit to productive firms and generates a recession. Based on a similar mechanism, Arellano, Bai, and Bocola (2020) measure the output costs of sovereign risk by combining a sovereign debt model with firm- and bank-level data. The effects of default risk on aggregate TFP and output estimated by these papers, as well as the aggregate effects of entry and exit estimated by Chaumont, Melkadze, and Vardishvili (2023), are contemporaneous. By construction, our model does not feature any "pass-through" of sovereign risk to current production or TFP. We, instead, focus on the dynamic effects that risk of future default has on present investment and, thus, on future output. We view our theoretical work as complementary to the work in this literature. Our modeling choice is intentionally more parsimonious on the details of aggregate production. In particular, we abstract from firm heterogeneity and domestic financial frictions, which allows us to model default risk endogenously and to study aggregate capital accumulation. The fact that default risk could further depress investment and production through the mechanisms documented in this literature implies that our conclusions about the desirability of fiscal rules with debt limits are conservative.

Finally, this paper relates to the literature on fiscal rules. Angeletos, Amador, and Werning (2006) study the trade-off between commitment and flexibility in a consumption savings model with taste shocks privately observed by an agent. They derive conditions under which minimum-savings policies, reminiscent to fiscal rules, characterize the solution to the principal-agent problem. In a similar vein, Halac and Yared (2014), Halac and Yared (2018), and Halac and Yared (2022) study fiscal rules under similar environments. At the core of the conflict studied in these papers is a disagreement between an agent (the government) and a principal (incumbent citizens) over preferences for intertemporal consumption. Fiscal rules emerge as an efficient mechanism through which citizens provide incentives to the government to behave according to their best interest. The government in our model is benevolent, however a similar tension between present and future governments emerges due to the presence of long-term debt (this is the debt-dilution problem studied by Hatchondo, Martinez, and Sosa-Padilla (2016)). More recently, Hatchondo, Martinez, and Roch (2022) study fiscal rules in the context of a quantitative sovereign debt model. We mostly build on their work and develop a richer model with production and capital accumulation to study how fiscal rules can be welfare improving through the interaction between sovereign risk and investment.

Layout.—Section 2 presents the model and discusses the main mechanisms and trade-offs in detail. Section 3 describes the numerical solution of the model, and presents the calibration and the quantitative exercises. Section 4 presents the empirical analysis. Section 5 concludes.

2 Model

We mostly build on the model developed by Gordon and Guerron-Quintana (2018). Our main deviation is to assume that aggregate investment is decentralized, chosen by domestic households instead of by the sovereign. There is a small-open economy populated by a large number of identical households, a competitive firm, and a benevolent government. Production of the final consumption good is carried out by the firm, which rents capital from households. Households own the firm and all the capital in the economy but do not have access to international financial markets. The benevolent government borrows on behalf of the households from risk-neutral foreign lenders and levies a proportional tax on total household income. The government cannot commit to repaying its debt, and lenders consider default risk when pricing it.

Preferences and technology.—Households have preferences for consumption of a tradable good c_t in each period represented by $u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$. They discount the future at a rate β and are relatively more impatient than international investors. That is, $\beta(1+r^*) < 1$ where r^* is the international risk-free interest rate. Households own all the capital in the economy and rent it to the firm for r_t. Capital depreciates at a rate δ and households face a quadratic capital adjustment cost $\frac{\phi}{2}\left(\frac{i_{k,t}}{k_t}\right)^2$, where $i_{k,t} = k_{t+1} - (1-\delta)k_t$ is investment and $\phi > 0$. The budget constraint of a representative household is:

$$c_t + i_{k,t} + \frac{\phi}{2}\left(\frac{i_{k,t}}{k_t}\right)^2 \leq (1-\tau_t)\left[r_t k_t + \Pi_t\right] + T_t, \tag{1}$$

where Π_t are profits from the firm, τ_t is a proportional income tax, and T_t is a lump-sum transfer from the government.

The consumption good is produced by the competitive firm with capital using technology $y_t = z_t A K_t^{\alpha}$, where K_t is all the capital rented by the firm, α is the capital share of income, z_t is a productivity shock, and A is a scaling parameter.[3] The productivity shock follows an AR(1) process:

$$\log z_{t+1} = (1-\rho)\log(\mu_z) + \rho\log(z_t) + \epsilon_t,$$

where ρ is the persistence parameter, $\epsilon_t \sim N\left(0, \sigma_z^2\right)$, and μ_z is mean productivity in the long-run.

Government debt and default.—The government is benevolent and makes borrowing decisions on behalf of the households. It issues long-term, non-contingent debt B_t that matures at a rate γ and pays a coupon κ on unmatured debt. The law of motion of debt is $B_{t+1} = (1-\gamma)B_t + i_{b,t}$, where $i_{b,t}$ is net debt issuance in period t. The government must finance a fixed amount of expendi-

[3]Implicitly, we are assuming that there is a unit of labor that is supplied inelastically by the households. We abstract from endogenous labor supply for simplicity.

ture $G > 0$ each period, regardless of the state of the economy. In addition to debt, the government can levy a proportional income tax τ_t and make lump-sum transfers to the households T_t. The government's budget constraint, when it is in good financial standing, is:

$$G + T_t + (\gamma + \kappa(1-\gamma)) B_t = \tau_t [r_t K_t + \Pi_t] + q_t i_{b,t}, \tag{2}$$

where K_t is the aggregate capital stock and q_t is the market price of government debt.

At the beginning of each period, the government can decide to default. If it does so, then it is excluded from financial markets for a stochastic number of periods, and the productivity in the economy drops to $z_D(z_t) = z_t - \max\{0, d_0 z + d_1 z^2\}$, where $d_0 < 0 < d_1$.[4] Therefore, the budget constraint is

$$G + T_t = \tau_t [r_t K_t + \Pi_t]. \tag{3}$$

The government gets readmitted to financial markets with a probability θ and all debt forgiven $B = 0$. The debt is purchased by a large number of risk-neutral investors with deep pockets. Investors pay a price q_t for the government debt and have access to a one-period risk-free bond that pays the risk-free interest rate r^*.

Fiscal rules.—In general, a fiscal rule is a correspondence $\mathcal{F} : \mathbb{R}^3_+ \to \mathbb{P}(\mathbb{R}^3)$ that maps the state space of the economy into the power set of $\mathbb{R}^3$. That is, given a state (z_t, K_t, B_t), the fiscal rule $\mathcal{F}$ returns admissible sets for each of the government's policy instruments (τ_t, T_t, B_{t+1}). For most of our analyses, we will focus on fiscal rules of the form:

$$\mathcal{F}(z_t, K_t, B_t) = \{(\tau, T, B) \,|\, \tau \geq 0, T \geq 0, B \leq \max\{\chi z_t K_t^\alpha, (1-\gamma) B_t\}\} \tag{4}$$

where $\chi \in (0,1)$. This formulation imposes that the debt-to-GDP cannot exceed χ. If, given the current realization of z_t, outstanding debt is already higher than this limit then it must be reduced by at least the fraction γ that matured.[5] In addition, we limit the tax instruments to

[4] We use the quadratic formulation introduced by Chatterjee and Eyigungor (2012) for a pure exchange economy. As discussed by Arellano (2008), an asymmetric cost of default that is increasing in z_t (such as this one) allows the model to generate a counter-cyclical current account and spreads, and default episodes "in bad times", all of which are features of the data for emerging economies. Mendoza and Yue (2012) show that these types of costs from default can be the result of a richer production structure in which some imported materials require working capital financing. For simplicity, we assume this exogenous form instead.

[5] Here, we follow Hatchondo, Martinez, and Roch (2022). This assumption allows a highly indebted government

positive proportional income taxes and positive lump-sum transfers to the households.

Timing.—At the beginning of a period, the government observes (z_t, K_t, B_t) and makes its default and fiscal policy decisions. Then, the households observe the government's choices and make their consumption and investment decisions. Finally, at the end of the period, lenders observe all choices and price the debt accordingly. We assume that the government can commit to policy within the same period. That is, if at the beginning of the period the government announces repayment and a debt issuance $i_{b,t}$, then it issues that amount at the end of the period and pays $(\gamma + \kappa(1-\gamma))B_t$ to the lenders. These assumptions allow us to rule out the multiplicity of equilibria studied by Cole and Kehoe (2000) because lenders price the debt after the government announces its policy and commits to it within the same period. We can also rule out the multiplicity studied by Galli (2021) because lenders price the debt after the capital allocation has been chosen.

2.1 Recursive formulation and equilibrium

The aggregate state of the economy is (z,x), where $x = (K,B)$ is the endogenous state. Let $g = (\tau, T, B')$ be the vector of fiscal policy in a given period, and let $d = 0$ denote that the government is in good financial standing and $d = 1$ that the government is in default.

Households.—The value of a representative household when $d = 0$ is

$$H^P(z,k,x,g) = \max_{k'} \left\{ u(c) + \beta \mathbb{E}\left[(1-d') H^P\left(z',k',x',g^P\right) + d' H^D\left(z',k',K',g^D\right) \right] \right\} \quad (5)$$

$$\begin{aligned} s.t. \qquad & c + i + \frac{\phi}{2}\frac{(i)^2}{k} \leq (1-\tau)\left[r(z,x,d)k + \Pi(z,x,d)\right] + T \\ & i = k' - (1-\delta)k \\ & x' = \Gamma_x^P(z,x,g), \quad g^P = \Gamma_g^P(z',x'), \quad g^D = \Gamma_g^D(z',K'), \quad d' = \Gamma_d(z',x') \end{aligned}$$

where Γ_x^P is the household's belief about the law of motion of the endogenous state x in repayment, Γ_g^P and Γ_g^D are the household's beliefs of fiscal policy in repayment and default, respectively, Γ_d the household's belief about the government's default decisions, the rental rate of capital is $r(z,x,g) = [(1-d)z + dz_D(z)]\alpha K^{\alpha-1}$, and profits are $\Pi(z,x,g) = [(1-d)z + dz_D(z)](1-\alpha)K^{\alpha}$.

to smooth the adjustment toward the debt limit.

The value of the household when $d = 1$ is

$$H^D(z,k,K,g) = \max_{k'} \left\{ u(c) + \beta \mathbb{E}\left[\theta(1-d') H^P\left(z',k',x',g^P\right) + (1-\theta+\theta d') H^D\left(z',k',K',g^D\right) \right] \right\} \tag{6}$$

$$\begin{aligned} s.t. \qquad & c + i + \frac{\phi}{2}\frac{(i)^2}{k} \leq (1-\tau)\left[r(z_D(z),x)k + \Pi(z_D(z),x)\right] \\ & i = k' - (1-\delta)k \\ & x' = \Gamma_x^D(z,x,g), \quad g^P = \Gamma_g^P(z',x'), \quad g^D = \Gamma_g^D(z',K'), \quad d' = \Gamma_d(z,x) \end{aligned}$$

where Γ_x^D is the household's belief about the law of motion of the endogenous state x in default.

Government.—At the beginning of a period in which the government is in good financial standing, its value is

$$V(z,x) = \max_{d\in\{0,1\}} \left\{ dV^D(z,K) + (1-d)V^P(z,x) \right\} \tag{7}$$

where d is its default decision. The value of repaying the debt is

$$\begin{aligned} V^P(z,x) &= \max_{g\in\mathcal{F}(z,x)} \left\{ u\left(c^P(z,K,x,g)\right) + \beta\mathbb{E}\left[V(z',x')\right] \right\} \\ s.t. \quad & G + T + (\gamma + \kappa(1-\gamma))B = \tau z K^\alpha + q(z,x')\left[B' - (1-\gamma)B\right] \\ & K' = k^P(z,K,x,g) \end{aligned} \tag{8}$$

where c^P and k^P are the household's policy functions for consumption and capital in repayment, respectively. The government chooses its fiscal policy g subject to the constraints implied by the fiscal rule $\mathcal{F}$ and to its budget constraint; and takes into account how fiscal policy affects aggregate household's decisions. The value of defaulting is

$$\begin{aligned} V^D(z,K) &= \max_{g\in\mathcal{F}(z,x)} \left\{ u\left(c^D(z,K,x,g)\right) + \beta\mathbb{E}\left[\theta V^D(z',K') + (1-\theta)V(z',x')\right] \right\} \\ s.t. \quad & G + T = \tau z_D(z) K^\alpha \\ & B' = 0, \qquad K' = k^D(z,K,K,g) \end{aligned} \tag{9}$$

where c^D and k^D are the household's policy function for consumption and capital in default, respectively.

Equilibrium.—An equilibrium is value and policy functions for the government, value, policy and beliefs functions for the households, and a price schedule for government debt q such that: (i) given q and the policy functions for the households, the value and policy functions of the government solve the problems in (7) through (9); (ii) given all prices and beliefs, the value and policy functions for the households solve the problems in (5) and (6); (iii) household's beliefs are consistent with government policy functions and household's policy functions evaluated at the aggregate state; and (iv) the price schedule of debt satisfies

$$q(z,x') = \frac{\mathbb{E}\left[(1-d')\left(\gamma+(1-\gamma)\left(\kappa+q\left(z',x''\right)\right)\right)\right]}{1+r^*} \tag{10}$$

where $x'' = \left(k^P\left(z',K',g^P\right), B\left(z',x'\right)\right)$.

2.2 Efficiency

A key friction in the model is the government's inability to directly pin down the economy's capital allocation. This gives rise to the pecuniary externality from aggregate investment studied by Esquivel (2023), who shows that the decentralized economy features inefficiently low levels of capital accumulation due to the presence of default risk.

As a benchmark for the efficient level of capital accumulation, we introduce the problem of a benevolent social planner who jointly makes borrowing and investment decisions. The value of the planner is

$$\hat{V}(z,x) = \max_{\hat{d}\in\{0,1\}} \left\{d\hat{V}^D(z,K) + (1-d)\hat{V}^P(z,x)\right\} \tag{11}$$

where $\hat{d}$ is the planners default choice. If the planner decides to repay, then its value is

$$\hat{V}^P(z,x) = \max_{x'} \left\{u(c) + \beta\mathbb{E}\left[\hat{V}\left(z',x'\right)\right]\right\} \tag{12}$$

$$s.t. \qquad c + I + \frac{\phi}{2}\frac{(I)^2}{K} + (\gamma+\kappa(1-\gamma))B + G \leq zK^\alpha + \hat{q}\left(x',z\right)\left[B' - (1-\gamma)B\right]$$

$$K' = I + (1-\delta)K, \quad (\tau, T, B') \in \mathcal{F}(z,x)$$

where it chooses both K' and B' subject to the economy's resource constraint and subject to the debt limit implied by the fiscal rule $\mathcal{F}$. Similarly, in default the value of the planner is

$$\hat{V}^{D}(K,z) = \max_{K'} \left\{ u(c) + \beta\theta\mathbb{E}\left[\hat{V}(0,K',z')\right] + \beta(1-\theta)\mathbb{E}\left[\hat{V}^{D}(K',z')\right] \right\} \tag{13}$$

$$s.t. \qquad c + I + \frac{\phi}{2}\frac{(I)^2}{K} + G \leq z_D(z) K^{\alpha}$$

$$K' = I + (1-\delta) K$$

where it directly chooses K'.

The definition of equilibrium for the planner is analogous to the decentralized case. In particular, $\hat{q}$ satisfies an equation similar to (10). However, the price schedule that the planner faces is not the same as the one the government faces in the decentralized equilibrium because $\hat{q}$ is a function of the planner's future default, capital, and borrowing decisions, which are different to those implied by the decentralized equilibrium, as discussed in the following subsection.

2.3 Discussion of the investment externality

When the government is in default, productivity is lower than it would be if the government was in good financial standing, which follows from the assumption $z \leq z_D(z)$. As discussed by Mendoza and Yue (2012), such a decrease in TFP can result from the economy losing access to certain imported inputs during default crises, which would result in inefficient bundles of production materials. We make this simplifying assumption to focus on how expectations of lower productivity due to default risk depress investment. The Euler equation of a representative household is

$$u'\left(c_t^P\right) P_{k,t} = \beta\mathbb{E}\left[(1-d_{t+1})\, u'\left(c_{t+1}^P\right) R_t^P + d_t u'\left(c_{t+1}^D\right) R_t^D\right] \tag{14}$$

where $P_{k,t} = 1 + \phi\frac{I_t}{K_t}$ is the shadow price of investment in t and the return to capital is

$$R_{t+1}^P = \left(1-\tau_{t+1}^P\right)\alpha z_{t+1} A K_{t+1}^{\alpha-1} + (1-\delta) P_{k,t+1} + \frac{\phi}{2}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 \tag{15}$$

in repayment and

$$R_{t+1}^{D} = \left(1 - \tau_{t+1}^{D}\right) \alpha z_D\left(z_{t+1}\right) A K_{t+1}^{\alpha-1} + (1-\delta) P_{k,t+1} + \frac{\phi}{2}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 \tag{16}$$

in default. As the probability of default increases, the expected return to capital decreases due to $z_D\left(z_{t+1}\right) \leq z$, which lowers household's incentives to invest. Note that this effect is different from the pass-through of sovereign risk documented by Bocola (2016), where high sovereign risk lowers contemporaneous production by hampering financial intermediation through tighter funding constraints of domestic banks that hold government debt. Considering such a channel would amplify the extent to which default risk depresses investment by tightening the resource constraint before default happens.

In addition to default risk depressing investment, households do not internalize how their investment decision affects default risk. To illustrate this, assume that $\hat{q}$ and all other objects are differentiable. Then, the Euler equation for capital from the planner's problem in repayment is:

$$u'\left(\hat{c}_t^P\right)\left[\hat{P}_{k,t} - \frac{\partial \hat{q}\left(z_t, \hat{x}_{t+1}\right)}{\partial K}\hat{i}_{b,t}\right] = \beta \mathbb{E}\left[\left(1-\hat{d}_{t+1}\right) u'\left(\hat{c}_{t+1}^P\right)\hat{R}_t^P + \hat{d}_t u'\left(\hat{c}_{t+1}^D\right)\hat{R}_t^D\right] \tag{17}$$

where the term $\frac{\partial \hat{q}(z_t,\hat{x}_{t+1})}{\partial K_{t+1}}\hat{i}_{b,t}$ denotes that the planner understands how its choice of K_{t+1} affects its the borrowing terms and, in turn, the resource constraint in t.

It can be shown that, under the assumptions we have made for z_D (and if $\hat{q}$ is differentiable), the derivative $\frac{\partial \hat{q}}{\partial K} \geq 0$.[6] This implies that households underinvest in periods where borrowing needs are positive $\hat{i}_{b,t} \geq 0$, because they do not internalize that additional investment improves the economy's ability to borrow. This inefficiency would not exist absent default risk ($\hat{q}$ would be constant) and is more severe in states for which $\hat{q}$ is "steeper", which, as we show in the quantitative analysis in Section (3), is the case in periods of distress.

In Section (3) we show that, under a standard calibration, fiscal rules that limit government borrowing are welfare improving because lower default risk ameliorates the severity of this inefficiency. In addition, we show that the fiscal consolidation that follows the implementation of such

[6]See Esquivel (2023) for a general proof and a discussion of the minimal assumptions. Intuitively, investment lowers default risk because it improves the ability to service the debt in the following period. In addition, capital increases both the value of default and of repayment, but it increases the latter more at the margin because it is less productive in default.

fiscal rules is expansionary in the long-run because the economy accumulates more capital.

3 Quantitative analysis

We solve numerically for the decentralized and the planner equilibria using value function iteration. Following Hatchondo, Martinez, and Sapriza (2010), we compute the limit of the finite-horizon version of the economy. For the planner, we jointly solve for optimal investment and borrowing decisions using a non-linear optimization routine in each iteration. For the decentralized economy, we use Newton's method to find investment decisions that solve the household's Euler equation for a given borrowing level. To find the optimal borrowing choice, we use a non-linear optimization routine where the objective function takes into account how each potential choice affects the solution to the household's Euler equation. We approximate value functions and the price schedules for debt using linear interpolation, and compute expectations over the productivity shock using a Gauss-Legendre quadrature.

3.1 Calibration

We calibrate the model using quarterly data for Indonesia from 2000 to 2019, a representative emerging economy that has committed to a debt rule since 2004. There are two sets of parameters: one with values that we take either from the literature or directly from the data and another chosen to match moments. We use the planner's problem for the moment-matching exercise.[7]

Table 1 presents the first set of parameters. The risk-free interest rate is $r^* = 0.01$ and the CRRA parameter is $\sigma = 2$. The capital share is $\alpha = 0.33$, the capital depreciation rate is $\delta = 0.05$, and the parameters governing the stochastic process for productivity are $\rho = 0.95$ and $\sigma_z = 0.027$, which are all standard values. The probability of reentry $\theta = 0.0325$, which gives an average exclusion period of 26 quarters, as in Chatterjee and Eyigungor (2012). We also take the debt duration parameter $\gamma = 0.05$ and the coupon rate $\kappa = 0.03$ from Chatterjee and Eyigungor (2012). Finally, we set $\chi = \infty$

[7]The numerical solution of the model is computationally demanding given the dimensionality of the state space. The computation of the decentralized equilibrium—which would ideally be used in a moment-matching calibration exercise—is an order of magnitude slower than that of the central planner—which is typically used in moment-matching calibration exercises in the literature. The last two columns in the second part of Table **??** present the targeted moments for both the planner and the decentralized economy.

so that our benchmark case does not have an upper bound for debt.

Table 1: Parameters Calibrated from the Data

Parameter	Description	Value	Source / Target
σ	Risk aversion	2	Standard
r^*	Risk-free interest rate	0.01	Annual US-Treasury bills rate = 4.0%
δ	Capital depreciation rate	0.05	Standard
γ	Bond maturity rate	0.05	Chatterjee and Eyigungor (2012)
κ	Bonds coupon rate	0.03	Chatterjee and Eyigungor (2012)
θ	Probability of re-entry	0.0325	Chatterjee and Eyigungor (2012)
A	Scaling parameter	0.63	Steady-state GDP=1.0
G	Fixed government expenditure	0.10	10% of Steady-state GDP
χ	Debt limit	∞	No debt limit for Benchmark
α	Capital share	0.33	Standard
ρ	Persistence of productivity	0.95	Standard
σ_z	Volatility of productivity	0.027	Standard

Table 2: Parameters Calibrated by Simulation

Parameter	Description	Value	Target	Planner (targeted)	Decentralized) (not targeted)
β^F	Discount factor	0.971	Debt-to-GDP ratio = 0.40	0.37	0.38
ϕ	Capital adjustment cost	7.679	$\sigma_i/\sigma_y = 2.7$	2.5	3.3
ξ_0	Default cost parameter	−0.284	Av. spread = 2.6%	2.4%	3.4%
ξ_1	Default cost parameter	0.422	Std. Spreads = 0.90%	1.2	2.2

The discount factor β, productivity loss parameters d_0 and d_1, and the capital adjustment cost parameter ϕ are set to jointly match an average debt-to-GDP ratio of 0.40, a relative volatility of total investment to GDP of 2.7, an average spread of 2.6%, and a standard deviation of spreads of 0.9%. The lower part of Table 2 reports these moments for the planner's problem and the decentralized equilibrium, both using the same parametrization and calibration. The decentralized economy experiences higher and more volatile spreads, a higher relative volatility of investment, and a slightly higher debt-to-GDP ratio.

Table 3 evaluates the performance of the model in explaining some untargeted moments from the data. In the last 100 years, Indonesia had one episode of debt restructuring in 1966. The model generates an average default frequency of 1 percent in both the planner and the decentralized economies.

Table 3: Untargeted moments

Moment	Data	Planner	Decentralized
Default Frequency	0.01	0.01	0.01
σ_c/σ_y	0.96	1.05	1.03
$\sigma_{\frac{CA}{y}}$	1.60	1.67	2.29
$Corr(\frac{CA}{y}, y)$	−0.33	−0.53	−0.53

Consumption is slightly more volatile than output in the model, which is a feature of many emerging economies (although not in the case of Indonesia). The volatility of the current account in the planner economy (the one used for the matching exercise) is very close to that in the data, while the decentralized economy features a more volatile current account. Finally, the model generates a countercyclical current account, which is a salient feature of emerging economies.

3.2 Optimal debt limit

We now compute the optimal value for χ as the limit to the debt-to-GDP ratio that maximizes welfare gains in the long-run. We define welfare gains of χ as the percentage increase in permanent consumption that would leave the representative household indifferent between adopting the debt limit or not. That is, welfare gains $\lambda(\chi)$ satisfy

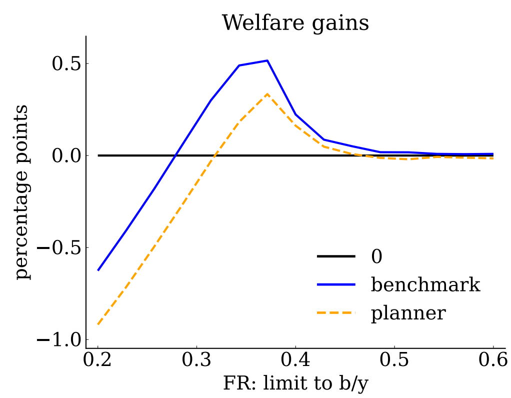
$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u\left((1+\lambda(\chi))\, c_t^{\text{no DL}}\right)\right] = \mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u\left(c_t^{\text{DL}=\chi}\right)\right]$$

where $\left\{c_t^{\text{no DL}}\right\}_{t=0}^{\infty}$ and $\left\{c_t^{\text{DL}=\chi}\right\}_{t=0}^{\infty}$ are series of consumption simulated from the model with no debt limit and with the debt limit equal to χ, respectively.

Imposing debt limits in our model can be desirable for two reasons. First, because it limits the degree to which future governments can dilute existing debt. This is the case even for the benevolent social planner. Second, because it lowers default risk and, with it, the distortions to private investment associated with default: real costs productivity and higher distortionary taxes due to financial autarky.

Figure 1 shows welfare gains for different values of χ. In order to disentangle the role of debt dilution and distortions to investment, we compute welfare gains for the benchmark decentralized economy and for the social planner.

Figure 1: Welfare gains, different debt limits



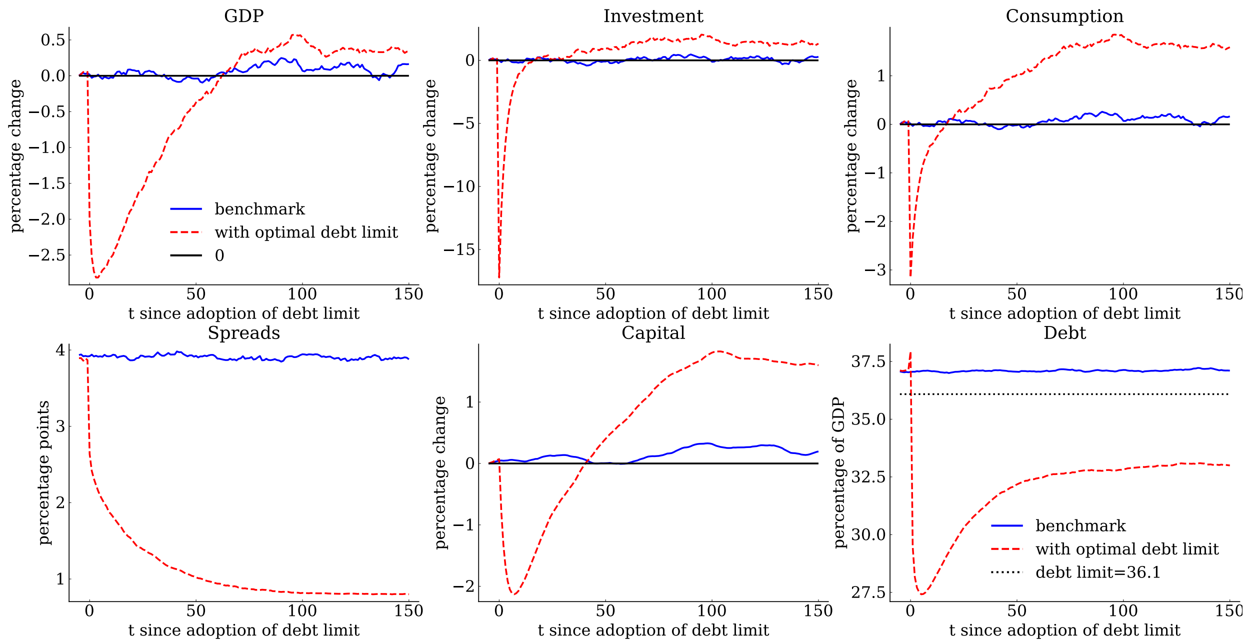
The gains are, evidently, larger for the benchmark economy, and roughly half of the gains come from investment distortions. It is important to recall that we are not including contemporary distortions to production from high spreads, which could potentially yield higher gains from lowering default risk.

We compute the optimal value for χ by approximating the curves in Figure 1 with a cubic spline and finding its maximizer. While each distortion adds to the potential gains of implementing the debt limit, they barely change the optimal value of χ, which is 0.36 for the benchmark case and the case with lump-sum taxes, and 0.37 for the social planner.

3.3 Expansionary fiscal consolidation

Figure 2 presents the average of 10,000 paths for the decentralized economy with and without the implementation of the optimal debt limit at $t = 0$. The economy that implements it (dashed-red line) goes through a painful fiscal consolidation in the short-run, where GDP, investment, and consumption decline in order to finance a gradual debt reduction. Importantly, this debt reduction is feasible thanks to a large decline in spreads on impact.

Figure 2: Average transition paths

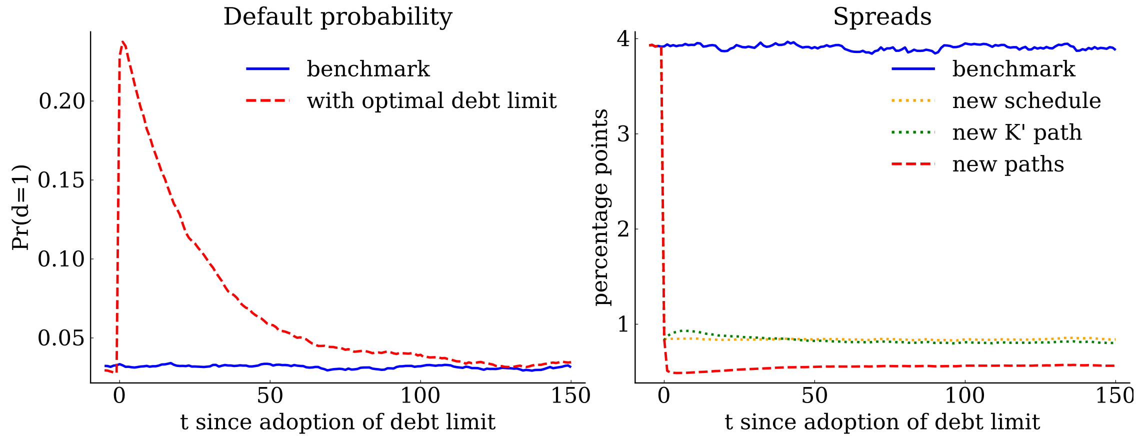


Each line corresponds to the average of 10,000 paths. The starting point of each path is taken from simulating the economy for 1,001 periods and dropping the first 1,000 to remove the influence of initial conditions.

After the initial fiscal consolidation, the economy converges to long-run averages that feature higher consumption, GDP, investment, and capital with a lower debt-to-GDP ratio and significantly lower spreads. Positive welfare gains are achieved despite the initial decline in consumption because consumption in the long-run is significantly higher and servicing the debt is significantly cheaper.

Interestingly, spreads drop on impact despite an increase in the probability of default during the adjustment periods, as shown in the left panel of Figure 3. To illustrate why this is the case, the right panel makes a decomposition of the different factors that drive the decrease in spreads. The yellow-dotted line presents the new price schedule with the fiscal rule evaluated at the average paths from the benchmark economy. Even with the benchmark paths for capital and debt, spreads are significantly lower due to expectations of lower debt and higher capital in all future periods.

Figure 3: Default probability and change in spreads decomposition

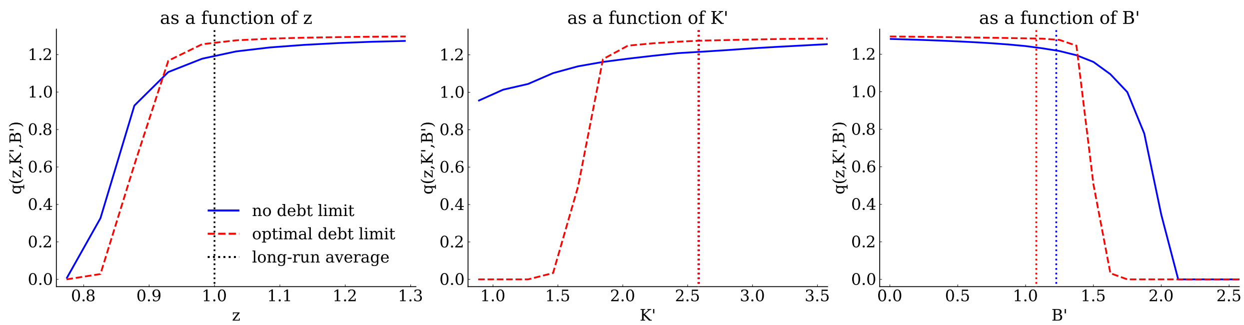


For the left panel, each line corresponds to the average of 10,000 paths. The starting point of each path is taken from simulating the economy for 1,001 periods and dropping the first 1,000 to remove the influence of initial conditions. For the right panel, each line corresponds to the price schedule from the economy with the fiscal rule evaluated at average paths for z, K', and B', except for the blue solid line, which is the benchmark path of spreads in Figure 2

The green-dotted line presents the same price schedule evaluated at the benchmark path of debt (i.e. without debt reduction) and the new average path for capital ("new K' path"). As can be seen in Figure 2, capital first drops and then surpasses the benchmark level at around the 40th quarter. The green-dotted line reflects this with spreads being initially larger than the yellow line and then lower once capital surpasses its benchmark level. Finally, the red-dashed line presents the new price schedule evaluated at the average paths for debt and capital from the economy with the fiscal rule.

Note that the government keeps the debt level way below the debt limit, despite the low spreads. Figure 4 presents the price schedule $q(z, K', B')$ for the benchmark economy with no debt limit and for the economy with the optimal χ. The left panel presents q as a function of productivity z, the middle panel shows it as a function of capital for next period K', and the right panel as a function of new debt B'. In each of the three panels, q is evaluated at the benchmark long-run averages for the pair of variables that are not on the horizontal axis. The vertical lines depict long-run average values for the benchmark (blue) and the economy with the optimal debt limit (red).

Figure 4: Bonds price schedule $q(z, K', B')$



Each line is the price of bonds $q(z, K', B')$ for the decentralized economy with no debt limit (solid-blue line) and the decentralized economy with the optimal debt limit (dashed-red line). The vertical lines depict the average long-run values of each variable for each case. In each panel, q is evaluated at the benchmark long-run averages for the pair of variables that are not on the horizontal axis.

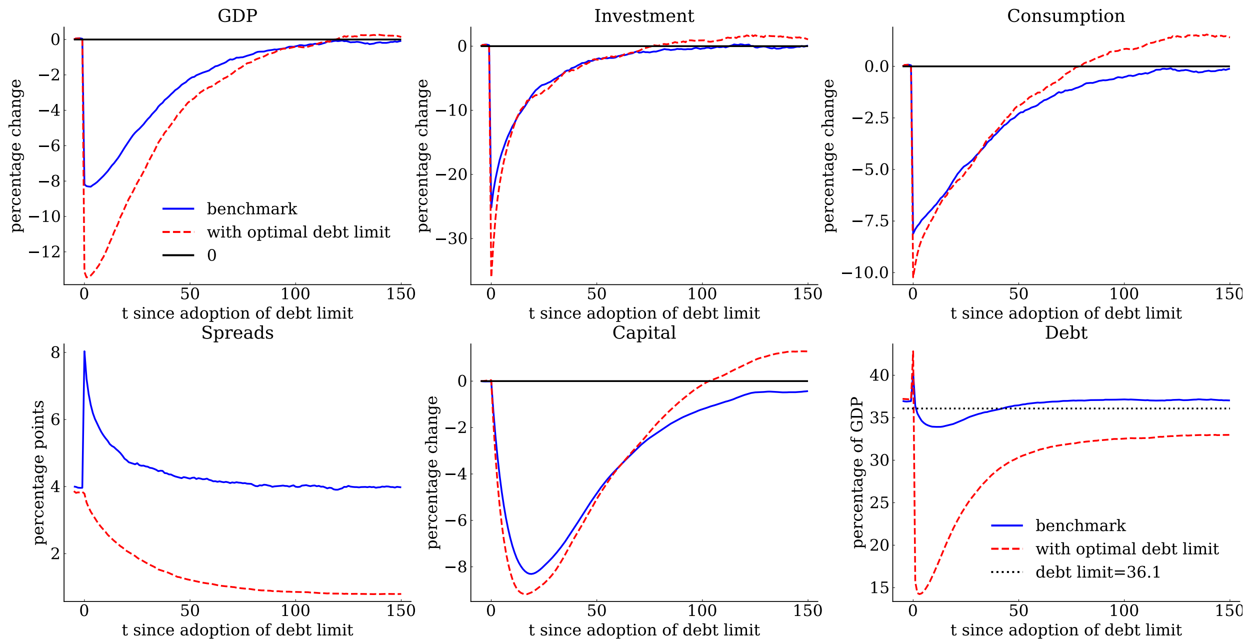
The price schedule is higher and flatter with the debt limit (dashed-red line) for the long-run average values (the vertical lines). However, it is also steeper for states that are close to a debt crisis—low productivity, low capital, and high debt. So, while the government faces lower and less increasing spreads on average, increasing the debt too much would push the economy closer to the region where q becomes steep. In addition, recall that the investment externality depends on how sensitive q is to capital (see equation (17)). The middle panel shows how the magnitude of this externality is lower for long-run values of capital in the economy with the debt limit, which is why this economy accumulates more capital in the long-run.

3.4 Fiscal consolidation after a large downturn

Figure (5) presents a similar exercise but for an economy that experienced a negative productivity shock of three standard deviations in $t = 0$. The blue-solid line is the economy with no debt limit and the dashed-red line is the economy that implements the optimal debt limit in period $t = 0$, when the crisis hits.[8]

[8] We are using the same value for $\chi = 0.36$. Interestingly, this value does not change much if the maximization of welfare gains is done considering this crisis as an initial state.

Figure 5: Average transition paths after large downturn



Each line corresponds to the average of 10,000 paths. The starting point of each path is taken from simulating the economy for 1,001 periods and dropping the first 1,000 to remove the influence of initial conditions.

The contraction on impact is, naturally, much larger for the economy that implements the debt limit in $t = 0$. However, consumption and investment recover much faster thanks to the lower level of spreads, which still go down despite the large negative shock. This illustrates the large role that expectations about future fiscal policy play on spreads, which are much more significant than the negative productivity shock itself. On the other hand, spreads virtually double on impact in the benchmark economy and consumption has barely recovered after 120 quarters.

4 Empirical Analysis

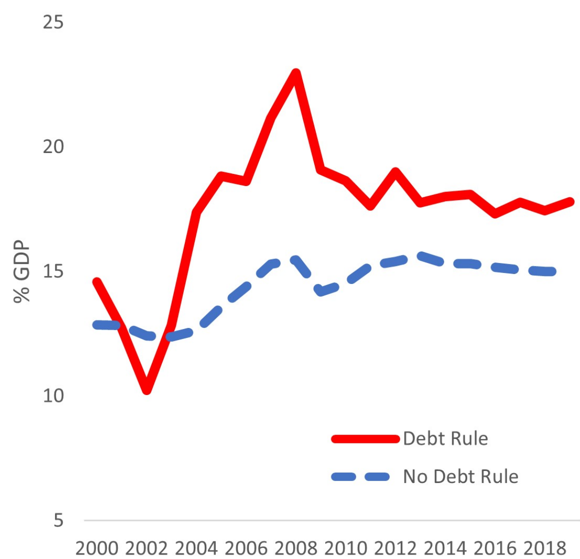
In this section we present evidence of the relationships between fiscal rules, private investment, and sovereign spreads that are implied by the model. We use data from 2000 to 2019 for a sample of 27 emerging market economies, which are commonly used in the literature.[9]

[9] The countries in our panel include Argentina, Brazil, Bulgaria, China, Colombia, Dominican Republic, Egypt, El Salvador, Indonesia, Iraq, Kazakhstan, Lebanon, Malaysia, Mexico, Morocco, Panama, Peru, Philippines, Romania, Russia, Serbia, South Africa, Thailand, Turkey, Ukraine, Venezuela, and Vietnam.

4.1 Debt Rules and Private Investment

A central prediction of the theory presented above is that countries with debt rules accumulate more capital relative to countries without them. To examine whether this prediction holds in the data, we use the IMF Fiscal Rules Dataset and sort countries into two categories: "debt rule" and "no debt rule". Figure 6 shows that while both sets of countries have experienced an increase in private investment, the surge is most notable for countries with a debt rule.[10] In the early 2000s, there is an increase in private investment among countries that recently adopted debt rules such as by Bulgaria, Indonesia, and Panama. Interestingly, the increasing trend in private investment observed among countries with debt rules slowed down after the Global Financial Crisis.

Figure 6: Private Investment, Debt Rule vs No Debt Rule



Countries are sorted based on the existence of a debt rule for a given year. Countries with debt rule include Bulgaria (2003-2019), Indonesia (2004-2019), Kazakhstan (2013-2019), Malaysia (2000-2019), Panama (2002-2019), Peru (2013-2019), Romania (2007-2019), Serbia (2011-2019), Thailand (2018-2019), and Vietnam (2016-2019).

Since the association between debt rules and investment might be driven by other confounding factors, we estimate the following panel fixed-effect regression:

$$log\left(I/y\right)_{i,t} = \alpha_i + \beta_1\left(D_r\right)_{i,t-1} + \beta_2 log\left(\hat{y}\right)_{i,t-1} + \beta_3 log\left(B/y\right)_{i,t-1} + \gamma_i + \eta_t + \varepsilon_{i,t}$$

where γ_i represents time-invariant country-fixed effects and η_t denotes time-fixed effects. The term

[10] The decreasing trend observed between 2000 and 2002 among countries with debt rule is only driven by Malaysia.

$(I/y)_{i,t}$ denotes the private investment, normalized by GDP for country i at time t. In addition, $(D_r)_{i,t}$ represents a dummy variable that assigns 1 if there is a debt rule in country i at period t and 0 otherwise, $(\hat{y})_{i,t}$ is the cyclical component of GDP for country i at period t, and $(B/y)_{i,t}$ denotes the level of public debt normalized by GDP for country i at period t. The term $\varepsilon_{i,t}$ denotes the regression residuals. The explanatory variables are lagged one period to control for endogeneity. The baseline specification includes as regressors all the variables considered in the theoretical model except for sovereign spreads.

Table 4 shows that, other things equal, the positive correlation between debt rules and private investment is robust to various controls and specifications. Specification (1) presents the simple correlation between debt rules and private investment only controlled by country and time-fixed effects. This estimate indicates that the ratio of private investment to GDP is 0.08 higher in countries with a debt rule in place. Specifications (2) and (3) control for other variables considered in the model, such as the cyclical component of GDP and the public debt-to-GDP ratio. Finally, specification (4) includes high-income countries.[11]

Table 4: Panel Regressions: Debt Rules and Private Investment

	Dependent variable: $log(I/y)$			
	(1)	(2)	(3)	(4)
DebtRule	**0.0872****	**0.0388****	**0.0431***	**0.0180**
	(**0.0280**)	(**0.0156**)	(**0.0241**)	(**0.0247**)
$log(\hat{y})$		1.376*	1.401**	1.338**
		(0.657)	(0.513)	(0.581)
$log(B/y)$			−0.0574	−0.101***
			(0.0461)	(0.0283)
Number of groups	27	26	26	55
Observations	513	494	488	1031

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

[11] The high-income countries include are Australia, Austria, Belgium, Chile, Croatia, Czech Republic, Denmark, Finland, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Qatar, Saudi Arabia, Slovak Republic, Spain, Sweden, United Kingdom, United States and Uruguay.

Importantly, the β_1 coefficient becomes statistically insignificant once we consider high-income countries, which is consistent with the model in the sense that debt rules affect investment because of the distortionary effect that large spreads have on expected capital returns, which are more prevalent in low and middle-income economies. Finally, the coefficient associated with the cyclical component of GDP is positive and significant, which suggests, as expected, that private investment is positively associated with economic activity, and the coefficient associated with public debt suggests a negative correlation between investment and debt, which is consistent with the findings in the debt overhang literature.

Overall, we document a positive correlation between the adoption of debt rules and private investment which is consistent with the quantitative predictions of our model.

4.2 Debt Rules and Sovereign Spreads

In order to further document the role of fiscal rules in creating confidence in financial markets, we study the relation between sovereign spreads and the adoption of debt rules. In particular, we change the dependent variable from previous subsection and estimate the following panel fixed-effect regression:

$$log\,(r_s)_{i,t} = \alpha_i + \beta_1\,(D_r)_{i,t-1} + \beta_2 log\,(\hat{y})_{i,t-1} + \beta_3 log\,(B/y)_{i,t-1} + \gamma_i + \eta_t + \varepsilon_{i,t}$$

where r_s is the 5-year CDS implied annual spread in government yields for country i at time t.

Table 5 shows that, other things equal, there is a negative and statistically significant correlation between debt rules and sovereign spreads that is robust to various controls and specifications. Having a debt rule in place is associated with a β_1 basis points drop in sovereign spreads. For instance, specification (3) suggests that the implementation of debt rules is associated with spreads that are 2 percentage points lower, which is in line with the 3 percentage-point drop predicted by the model after the adoption of the debt rule. Overall, our empirical results are consistent with previous empirical studies that document that fiscal rules are negatively associated with fiscal rules. Moreover, we show that the decrease in spreads following the implementation of a debt rule is also associated with higher private investment, as suggested by the model.

Table 5: Panel Regressions: Debt Rules and Sovereign Spreads

	Dependent variable: r_s			
	(1)	(2)	(3)	(4)
DebtRule	**−486*****	**−192***	**−202***	**−114**
	(127)	**(107)**	**(115)**	**(66)**
$log(\hat{y})$		30	−1369	−3706
		(1503)	(2240)	(3341)
$log(B/y)$			−277	7
			(253)	(213)
Number of groups	26	25	25	55
Observations	446	427	427	881

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

5 Conclusion

We developed a quantitative sovereign default model with capital accumulation, long-term debt, and fiscal rules. We found that the optimal debt limit generates an economic expansion in the long-run, fueled by higher capital accumulation due to lower default risk. Moreover, there are sizeable welfare gains from this policy, most of which are a result of a significant reduction in spreads due to expectations about future borrowing and investment. This highlights the importance of institutional mechanisms that provide credibility to the adoption of any fiscal rule. We also presented evidence of how the relations implied by the model between debt limits, spreads, and investment are featured by data from emerging economies.

As noted in the paper, there are important mechanisms that we are not modeling which could make the expansions from debt limits even higher. Developing models that can accommodate distortions to production from high spreads, as well as capital accumulation with endogenous default is an exciting research avenue. In addition, alternative designs to debt-limits, such as the spread-break proposed by Hatchondo, Martinez, and Roch (2022), could result in even higher welfare gains from a more efficient reduction of default risk. Finally, we are silent about comprehensive fiscal consolidation plans that could weight potential trade-offs between lowering expenditure or raising taxes, which we leave for future research.

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