Expansionary Fiscal Rules Under Sovereign Risk*

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Abstract

We study fiscal rules in a sovereign default model with private capital accumulation and long-term debt. Their adoption strengthens public finances and increases long-run income by mitigating two distortions: debt dilution and underinvestment. In the short run, however, the economy experiences a costly transition where consumption and investment drop to finance debt reduction. To study this tradeoff, we calibrate the model to Argentina and evaluate three commonly proposed rules: a debt limit, a deficit limit, and a dual rule combining both. The deficit limit is preferred only when implemented at high debt levels because it features smoother debt reduction but imposes strict discipline in all states. Otherwise, gains are highest under the dual rule that combines the flexibility of debt limits at low levels with the discipline of deficit limits at higher levels. Results are robust to alternative formulations for capital accumulation and stronger in the presence of political myopia.

Keywords: Fiscal rules, sovereign risk, debt dilution, underinvestment.

JEL Codes: E62, F34, F41, H61, H63

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1 Introduction

The literature has studied fiscal rules because of their effects in disciplining fiscal policy and anchoring expectations.[1] We study these effects in the context of capital accumulation because it has important implications for the implementation of fiscal rules and their long-run effects. Specifically, rules can strengthen public finances while promoting private capital accumulation and, in turn, enhancing growth in the long-run. This is because they mitigate two distortions particularly relevant for emerging economies facing significant sovereign spreads: dilution of long-term debt (Hatchondo, Martinez, and Sosa-Padilla (2016)) and underinvestment (Esquivel (2024)). Our key policy prescription is that large welfare gains can be attained in the long-run by focusing on containing debt dilution with fiscal rules, which in turn ameliorates underinvestment as a side effect. In the short-run, however, the implementation of fiscal rules may result in costly transitions in which consumption and investment decrease to finance debt reduction.

To study these tradeoffs and uncover the mechanism through which rules improve long-run outcomes, we develop a quantitative sovereign debt model with private capital accumulation, long-term debt, and fiscal rules.[2] Domestic households consume and accumulate productive capital, while a benevolent government makes optimal borrowing and default decisions. We model fiscal rules as an upper bound to fiscal aggregates, following the benchmark analysis of Hatchondo, Martinez, and Roch (2022a). An important difference from their work is that, in our model, whether the limit binds depends not only on the realization of random shocks, but also on the history of capital accumulation. As is standard, we assume that when the government defaults it is excluded from financial markets for a random number of periods and there is an exogenous productivity cost. The latter implies that default risk lowers the expected return to capital, which depresses investment.

In our model, fiscal rules are a second-best instrument that mitigates the two key distortions, debt dilution and underinvestment. As a commitment mechanism, they limit the time inconsistency problem at the core of debt dilution. This lowers default risk, which in turn mitigates underinvestment. In a sense, fiscal rules help to "kill two birds with one stone". In this environment, the effect of fiscal rules is particularly large because in addition to lowering default risk through immedi-

[1] See Potrafke (2025) for a comprehensive review on the economic consequences of fiscal rules.

[2] The model builds on the quantitative literature following the seminal work of Eaton and Gersovitz (1981).

ate debt reduction, they also provide an anchor for private expectations about future fiscal policy. These expectations further improve the government's borrowing terms and allow for a transition to a new ergodic state with lower debt, and higher investment, output and consumption.

We calibrate the model to Argentina, which is an economy that faces high default risk and has frequent default episodes. Our benchmark calibration considers an economy with no fiscal rule, which we then use as a laboratory to evaluate the costs of both inefficiencies, and the effects of implementing different policies.

First, we characterize the first-best equilibrium with two state-contingent policy tools that correct for each of the two distortions separately: debt covenants (like the ones in Hatchondo, Martinez, and Sosa-Padilla (2016)) and investment subsidies (like the ones in Gordon and Guerron-Quintana (2018) and Esquivel (2024)). We do a welfare decomposition following the methodology in Aguiar, Amador, and Fourakis (2020) and find that 85 percent of the welfare gains from implementing the first-best equilibrium can be attained by neutralizing debt dilution alone. Furthermore, we find that investment policy is also time inconsistent, which highlights the potential of simple commitment devices such as the fiscal rules that we explore.

Second, we characterize optimal fiscal rules and quantify the associated welfare gains. Specifically, we analyze three types of rules: a debt limit, a deficit limit, and a dual rule combining both.[3] Specifically, we consider a dual rule that imposes a deficit limit only when the debt limit binds. For each of these rules, we identify the numerical limit that maximizes welfare gains in the ergodic distribution. In all cases, the economies transition to a distribution with a lower debt-to-GDP ratio, lower sovereign spreads, lower default risk, higher capital stock, higher output, and higher consumption compared with the benchmark economy without rules. Welfare gains, however, are largest under the deficit limit, as it smooths the transition during consolidation while imposing fiscal discipline in all future states. In contrast, the debt limit and the dual rule do not impose any sort of discipline when debt levels are low. This stringent fiscal discipline associated with deficit limits is internalized by the market, resulting in a significant reduction in sovereign spreads both on impact and over the long run. The economy with a deficit limit transitions to a distribution with lower debt levels, lower sovereign spreads, lower default probability, and higher consumption

[3] Hatchondo, Martinez, and Roch (2022a) explore rules with a spread brake and find that they are particularly useful for economic unions that require a common rule for heterogeneous members. Such an analysis is beyond the scope of this paper.

relative to the economies with other rules. Notably, the relatively lower spreads allow for higher consumption on average despite the slightly lower levels of capital, private investment, and output.

Importantly, the stringent fiscal discipline associated with the deficit limit only delivers relatively larger welfare gains when achieving fiscal consolidation (i.e. debt reduction) from high debt levels, like the average debt level in the initial ergodic distribution. In contrast, when these rules are implemented with zero initial debt then the deficit limit delivers the lowest welfare gains precisely because of how it limits debt accumulation over time. In this case, average welfare gains are the highest under the dual rule described above because it combines the flexibility of debt limits at low levels of debt with the discipline imposed by the deficit limit once the debt level is high enough. These contrasts highlight the importance of the starting point and transition costs when designing and implementing fiscal rules.

Finally, we present empirical evidence that supports the main mechanism of the model. While the relationship between fiscal rules and sovereign spreads is well established in the literature, the link between rules and private investment has been less explored.[4] We fill this gap by estimating the relationship between fiscal rules and private investment for a panel of 63 emerging economies. We estimate a significant positive relationship between having a fiscal rule in place and private investment as percentage of GDP. We interpret this result as evidence of higher investment in countries with a fiscal rule. Furthermore, we contrast our results with the findings of Magud and Pienknagura (2024), which exploit granular, firm-level data, to study the impact of fiscal shocks on private investment. Interestingly, they estimate changes in corporate investment following an unexpected fiscal shock and find evidence of a transition path similar to the one predicted by the model: an initial drop in investment shortly followed by an expansion. Overall, evidence based on both macro and micro data is consistent with the predictions of our model.

Related literature.—We mainly contribute to the quantitative sovereign debt literature (Eaton and Gersovitz (1981); Arellano (2008); Aguiar and Gopinath (2006)) that studies the effect of fiscal rules on debt dynamics and sovereign spreads (Alfaro and Kanczuk (2017); Hatchondo, Martinez, and Roch (2022a); Hatchondo, Martinez, and Roch (2022b); Bianchi, Ottonello, and Presno (2023)); Deng and Liu (2025); Felli, Piguillem, and Shi (2025)). Specifically, we extend the

[4] See Iara and Wolff (2010), Kalan, Popescu, and Reynaud (2018), Davoodi et al. (2022), and Islamaj, Samano, and Sommers (2024)).

model in Hatchondo, Martinez, and Sosa-Padilla (2016) to incorporate private capital accumulation (like Gordon and Guerron-Quintana (2018) and Esquivel (2024)), and fiscal rules similar to those in Hatchondo, Martinez, and Roch (2022a). This allows us to study the effects of fiscal rules on the long-run level of income and the welfare costs of transitioning from one policy to another. The paper also relates to the broader literature on sovereign debt with constraints to fiscal policy (Azzimonti and Mitra (2023a); Azzimonti and Mitra (2023b)). Our main contribution is to show that using a fiscal rule to contain debt dilution can also mitigate underinvestment, enabling an expansionary transition to a new ergodic state characterized by lower debt, higher investment, greater output, and higher consumption.

Our paper is also related to the literature on rules versus discretion. Angeletos, Amador, and Werning (2006) study the tradeoff between commitment and flexibility in a consumption savings model with taste shocks privately observed by an agent. Halac and Yared (2014), Halac and Yared (2018), and Halac and Yared (2022) study debt limits 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. Debt limits emerge as an efficient mechanism through which citizens provide incentives to the government ex ante. We contribute by showing that, with capital accumulation and default risk, a dual rule imposing a deficit limit only when the debt limit binds combines the flexibility of debt limits at low debt levels with the discipline of deficit limits at higher debt levels, delivering the highest welfare gains when initial debt is low. In contrast, we find that the deficit limit outperforms the debt limit at high debt levels.

Our paper also relates to the empirical literature on the economic consequences of fiscal rules. On one hand, the disciplinary effect of fiscal rules is well established (Bergman, Hutchison, and Jensen (2016); Heinemann, Moessinger, and Yeter (2018); Caselli and Reynaud (2020)). On the other hand, a growing strand of the literature has documented the compressing effect of fiscal rules on sovereign spreads (Iara and Wolff (2010); Kalan, Popescu, and Reynaud (2018); Davoodi et al. (2022); Islamaj, Samano, and Sommers (2024)). Our paper contributes to this strand of the literature with new insights on the economic consequences of fiscal rules. Specifically, the mechanism in our model is not only consistent with the disciplinary and spread-compressing effects of fiscal rules, but further suggests that fiscal rules are positively correlated with private investment as a share of GDP. While we provide supporting evidence for this channel, a rigorous empirical study on the expansionary effect of fiscal rules remains a promising direction for future empirical research.

Finally, the paper is tangential to the literature that studies whether fiscal consolidation is expansionary or contractionary (Giavazzi and Pagano (1990); Blanchard (1990); Bertola and Drazen (1993); Bi (2012); Bi, Leeper, and Leith (2013)). This literature highlights a tension between a Keynesian view, which posits that fiscal consolidation contracts aggregate demand, and a Ricardian view, which argues that if private agents anticipate future fiscal discipline, they revise upward their estimates of permanent income, thereby increasing current and planned consumption and generating an economic expansion. We present a novel channel through which rule-based fiscal consolidation may generate an expansion in emerging economies facing high default risk.

Layout.—Section 2 presents the model environment and discusses the main mechanism and tradeoffs in detail. Section 3 presents the quantitative analysis and the main results. Section 4 presents the empirical analysis. Section 5 concludes.

2 Model

We develop a sovereign default model with private capital accumulation and fiscal rules. 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 by issuing long-term debt that is purchased by risk-neutral foreign lenders. The government makes lump-sum transfers (or levies lump-sum taxes) to the households and cannot commit to repaying its debt.

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 foreign lenders. 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 $\frac{\phi}{2}\frac{(k_{t+1}-k_t)^2}{k_t}$, where $\phi > 0$. The budget constraint of a representative household is:

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

where $i_{k,t} = k_{t+1} - (1-\delta) k_t$ is investment, Π_t are profits from the firm, and T_t is a lump-sum transfer from the government.

The consumption good is produced by the competitive firm using technology $y_t = z_t K_t^{\alpha}$, where K_t is the capital rented by the firm, α is the capital share of income, and z_t is a productivity shock.[5] The productivity shock follows an AR(1) process:

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

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 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's budget constraint when it is in good financial standing is:

$$T_t + (\gamma + \kappa(1-\gamma)) B_t = q_t i_{b,t}, \tag{2}$$

where q_t is the market price of government debt.

At the beginning of each period the government can decide to default. If it does, then it is excluded from financial markets for a stochastic number of periods, and the productivity in the economy drops to $z_D(z_t) = z_t - \max\left\{0, \xi_0 z + \xi_1 z^2\right\}$, where $\xi_0 < 0 < \xi_1$.[6] 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

[5] 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.

[6] 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.

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 $\mathcal{F}$ that maps the state space of the economy into the power set of government policy instruments. We study debt limits where the fiscal rule is of the form:

$$\mathcal{F}(z_t, K_t, B_t) = \left\{B_{t+1} | B_{t+1} \leq \max\left\{\chi_b z_t K_t^{\alpha}, (1-\gamma) B_t\right\}\right\} \tag{3}$$

where $\chi_b \in (0,1)$. This formulation imposes that the debt-to-GDP ratio cannot exceed χ_b. If outstanding debt B_t is already higher than this limit then it must be reduced by at least the fraction γ that matured. This implicitly imposes that when debt is above the limit there cannot be a primary deficit (debt issuance $i_{b,t}$ cannot be positive). We later relax this assumption and allow for positive (but limited) primary deficits when debt is above its limit. An important contribution of our model is that capital accumulation relaxes the fiscal rule in subsequent periods.[7] As we discuss extensively in the following section, this feature increases the value of sustaining higher levels of capital under a fiscal rule.

Timing.—At the beginning of a period, the government observes (z_t, K_t, B_t) and makes its default and borrowing 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. These timing assumptions also rule out the multiplicity studied by Galli (2021) because lenders price the debt after the capital allocation has been chosen.

[7] This effect is similar to how capital accumulation lowers future capital adjustment costs.

2.1 Recursive formulation and equilibrium

The aggregate state of the economy is (z, x), where $x = (K, B)$ is the endogenous aggregate state. Let $g = (T, B')$ 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

$$\begin{aligned} H^P(z,k,x,g) = \max_{c,i,k'} \Big\{ & u(c) + \beta\mathbb{E}\left[(1-d')H^P\left(z',k',x',g^P\right)\right] \\ & + \beta\mathbb{E}\left[d'H^D(z',k',K')\right]\Big\} \\ s.t. \quad c + i + \frac{\phi}{2}\frac{(k'-k)^2}{k} & \leq r(z,K)k + \Pi(z,K) + T \\ i & = k' - (1-\delta)k \\ x' = \Gamma_x^P(z,x,g), \quad & g^P = \Gamma_g^P(z',x'), \quad d' = \Gamma_d(z',x') \end{aligned} \tag{4}$$

where Γ_x^P is the household's belief about the law of motion of the endogenous aggregate state x in repayment, Γ_g^P is the household's belief of fiscal policy in repayment, Γ_d the household's belief about the government's default decisions, the rental rate of capital is $r(z,K) = z\alpha K^{\alpha-1}$, and firm profits are $\Pi(z,K) = z(1-\alpha)K^\alpha$. The value of the household when $d = 1$ is

$$\begin{aligned} H^D(z,k,K) = \max_{c,i,k'} \Big\{ & u(c) + \beta\mathbb{E}\left[\theta(1-d')H^P\left(z',k',x',g^P\right)\right] \\ & + \beta\mathbb{E}\left[(1-\theta+\theta d')H^D(z',k',K')\right]\Big\} \\ s.t. \quad c + i + \frac{\phi}{2}\frac{(k'-k)^2}{k} & \leq r(z_D(z),K)k + \Pi(z_D(z),K) \\ i & = k' - (1-\delta)k \\ x' = \Gamma_x^D(z,K), \quad & g^P = \Gamma_g^P(z',x'), \quad d' = \Gamma_d(z',x') \end{aligned} \tag{5}$$

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

$$V(z,x) = \max_{d\in\{0,1\}} \left\{dV^D(z,K) + (1-d)V^P(z,x)\right\} \tag{6}$$

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

$$V^P(z,x) = \max_{T,B' \in \mathcal{F}(z,x)} \left\{ u\left(c^P(z,K,x,g)\right) + \beta \mathbb{E}\left[V(z',x')\right] \right\} \tag{7}$$

$$s.t. \quad T + (\gamma + \kappa(1-\gamma)) B = q(z,x')\left[B' - (1-\gamma)B\right]$$

$$K' = k^P(z,K,x,g), \quad g = (T,B')$$

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

$$V^D(z,K) = u\left(c^D(z,K,K)\right) + \beta \mathbb{E}\left[\theta V^D(z',K') + (1-\theta)V(z',x')\right] \tag{8}$$

where $K' = k^D(z,K,K)$, and c^D and k^D are the household's policy functions for consumption and capital in default.

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 (6) through (8); (ii) given all prices and beliefs, the value and policy functions for the households solve the problems in (4) and (5); (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

$$q(z,x') = \frac{\mathbb{E}\left[(1-d')(\gamma + (1-\gamma)(\kappa + q(z',x'')))\right]}{1+r^*} \tag{9}$$

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

2.2 Debt dilution and underinvestment

Two dynamic frictions arise from the government's inability to commit to future policy: debt dilution from not being able to commit to future debt issuance, and private underinvestment from not being able to commit to future debt payments. By curbing debt dilution, fiscal rules generate positive spillovers by reducing sovereign risk and, consequently, mitigating underinvestment.

In the presence of long-term debt, the issuance of new debt reduces the value of existing outstanding debt. The government does not internalize this loss in value because outstanding debt is held by foreign lenders. Lenders then offer a lower price for currently issued bonds in anticipation of future borrowing increasing default risk and diluting the future market value of these long-term bonds. This is captured by the term $q(z', x'')$ in equation (9), where lenders internalize the effect of future borrowing through x'', which the current government cannot control or commit to. Hatchondo, Martinez, and Sosa-Padilla (2016) find that this negative externality from current debt issuance on past governments substantially increases default risk.

Underinvestment arises because households do not internalize how the aggregate capital allocation affects future default incentives. They do respond, however, to default risk because the marginal product of capital is lower in default. The Euler equation of a representative household is

$$u'\left(c_t^P\right) P_{k,t} = \beta \mathbb{E}\left[\left(1-d_{t+1}\right) u'\left(c_{t+1}^P\right) R_t^P + d_t u'\left(c_{t+1}^D\right) R_t^D\right] \tag{10}$$

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

$$R_{t+1}^P = \alpha z_{t+1} A K_{t+1}^{\alpha-1} + (1-\delta) P_{k,t+1} + \frac{\phi}{2}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 \tag{11}$$

in repayment and

$$R_{t+1}^D = \alpha z_D\left(z_{t+1}\right) A K_{t+1}^{\alpha-1} + (1-\delta) P_{k,t+1} + \frac{\phi}{2}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 \tag{12}$$

in default. As the probability of default increases, the expected return to capital decreases because $z_D\left(z_{t+1}\right) \leq z_{t+1}$, which lowers household's incentives to invest. In addition to default risk depressing investment, households do not internalize how their investment decision affects default risk and, thus, the price of newly issued debt. To illustrate this, consider the case in which the government can directly choose the aggregate capital allocation. Then, the Euler equation for capital in repayment would be:

$$u'\left(c_t^P\right)\left[P_{k,t} - \frac{\partial q\left(z_t, x_{t+1}\right)}{\partial K_{t+1}} i_{b,t}\right] = \beta \mathbb{E}\left[\left(1-d_{t+1}\right) u'\left(c_{t+1}^P\right) R_t^P + d_t u'\left(c_{t+1}^D\right) R_t^D\right] \tag{13}$$

where the term $\frac{\partial q(z_t, x_{t+1})}{\partial K_{t+1}} i_{b,t}$ shows that the government understands how its choice of K_{t+1} affects its borrowing terms and, in turn, the resource constraint in t. Esquivel (2024) shows that under standard assumptions on z_D default incentives are decreasing in capital and the derivative $\frac{\partial \hat{q}}{\partial K} \geq 0$.[8] This implies that households underinvest in periods where borrowing needs are positive $i_{b,t} \geq 0$. Note that this inefficiency vanishes without default risk (q would be constant) and is more severe in states for which q is "steeper", which is the case in periods of distress.

The severity of these inefficiencies depends directly on the shape of the price q and its sensitivity to dynamic choices. On one hand, government overborrowing due to debt dilution exacerbates default risk, which depresses long-run levels of capital. On the other hand, underinvestment in periods of distress further increases default risk and the ex ante penalty that forward-looking lenders impose on the price of government debt. These interactions suggest that these frictions may amplify (or mitigate) each other. In this context, debt limits help curb debt dilution and lower default risk, thereby enhancing the expected returns on private investment and promoting capital accumulation.

2.3 First-best equilibrium

Before proceeding with the quantitative analysis we define and characterize the first-best equilibrium for this economy. Our characterization proceeds in two steps that allow us to mute one inefficiency at a time, which we later use to decompose the welfare costs from each and to illustrate how they interact (see Subsection 3.2). We also use this first-best equilibrium as a benchmark for the outcomes of implementing different fiscal rules in Subsection 3.3.

A first-best equilibrium is one in which there is no debt dilution and no underinvestment. First, we introduce covenants like the ones studied by Hatchondo, Martinez, and Sosa-Padilla (2016) that eliminate debt dilution. Specifically, the covenant stipulates that if borrowing results in a lower market price of debt then the government has to compensate existing bond holders for this dilution:

$$C\left(z, B, K', B'\right) = \max\left\{0, q\left(z, K', (1-\gamma) B\right) - q\left(z, K', B'\right)\right\}. \tag{14}$$

[8] See Esquivel (2024) 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.

This covenant eliminates debt dilution because it makes the value of long-term bonds independent of future borrowing decisions. The second step consists on solving the problem of a benevolent social planner with debt covenants. That is, allowing the (benevolent) government who no longer has incentives to dilute outstanding bonds to also choose the aggregate capital allocation.[9] As discussed by Gordon and Guerron-Quintana (2018), this planner's allocation can be decentralized with a state-contingent subsidy to future capital K_{t+1} equal to

$$\tau_{k,t} = \frac{\partial q\left(z_t, \hat{x}_{t+1}\right)}{\partial K_{t+1}} \left(\hat{B}_{t+1} - (1-\gamma) B_t\right), \tag{15}$$

where $\hat{x}_{t+1} = \left(\hat{K}_{t+1}, \hat{B}_{t+1}\right)$ are the planner's choices for next period's capital and debt.

Implementing these subsidies and covenants outside of the model is impractical because they require knowing the exact shape and derivatives of the price function q, which is why we focus our quantitative analysis on the implementation of fiscal rules with debt limits.

3 Quantitative analysis

We solve numerically for the equilibrium using value function iteration. Following Hatchondo, Martinez, and Sapriza (2010), we compute the limit of the finite-horizon version of the 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 of the government 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.

[9] In this case we modify the covenant in equation (14) to be $C(z, B, K', B') = \max\{0, q(z, K, (1-\gamma) B) - q(z, K', B')\}$ so that it compensates lenders for dilution due to any government policy, which can be debt issuance or changes to the aggregate stock of capital.

3.1 Calibration

We calibrate the model to Argentina, which is a common reference in the sovereign debt literature and for which the potential gains from fiscal discipline are frequently featured in policy debates.[10] A period in the model is one quarter. Unless specified otherwise, we use data from the fourth quarter of 1993 to the fourth quarter of 2024.[11] There are two sets of parameters: one with values taken from the literature or directly from the data (summarized in Table 1) and another chosen to match some empirical moments in model simulations with no debt limit ($\chi_b = \infty$, Table 2). Most of our externally calibrated parameters rely on Chatterjee and Eyigungor (2012) and Gordon and Guerron-Quintana (2018), who calibrate for Argentina as well.

Table 1: Independent parameters

Parameter		Value	Source
Relative risk aversion	σ	2	Standard value
Risk-free rate	r^*	0.01	Standard value
Discount factor	β	0.95	Standard value for Argentina
Debt duration	γ	0.05	Chatterjee and Eyigungor (2012)
Coupon	κ	0.03	Chatterjee and Eyigungor (2012)
Probability of reentry	θ	0.0625	Gelos, Sahay, and Sandleirs (2011)
Capital share	α	0.33	Standard value
Depreciation rate	δ	0.05	Standard value
Persistence of productivity	ρ	0.95	Gordon and Guerron-Quintana (2018)
St. dev of productivity	σ_z	0.017	Gordon and Guerron-Quintana (2018)

The relative risk aversion parameter is $\sigma = 2$ and the risk-free rate $r^* = 0.01$, which are standard values in the business cycle literature. We set the discount factor of the households (and the benevolent government) to $\beta = 0.95$, which is close to values that have been calibrated for the Argentinean economy in similar models.[12] Following Chatterjee and Eyigungor (2012), we set the debt duration parameter $\gamma = 0.05$ and the coupon rate to $\kappa = 0.03$ to match the maturity and coupon information for Argentina reported in Broner, Lorenzoni, and Schmukler (2013). We set the probability of reentry to financial markets to $\theta = 0.0625$ for an average duration in autarky of 16 quarters,

[10] See "Argentine executives pitch fiscal discipline as election hits home stretch." *Reuters*, October 11, 2023. "Javier Milei implements shock therapy in Argentina." *The Economist*, December 13, 2023.

[11] National Accounts data for Argentina are from Instituto Nacional de Estadística y Censos (INDEC). GDP, investment, and consumption data are logged and HP-filtered with a smoothing parameter of 1,600. Investment data correspond to gross fixed capital formation and we use the sum of private and public consumption for our total consumption figures.

[12] Arellano (2008) chooses 0.953, Chatterjee and Eyigungor (2012) choose 0.954, and Gordon and Guerron-Quintana (2018) choose 0.946.

which is the median duration of default events documented by Gelos, Sahay, and Sandleirs (2011). The capital share $\alpha = 0.33$ and the capital depreciation rate $\delta = 0.05$ are standard values. Finally, we take the persistence $\rho = 0.95$ and variance $\sigma^2 = 0.017$ of the productivity shock from Gordon and Guerron-Quintana (2018), who calibrate them for Argentina using a similar production technology.

Table 2: Parameters chosen to target simulation moments

Parameter		Value	Target	Data	Model
Capital adjustment cost	ϕ	25.0	σ_i/σ_y	2.50	2.49
Quadratic cost on	ξ_0	-0.6608	$Av\,(r_t - r^*)$	0.07	0.07
productivity in default	ξ_1	0.8501	$\frac{B}{4*Y}$	0.45	0.45

The moments in the model are calculated using 10,000 samples of 1,000 periods each after dropping the first 1,000. The annualized yield on government bonds is $r_t = ((\gamma + (1-\gamma)(\kappa + q_t))/q_t)^4 - 1$ and the annualized risk-free interest rate is $r^* = 0.04$. Spreads are $r_t - r^*$. Both in the data and the model real GDP and investment are measured with base-period prices, we take the natural logarithm and detrend using an HPfilter with a smoothing parameter of 1600.

Table 2 summarizes the moment-matching exercise. We choose the capital adjustment cost parameter $\phi = 25$ and the two parameters governing the productivity penalty of default $\xi_0 = -0.6608$ and $\xi_1 = 0.8501$ to jointly match: (i) a ratio of investment volatility-to-GDP volatility of 2.65, (ii) an average spread of 0.08, and (iii) an average debt-to-GDP ratio of 0.45. Spreads in the model are calculated as $r_t - r^*$, where $r_t = \left(\left(\gamma + (1-\gamma)(\kappa + q_t)\right)/q_t\right)^4 - 1$ is the annualized yield of government bonds implied by q_t. Spreads in the data are from the Emerging Markets Bond Index, an index composed of U.S. dollar-denominated emerging market bonds.[13] For debt, we use the general government gross debt measured as a percentage of GDP from the IMF. Both in the model and in the data, we only consider periods in good financial standing. Thus, the sample in the data includes the periods 1993-2001 and 2005-2019.

[13] We use the Argentina-specific EMBI. We consider data from 1993Q4 to 2019Q4 and drop the periods between 2001Q4 and 2005Q1 since Argentina was in the midst of a default episode during this period. This gives us an average spread of 0.07, which is in line with what other papers in the literature use as a target for Argentina (See Chatterjee and Eyigungor (2012) or Gordon and Guerron-Quintana (2018)). The average spread considering the entire sample would be 0.14, which is roughly twice as large, but conceptually inconsistent with what spreads are in our model since the price of bonds is not defined during default.

Table 3: Non-targeted moments

Moment	Data	Model
default frequency	0.03	0.03
σ_{r-r^*}	0.04	0.04
σ_c/σ_y	1.1	1.7
σ_y	4.8	3.5
$\sigma_{tb/y}$	2.3	6.2
$Cor(r-r^*,y)$	-0.79	-0.32
$Cor(tb/y,y)$	-0.68	-0.46

The moments in the model are calculated using 10,000 samples of 1,000 periods each after dropping the first 1,000. The annualized yield on government bonds is $r_t = ((\gamma+(1-\gamma)(\kappa+q_t))/q_t)^4 - 1$ and the annualized risk-free interest rate is $r^* = 0.04$. Spreads are $r_t - r^*$. Both in the data and the model real GDP and consumption are measured with base-period prices, we take the natural logarithm and detrend using an HPfilter with a smoothing parameter of 1600.

Table 3 reports other business cycle moments not targeted in the calibration. The model generates an annual default frequency of three defaults per century, as reported in other studies. The model also does a good job on the volatility of spreads and in generating countercyclical spreads and trade balances, which is an important feature of business cycles in emerging market economies that has been highlighted in the literature. Consumption is more volatile than GDP, as in the data, but this ratio of volatilities is slightly larger. The volatility of output is close to that of the data, but not the volatility of the trade balance, which is much larger.

3.2 Welfare decomposition

We follow the decomposition used by Aguiar, Amador, and Fourakis (2020) to analyze welfare gains of moving from one equilibrium to another. Let

$$W^i(s) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t^i\right) \tag{16}$$

be the welfare of the representative household in equilibrium i starting from some state $s = (z,x)$; and define $\lambda_f(s)$ as

$$\left(1+\lambda_f(s)\right) = \left(\frac{W^f(s)}{W^b(s)}\right)^{\frac{1}{1-\sigma}}, \tag{17}$$

where $W^f(s)$ and $W^b(s)$ are the welfare of the household in the first-best and benchmark equilibrium, respectively. The average welfare gains of implementing the first-best equilibrium are $100 * \bar{\lambda}_f = 1.09$ percent, where $\bar{\lambda}_f$ is the average of $\lambda_f(s)$ over 10,000 draws of s from the ergodic distribution in the benchmark economy. If we instead consider the average state in the benchmark economy $\bar{s} = \left(\bar{z}, \bar{K}, \bar{B}\right)$, then welfare gains are $100 * \lambda_f\left(\bar{s}\right) = 1.07$ percent and we can make the following decomposition:

$$\left(1+\lambda_f\left(\bar{s}\right)\right) = \underbrace{\left(\frac{W^d\left(\bar{s}\right)}{W^b\left(\bar{s}\right)}\right)^{\frac{1}{1-\sigma}}}_{1+\lambda_d} \times \underbrace{\left(\frac{W^f\left(\bar{s}\right)}{W^d\left(\bar{s}\right)}\right)^{\frac{1}{1-\sigma}}}_{1+\lambda_{df}} \tag{18}$$

$$= \underbrace{\left(\frac{W^k\left(\bar{s}\right)}{W^b\left(\bar{s}\right)}\right)^{\frac{1}{1-\sigma}}}_{1+\lambda_{bk}} \times \underbrace{\left(\frac{W^f\left(\bar{s}\right)}{W^k\left(\bar{s}\right)}\right)^{\frac{1}{1-\sigma}}}_{1+\lambda_{kf}}, \tag{19}$$

where W^d is household welfare in the economy with debt covenants and decentralized investment, and W^k corresponds to the economy with centralized investment and no debt covenants. Equation (18) computes the welfare gains of first introducing debt covenants $100 * \lambda_d = 0.90$ and then centralizing investment $100 * \lambda_{df} = 0.17$. Just removing debt dilution from issuance already achieves 85 percent of the welfare gains from the first-best equilibrium, while the remainder comes from removing the underinvestment externality. Equation (19) reverses the order. In this case, centralizing investment while still allowing for costless dilution generates welfare losses of $100 * \lambda_{bk} = -0.09$. This is because the government still has strong incentives to dilute outstanding debt, but now has an additional instrument to affect the price q. This, in turn, makes neutralizing debt dilution a lot more valuable with welfare gains of $100 * \lambda_{kf} = 1.16$ percent.

There are two takeaways from this exercise. The first is that underinvestment cannot be addressed by the government with outstanding long-term debt. In fact, as long as the government has the time-inconsistency problem of debt dilution, allowing it to influence capital accumulation only makes matters worse. This is because the government faces a tension between increasing investment to lower default risk and reducing investment to lower the price of outstanding debt (just like increasing debt issuance would). The second takeaway is that while decentralized investment limits debt dilution, it barely offsets its costs. In fact, the welfare losses of 0.09 percent from centralizing investment with dilution are smaller than the gains of 0.17 from doing so once dilution has been addressed. This implies that policies that curb debt dilution by limiting debt issuance—like the fiscal rules that we analyze next—have the additional benefit of reducing the time-inconsistency problem of government's investment policies. That is, by limiting the time-inconsistency problem in debt, these policies create an opportunity for the government to credibly address the underinvestment externality as well, in a way that increases welfare.

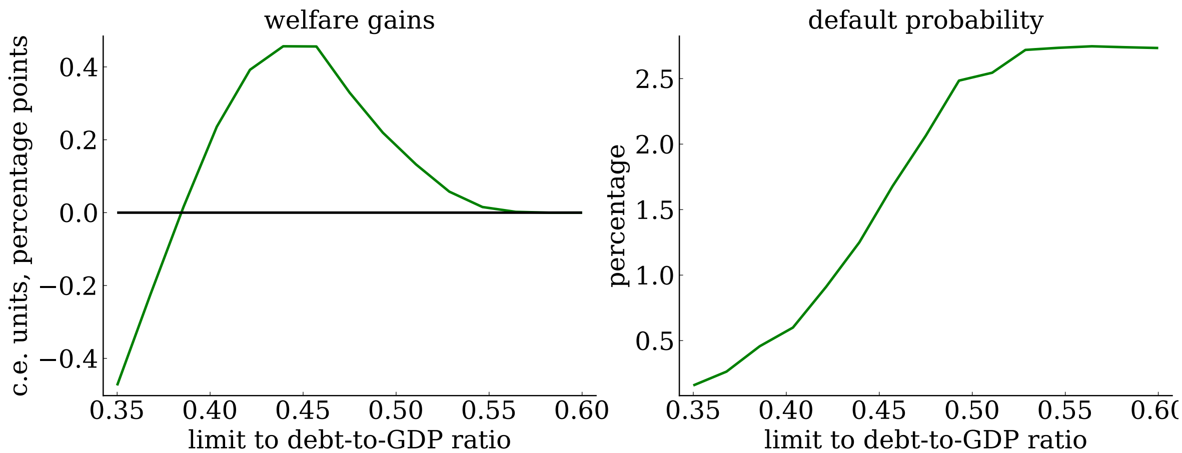
3.3 Optimal fiscal rules

As discussed by Hatchondo, Martinez, and Roch (2022a), fiscal rules can lower default risk and mitigate the costs from debt dilution. Lower default risk in turn mitigates underinvestment and enables the economy to sustain higher levels of capital, output, and consumption in the long-run. The implementation of a fiscal rule, however, may result in a costly transition by inducing a recession with temporarily lower investment and consumption if debt has to be consolidated downward. In this subsection we quantify these tradeoffs and characterize fiscal rules that maximizes welfare gains. Specifically, we consider three fiscal rules: debt limits, deficit limits, and a dual rule that considers both.

Our benchmark calibration considers an economy with no explicit fiscal rule (i.e. $\chi_b = \infty$ in equation (3)). We now search for the χ_b^* that maximizes the average welfare gains of implementing a debt limit in the ergodic distribution. Let $\lambda(s_t; \chi_b)$ be the welfare gains, expressed in consumption equivalent units, of implementing χ_b when the state is $s_t = (z_t, x_t)$. Also, let $\bar{\lambda}(\chi_b)$ be the average of λ in the ergodic distribution. The left panel of Figure 1 shows $\bar{\lambda}$ for different values of χ_b, calculated as the average of 10,000 random draws of $\lambda(s_t; \chi_b)$.[14] The optimal debt limit for fiscal rules of the form described by equation (3) is $\chi_b^* = 0.44$ and generates welfare gains of 0.46 percent. The right panel shows the default probability under each limit.

[14] We pick each $s_t = (z_t, x_t)$ as the last element from a simulation of 1,001 periods in the benchmark economy.

Figure 1: Welfare gains of implementing debt limits



For each value of the limit to the debt-to-GDP ratio χ_b the left graph depicts average welfare gains $\bar{\lambda}(\chi_b)$ expressed in consumption equivalent units. Each $\bar{\lambda}(\chi_b)$ is the average welfare gains $\lambda(s_t;\chi_b)$ of 10,000 draws of $s_t = (z_t, x_t)$ from the ergodic distribution in the benchmark economy without fiscal rules.

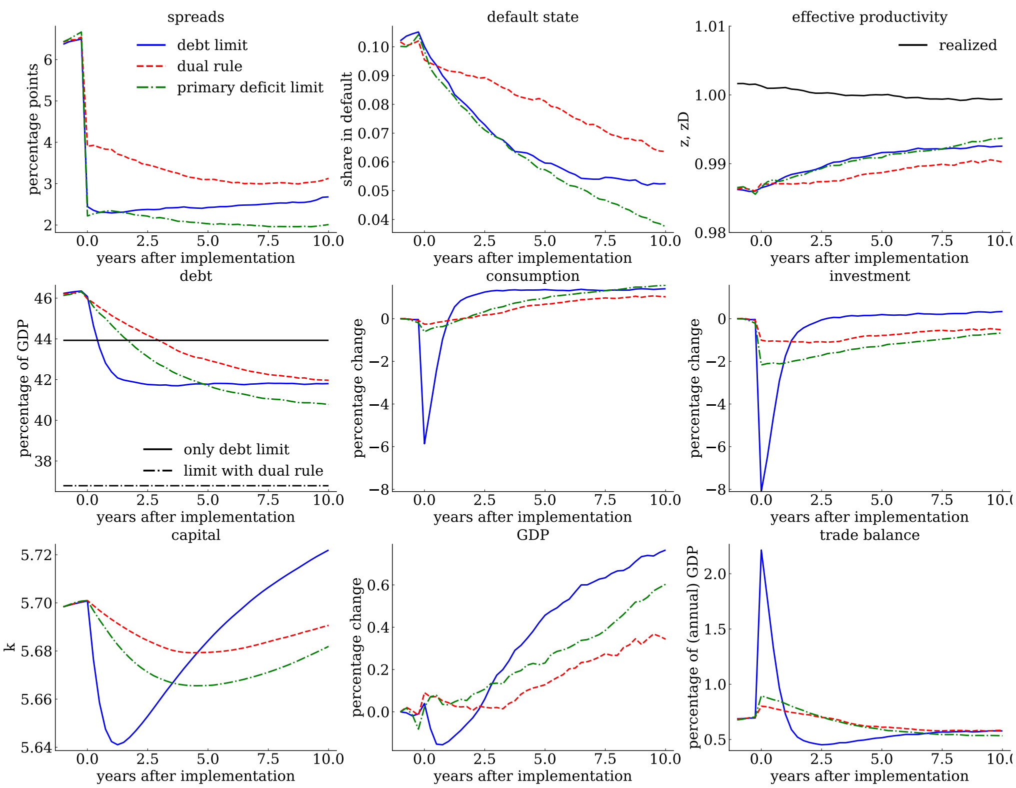
If the debt limit is too high then welfare gains are zero because the fiscal rule is so relaxed that it has no effect on the government's incentives and, thus, no effect on prices or investment. As the debt limit becomes stricter, the default probability goes down and welfare gains increase because the debt limit curbs debt dilution, reduces sovereign risk, and, consequently, mitigates underinvestment. If the debt limit is too strict, however, then there are welfare losses from implementing the rule mainly because the implementation requires a costly adjustment period during which consumption and investment are depressed. The stricter the rule, the costlier the transition. Additionally, welfare losses arise because the economy's ability to borrow in the long-run would be too restricted, which is consistent with the findings by Aguiar, Amador, and Fourakis (2020).[15]

The solid blue lines in Figure 2 show the averages of 10,000 paths of relevant macroeconomic variables following the implementation of the optimal debt limit $\chi_b^* = 0.44$. All initial periods are drawn from the ergodic distribution in the benchmark economy and each period is one quarter (the plot shows the units in years for clarity of the exposition). The economy transitions to a distribution with a higher capital stock, higher output, higher consumption, lower debt-to-GDP ratio, lower sovereign spreads, and lower default risk. This transition, however, comes with a short-term cost: when the limit is implemented, investment and consumption drop to finance a large and quick debt

[15]They find that households strictly prefer access to financial markets over autarky as long as the households' discount rate is slightly higher than the world interest rate. They also find that this conclusion is almost insensitive to the discount rate of the government when it differs from that of the households. Their results are robust for a wide range of reasonable values for discount factors and the risk-aversion coefficient.

reduction.

Figure 2: Transition paths to fiscal rules



Each panel shows the average of 10,000 time series that start at one draw from the ergodic distribution in the benchmark economy without fiscal rules and implement the optimal fiscal rules in year $t = 0$. For each path, the initial state is the end-state of a simulation of 1,001 periods. For spreads we only consider paths with no default. For debt we set $B_t = B_{t-1}$ if $dt = 1$ and $B_t = 0$ when the economy is readmitted to financial markets.

The debt-to-GDP ratio drops to an average of 0.42, lower than the 0.44 imposed by the rule. This is because having the rule bind is very costly, which makes default more attractive in those states. The government ex ante chooses to avoid these occurrences by issuing lower levels of debt.[16] Spreads sharply drop on impact and remain low, reflecting both lower default risk and less future debt dilution. In the long-run, lower default risk and the implied higher expected marginal product of capital drive an increase in investment and the economy converges to a new ergodic distribution with higher average consumption and output, as can be seen in Figure 7 in the Appendix.

Interestingly, average GDP sightly increases on impact because fewer simulated economies default in that period, as can be seen in the top middle panel where the share of economies in default drops in $t = 0$. Effective TFP, net of the default penalty, is then higher in each of these

[16]In the benchmark economy with no fiscal rule the optimal debt limit would bind 78 percent of the time in the ergodic distribution, compared to the limit actually binding only 7.4 percent of the time when the debt rule is in effect.

economies that would have defaulted otherwise, which is reflected in a higher average GDP in $t = 0$. These economies can avoid defaulting in $t = 0$ thanks to lower sovereign spreads. After increasing on impact, average GDP drops during the first year following the implementation of the rule but then starts growing after the fifth quarter as investment and consumption recover.

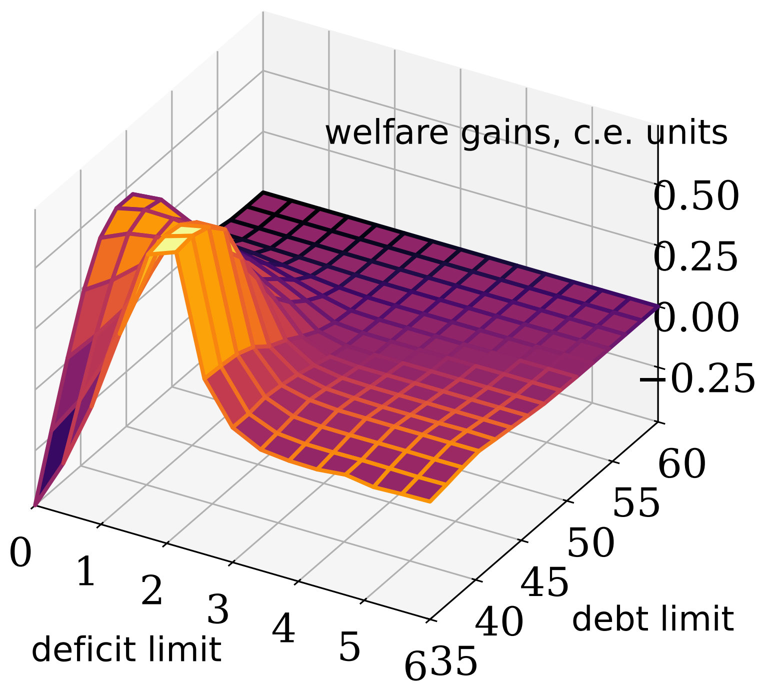
Welfare gains are higher than in models with no capital accumulation (such as those studied by Hatchondo, Martinez, and Sosa-Padilla (2016) or Hatchondo, Martinez, and Roch (2022a)) because of higher consumption possibilities thanks to the increase in the capital stock. Average consumption converges to a level that is 1.6 percent higher in the economy with a debt limit. Welfare gains of implementing the rule are only 0.46 percent due to the painful transition in which consumption decreases to finance large debt payments.

The transition under this debt-limit rule is particularly costly because it implicitly imposes a weakly positive primary surplus when debt is above its limit. To smooth the transition, we now explore fiscal rules that allow positive, but limited, primary deficits when the debt limit binds. Specifically, we now consider fiscal rules of the form

$$\mathcal{F}\left(z_t, K_t, B_t\right) = \left\{B_{t+1} | B_{t+1} \leq \max\left\{\chi_b z_t K_t^{\alpha}, \left(1-\gamma\right) B_t + \chi_d z_t K_t^{\alpha}\right\}\right\},$$

where χ_b is the debt limit and $\chi_d > 0$ bounds the primary deficit. Figure 3 shows the welfare gains of implementing different pairs of (χ_b, χ_d).

Figure 3: Welfare gains of deficit and debt limits



For each pair (χ_b, χ_d) the graph depicts average welfare gains $\bar{\lambda}(\chi_b, \chi_d)$ expressed in consumption equivalent units. Each $\bar{\lambda}(\chi_b \chi_d)$ is the average welfare gains $\lambda(s_t; \chi_b, \chi_d)$ of 10,000 draws of $s_t = (z_t, x_t)$ from the ergodic distribution in the benchmark economy without fiscal rules.

If the deficit limit, χ_d, is too loose then it completely undermines the debt limit, since the government is allowed to issue more debt than it would want to regardless. On the other hand, if the rule is strict enough in either dimension then it generates welfare losses, which highlights the robustness of the results in Aguiar, Amador, and Fourakis (2020) discussed above. The optimal fiscal rule under this formulation has a debt limit of $\chi_b^* = 0.37$ and allows a primary deficit of up to 2.1 percent of GDP when the debt limit is binding ($\chi_d^* = 0.021$). This debt limit is slightly tighter than the optimal debt limit from the exercise in Figure 1, but its combination with a contingent deficit limit for the transition delivers higher welfare gains of 0.74 percent (as opposed to 0.46 with $\chi_b^* = 0.44$ and no primary deficits during the transition). These higher gains are explained by a smoother transition, as illustrated by the red-dashed lines in Figure 2.

Interestingly, the debt-to-GDP ratio does not converge to a level at or below the optimal debt limit under the dual rule ($\chi_b^* = 0.37$ and $\chi_d^* = 0.021$), but to almost the exact same level as it does under the rule that does not allow for primary deficits (see Figure 7 in the Appendix).[17] This

[17]This is true even if the dual rule is implemented with zero debt in the first period, as illustrated by Figure 8 in the Appendix. The long-run average value of debt is the same regardless of the starting point.

suggests that deficit limits may outperform debt limits when achieving fiscal consolidation because of a smoother transition path.

To compare welfare gains from debt and deficit rules, we compute the optimal deficit limit without any debt limit. Specifically, we now consider deficit limits of the form

$$\mathcal{F}(z_t, K_t, B_t) = \left\{B_{t+1} | B_{t+1} \leq (1-\gamma) B_t + \chi_d z_t K_t^{\alpha}\right\},$$

where $\chi_d > 0$ represents the primary deficit limit. The left panel of Figure 6 in the appendix shows welfare gains at different values of χ_d. The optimal deficit limit is almost identical as under the optimal dual rule $\chi_d^* = 0.021$, but generates welfare gains of 1.24 percent, which are significantly larger than those arising from the debt limit (0.46) and the dual rule (0.74).[18]

Welfare gains are larger under the deficit limit not only because it smooths the transition during fiscal consolidation, but also because it imposes some fiscal discipline in all states. In contrast, the debt limit and the dual rule do not impose fiscal discipline in states with low levels of debt. This stringent fiscal discipline associated with deficit limits is internalized by the market (see next Subsection), contributing to a significant reduction on sovereign spreads both on impact and in the long-run. The dashed green line in Figure 2 shows that the economy with a deficit limit transitions to a distribution with lower sovereign spreads, lower debt levels, lower default probability, and higher consumption relative to the economies with other rules. Notably, the relatively lower spreads allow for higher consumption on average despite the slightly lower levels of capital, private investment, and output.

Finally, it is worth noting that the stringent fiscal discipline associated with the deficit limit only delivers relatively larger welfare gains when achieving fiscal consolidation from high debt levels. When these rules are implemented with zero initial debt then the deficit limit delivers the lowest welfare gains precisely because of how it limits debt accumulation over time. This is illustrated in Figure 8 in the Appendix, which shows how the economy accumulates debt faster under the other two rules. In this case, average welfare gains are the highest under the dual rule because it combines the flexibility of debt limits at low levels of debt with the discipline imposed

[18]These gains of 1.24 are also larger than the ones we computed for the first-best equilibrium of 1.09. This comparison, however, is misleading because it includes large transition costs from implementing either policy starting from high levels of debt. If we were to compute these average gains starting from zero debt, they would be 0.24 for the primary-deficit limit and 1.79 for the first-best. This is consistent with our broader analysis of transition costs.

by the deficit limit at higher debt levels. Instead of being an upper bound for indebtedness, the debt limit under the dual rule effectively acts as a trigger for discipline on the primary deficit. These contrasts highlight the importance of the starting point and transition costs when designing and implementing fiscal rules.

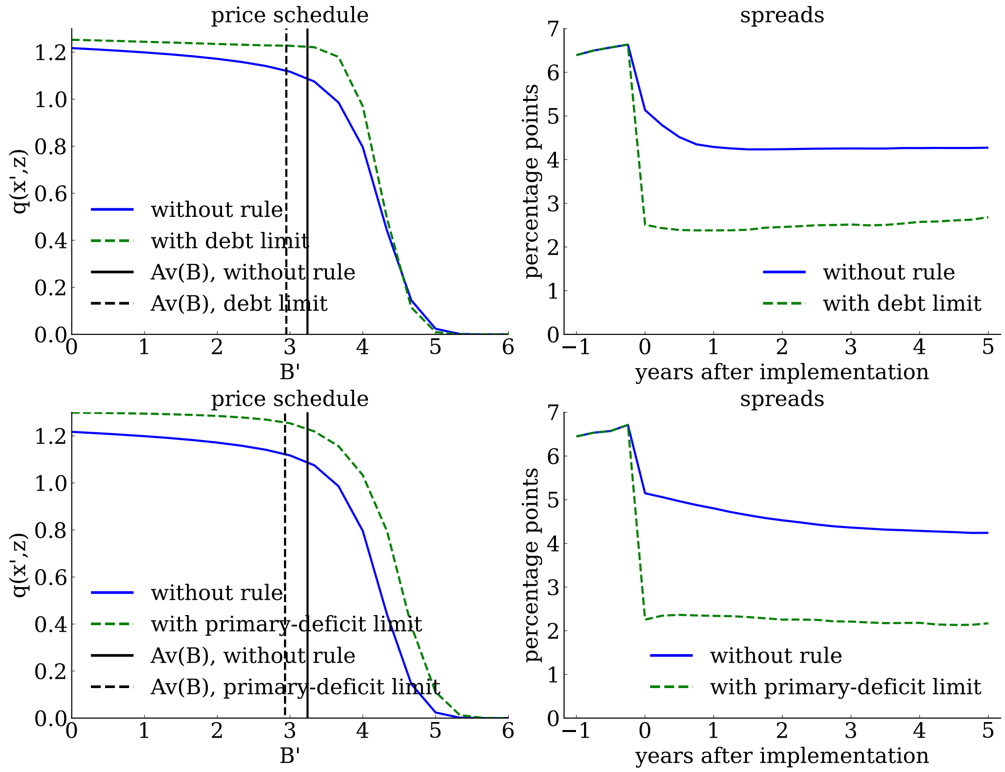
3.4 Inspecting the mechanism

Lower default risk and spreads are at the core of the welfare gains from fiscal rules. The mechanism through which they lower default risk (and spreads) has two components: stricter fiscal discipline from the government and anchored expectations in the private sector.

To understand the government's behavior, the left panels of Figure 4 compare the price schedule of debt with and without fiscal rules. The top-left panel makes the comparison with the optimal debt limit and the bottom-left panel makes it with the optimal primary-deficit limit. In both cases, the price with the fiscal rule is "flatter" for low debt levels and "steeper" for higher levels. The price is flatter for low levels because the fiscal rule limits future dilution, so a marginal increase has a small negative effect on its price. It is steeper for high levels because default is more attractive closer to the debt limit since it prevents new debt issuance.[19]

[19] These differences are starker in the case of the debt limit because it provides less flexibility when the rule binds, but our analysis applies to all cases.

Figure 4: Spreads and the price of debt



The top-left panel shows the price schedules of debt in the economy with no rules and the economy with the optimal debt limit. Both are evaluated at the average capital stock and the average shock. The top-right panel shows the time series of spreads following the average consolidation path of debt and capital after the implementation of the optimal debt limit. The solid-blue line uses the price schedule in the benchmark economy and the dotted-green line uses the price schedule with the debt limit. The bottom panels repeat the analysis for the implementation of the optimal primary-deficit limit.

This change in shape reflects the fact that default under the fiscal rule is more dependent on the debt level and less so on the realization of the shock, as is the case in models with short-term debt (see the discussions in Aguiar and Gopinath (2006) and Hatchondo and Martinez (2009)). There is a critical level of debt beyond which the government almost surely defaults, which gives it strong incentives to keep its debt well below it and avoid being too close to this steep region of the price schedule. This is the mechanism that prevents models with short-term debt from sustaining high levels of both default risk and debt in equilibrium. In our environment, this gives the government the precautionary motive to keep the debt level in the flat region of the price schedule most of the time, which limits the severity of the underinvestment externality (the absolute size of the wedge in Euler Equation (13) is small).

The right panels of Figure 4 show how large the effect of anchored private expectations is. Spreads drop following the announcement of a fiscal rule because the price schedule of debt shifts, as illustrated by the left panels, but also because the government reduces its outstanding debt. Even without a fiscal rule, an aggressive debt-repayment plan such as the one following the rule would also lower spreads, but this reduction would not be as significant absent a commitment mechanism not to dilute the debt with future issuance. To illustrate this, the right panels of Figure 4 compare the observed paths of spreads following the implementation of a rule (dotted green lines) with a hypothetical path in which the government implemented the same debt reduction (under each corresponding rule) but facing the price schedule without rules. Spreads would drop but only by half of what they do with fiscal rules. Anchored expectations from the private sector generate the large shift in the price schedule of debt that drives the rest of the drop in spreads, which is more pronounced with the primary-deficit rule. This is because the primary-deficit rule smoothly imposes some fiscal discipline in the entire state space, while debt-limit rules only impose strict fiscal discipline when debt levels are already high and no discipline when debt levels are low.

3.5 Robustness

We now show that our main results are robust to alternative formulations of capital accumulation in the model and to different discounting between households and their government, which affects how welfare is calculated.

Financing of capital.—Our benchmark model assumes that households accumulate capital without access to international financial markets. This directly links the overall financing of investment to government borrowing, which may be imposing a harsh constraint on the economy's ability to accumulate capital. We now consider the diametrically opposite case in which capital is fully financed by foreign investors.[20] These investors are risk-neutral, behave competitively, and pay the same capital adjustment cost as the households in the benchmark model. Importantly, these investors have access to international capital markets and discount the future at the risk-free rate. The government cannot expropriate this capital, but if the government defaults then returns to capital are affected by the overall productivity penalty in the economy. A representative in-

[20] An intermediate scenario would be one in which domestic households, or a subset of them, have access to international financial markets. Investment financing in this case would only be partially linked to government borrowing (the government would still have access to lump-sum transfers), but the aggregate stock of private debt would introduce an additional externality on government default incentives (see Jeske (2006), Kim and Zhang (2012), and Arce (2024)). Given the similarity of the results with foreign investment and the fact that private overborrowing has been widely studied in the literature, we believe that this intermediate extension is beyond the scope of this paper.

vestor chooses how much capital to install in the economy according to the following no-arbitrage condition:

$$(1+\psi_1)(1+r^*) = \mathbb{E}\left[(1-d_{t+1})R_t^P + d_t R_t^D\right], \tag{20}$$

where R_t^P and R_t^D are the returns to capital in repayment and default, respectively, as defined in equations (11) and (12). The domestic firm pays these returns to foreign investors and rebates its remaining profits to the domestic household. The rest of the environment is the same as described in Section 2.

Table 4 compares this alternative formulation with our benchmark. The third column reports the fiscal rules that maximize welfare gains under all the cases we considered for χ_b and χ_d. The fourth column reports average welfare gains in consumption equivalent units and columns 5 through 10 report the default probability, average spreads, the standard deviation of spreads, the average debt-to-GDP ratio, average consumption with the rule relative to average consumption without it, and the volatility of consumption relative to that of output.

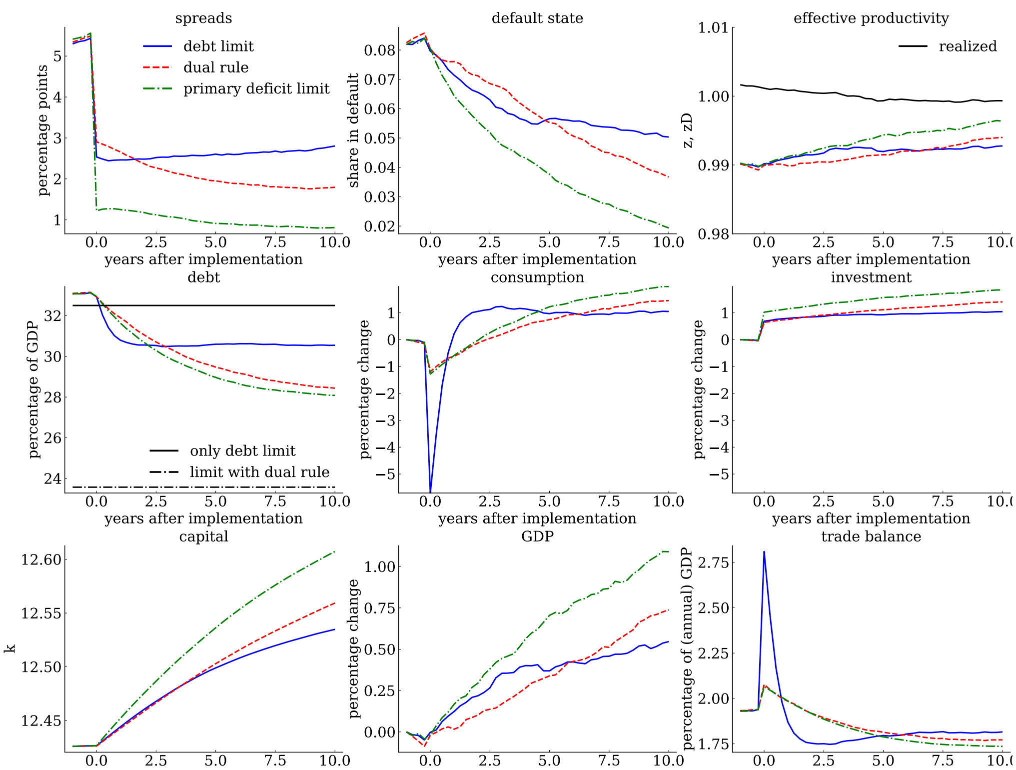
Table 4: Fiscal rules in alternative models

model	case	(χ_b^*, χ_d^*)	w.g.	$Pr\,(\text{def.})$	μ_{r-r^*}	σ_{r-r^*}	$\frac{B}{4*Y}$	$\frac{Av(c^{\text{rule}})}{Av(c^{\text{no rule}})}$	$\frac{\sigma_c}{\sigma_y}$
benchmark model	no rule	n.a.	n.a.	0.027	0.07	0.04	0.45	1.000	1.70
	debt limit	(0.44,0.000)	0.46	0.013	0.03	0.03	0.41	1.029	1.73
	dual rule	(0.37,0.021)	0.74	0.013	0.03	0.03	0.41	1.026	1.57
	primary deficit limit	(∞,0.021)	1.24	0.007	0.02	0.02	0.41	1.031	1.19
foreign investors	no rule	n.a.	n.a.	0.023	0.06	0.04	0.32	1.000	1.87
	debt limit	(0.32,0.000)	0.43	0.013	0.03	0.03	0.30	1.018	1.90
	with deficit limit	(0.24,0.014)	0.71	0.007	0.02	0.02	0.28	1.025	1.50
	primary deficit limit	(∞,0.014)	1.22	0.002	0.01	0.01	0.28	1.029	1.17
patient households	no rule	n.a.	n.a.	0.024	0.06	0.04	0.44	1.000	1.62
	debt limit	(0.39,0.000)	0.88	0.005	0.01	0.02	0.37	1.032	1.55
	with deficit limit	(0.20,0.017)	1.18	0.002	0.006	0.01	0.34	1.036	1.20
	primary deficit limit	(∞,0.017)	1.39	0.001	0.002	0.005	0.34	1.037	1.10

The fiscal rules in each row correspond to those that maximize average welfare gains in the ergodic distribution without rules. Welfare gains are reported in consumption equivalent units. The moments in the model are calculated using 10,000 samples of 1,000 periods each after dropping the first 1,000. The annualized yield on government bonds is $r_t = ((\gamma+(1-\gamma)(\kappa+q_t))/q_t)^4 - 1$ and the annualized risk-free interest rate is $r^* = 0.04$. Spreads are $r_t - r^*$. Both in the data and the model real GDP and consumption are measured with base-period prices, we take the natural logarithm and detrend using an HPfilter with a smoothing parameter of 1,600.

First, note that the overall results are very similar. Welfare gains are larger for the dual rule than for the debt limit, and largest for the rule with a deficit limit. The magnitudes are also similar to those in the benchmark case. The average default probability is lower with fiscal rules and this allows to sustain higher levels of average consumption. Figure 5 presents the average transition paths for all fiscal rules in the case with foreign investors. The main difference with the benchmark case is that investment immediately increases to its new long-run level instead of contracting. This is because the government cannot heavily tax foreign investors and their access to international financial markets allows them to immediately increase investment as a response to lower future default rates. GDP increases on impact and continues to increase as the economy accumulates more capital. Consumption contracts almost the same as in the benchmark case under the strict debt limit to finance the necessary trade surpluses that reduce the stock of debt.

Figure 5: Transition paths to fiscal rules, foreign investors



Each panel shows the average of 10,000 time series that start at one draw from the ergodic distribution in the benchmark economy without fiscal rules and implement the optimal fiscal rules in year $t = 0$. For each path, the initial state is the end-state of a simulation of 1,001 periods. For spreads we only consider paths with no default. For debt we set $B_t = B_{t-1}$ if $dt = 1$ and $B_t = 0$ when the economy is readmitted to financial markets.

Patient households.—The last four rows in Table 4 correspond to an environment in which the discount factor of the government β_G is lower than the households' β_{HH}. This difference captures political myopia that may arise as a result of political polarization or political turnover and has been explored as a justification for borrowing limits.[21] We set $\beta_G = 0.95$ as in our benchmark calibration and $\beta_{HH} = 0.97$, which is the mid-point between the government's discount factor and the one implied by the risk-free rate of 0.01. The overall results are the same: dual rules increase welfare more than debt limits, and deficit limits increase welfare the most. Overall welfare gains are larger because fiscal rules are correcting for political myopia in addition to debt dilution and underinvestment, which are still present. The government consolidates its debt to lower levels and there is less default risk and lower spreads. Lower default risk allows the households to sustain higher levels of average consumption because of the production expansion that results from higher capital accumulation. Figure 9 in the Appendix presents the transition paths for this case, which show a similar behavior as those in the benchmark.

4 Supportive evidence

A central prediction of the theory presented above is that countries with fiscal rules tend to face lower sovereign spreads and accumulate more capital than countries without rules. Although the link between fiscal rules and sovereign spreads is well-established in the literature, the relationship between rules and private investment remains unexplored.[22] To fill this gap, we study the relation between fiscal rules and private investment using annual data from 2000 to 2019 for a sample of 63 emerging market economies, which are commonly used in the literature.[23] Moreover, we discuss the findings of other papers with empirical work exploiting firm-level data to study the response of corporate investment following a fiscal shock. Interestingly, their findings are consistent with the private investment dynamics observed in our model.

[21] See Alesina and Tabellini (1990), Cuadra and Sapriza (2008), Azzimonti (2011), Aguiar and Amador (2011), Amador (2012), Halac and Yared (2014), Hatchondo, Martinez, and Roch (2022a), among many others

[22] See for example, Iara and Wolff (2010), Kalan, Popescu, and Reynaud (2018), Davoodi et al. (2022), and Islamaj, Samano, and Sommers (2024).

[23] The countries in our panel include Angola, Argentina, Armenia, Azerbaijan, Belize, Bolivia, Brazil, Bulgaria, Cameroon, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Gabon, Georgia, Ghana, Guatemala, Honduras, Hungary, India, Indonesia, Iraq, Jordan, Kazakhstan, Kenya, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Mongolia, Morocco, Mozambique, Namibia, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Romania, Russia, Senegal, Serbia, Slovak Republic, South Africa, Sri Lanka, Thailand, Tunisia, Turkiye, Ukraine, Uruguay, Venezuela, Vietnam, and Zambia.

4.1 Regression analysis

We use the IMF Fiscal Rules Dataset to sort countries into two categories: "fiscal rule" and "no fiscal rule".[24] Then, we use the IMF Investment and Capital Stock Dataset for private investment, J.P. Morgan EMBI for sovereign spreads, and IMF World Economic Outlook for public debt and GDP to estimate the following panel fixed-effect regression:

$$(I/y)_{i,t} = \alpha_i + \beta d_{i,t-1} + \gamma_1 r^s_{i,t-1} + \gamma_2 (B/y)_{i,t-1} + \gamma_3 \hat{y}_{i,t-1} + \varepsilon_{i,t}$$

where $(I/y)_{i,t}$ denotes private investment, normalized by GDP for country i at time t; $d_{i,t}$ is a dummy variable that assigns 1 if there is a fiscal rule in country i at period t and 0 otherwise; $r^s_{i,t}$ denotes EMBI sovereign spreads in basis points for country i at period t; $(B/y)_{i,t}$ denotes the level of public debt normalized by GDP for country i at period t; and $\hat{y}_{i,t}$ is the cyclical component of GDP for country i at period t. All regressors are lagged one period to control for endogeneity. The term $\varepsilon_{i,t}$ denotes the regression residuals.

Table 5 shows that, other things equal, having a fiscal rule in place is positive correlated with higher private investment. The coefficient on the rule dummy is positive and statistically significant, and this result is robust to various controls and specifications. Specification (1) presents the unconditional correlation between fiscal rules and private investment. Specification (2) controls for sovereign spreads, specification (3) controls for spreads and public debt, and specification (4) presents the baseline specification controlling for spreads, debt, and the cyclical component of GDP, which are the main macro variables driving the dynamics of private investment in our quantitative model. The estimate in column (4) suggests that private investment in countries with a fiscal rule in place is, on average, 1.1 percentage points of GDP higher than in countries without a rule. In the Appendix, Table 7 presents an alternative specification using country fixed effects. Overall, the positive correlation between fiscal rules and private investment holds.

Importantly, the rest of independent variables have the expected sign and most of them are statistically significant. On one hand, the coefficient associated with sovereign spreads is negative and significant, suggesting, as expected, that a decrease in sovereign risk is associated to higher investment. On the other hand, the coefficient associated with public debt is negative, which is con-

[24] We consider only debt and deficit rules, consistent with the model.

sistent with the findings in the debt overhang literature regarding the negative effects of debt levels on investment. However, our estimate in the baseline specification is not statistically significant. Finally, the coefficient associated with the cyclical component of GDP is positive and significant, suggesting, as expected, that investment is positively associated with economic activity (regardless of the income level).

Table 5: Panel Regressions: Fiscal Rules and Private Investment

	Dependent variable: (I/y)			
	(1)	(2)	(3)	(4)
FiscalRule	**1.116***	**1.087***	**1.130***	**1.100***
	(**0.666**)	(**0.652**)	(**0.647**)	(**0.656**)
Sovereign Spreads		-0.00173^{***}	-0.00127^{**}	-0.00128^{**}
		(0.000670)	(0.000500)	(0.000520)
Public Debt			-0.0373^{**}	-0.0260
			(0.0172)	(0.0215)
Cyclical GDP				7.689^{**}
				(3.338)
Observations	782	782	782	782
Number of countries	63	63	63	63

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

4.2 Fiscal shocks and private investment

Our results are also consistent with recent empirical work that studies the impact of fiscal shocks on private investment. Specifically, Magud and Pienknagura (2024) exploit granular, firm-level data, to show that, in emerging markets, unexpected public expenditure reductions increase firm-level investment, which quickly surpasses pre-shock levels after a temporary contraction, owing to a decline in financing costs. Consistent with the role played by financing cost dynamics and financial frictions, they show that countries with lower sovereign credit ratings experience a sharper boost in investment. Although the nature of the fiscal shock in Magud and Pienknagura (2024) differs from the one studied in this paper, the dynamics of private investment they document are consistent with those in our model following the introduction of a fiscal rule. This is, a short-run contraction followed by an expansionary effect. Moreover, their findings underscore the same mechanism emphasized in our framework: countries with higher sovereign risk benefit most from a shock that increases fiscal discipline, as it mitigates the underinvestment associated with such risk.

Overall, the positive correlation between debt rules and private investment observed using macro data, together with empirical evidence from firm-level data on responses to fiscal shocks, is consistent with the predictions of our model.

5 Conclusion

We studied how fiscal rules can generate a long-run economic expansion in the presence of sovereign risk. This is because rules directly contain dilution of long-term debt and indirectly mitigate private underinvestment, both of which reduce sovereign risk and increase capital accumulation that supports higher income in the long-run. In the short-run, however, the implementation of fiscal rules may result in costly transitions in which consumption and investment decrease to finance debt reduction.

We used the model to evaluate three commonly proposed rules and to compute their optimal levels: a debt limit, a deficit limit, and a dual rule. An important finding is that the desirability of each type of rule depends on the initial debt level. While the deficit limit is optimal when achieving fiscal consolidation from high debt levels, the dual rule is preferred at lower levels of indebtedness. This is because it combines the flexibility of debt limits at low levels with the discipline of deficit limits at higher levels, which is less stringent than that imposed by rigid debt limits at high levels. Our results are robust to different assumptions regarding who are the agents that accumulate capital and how restricted their access to financing is. We also find that our results are stronger in the presence of political myopia, which further highlights the importance of considering fiscal rules as a long-run mechanism to increase income levels and reduce fiscal risk.

Finally, we acknowledge that there are additional considerations that may strengthen the case for fiscal rules but also make their implementation more difficult. Endogenous maturity of total debt may give the government an additional lever to dilute its market value without issuing additional quantities, which would undermine the commitment gains from fiscal rules. Similarly, accounting manipulations may allow governments to escape debt rules and there may be large shocks to the level of debt like bailouts to the banking sector or state-owned enterprises, all of which may make fiscal rules difficult to implement. We think these are exciting avenues for future research.

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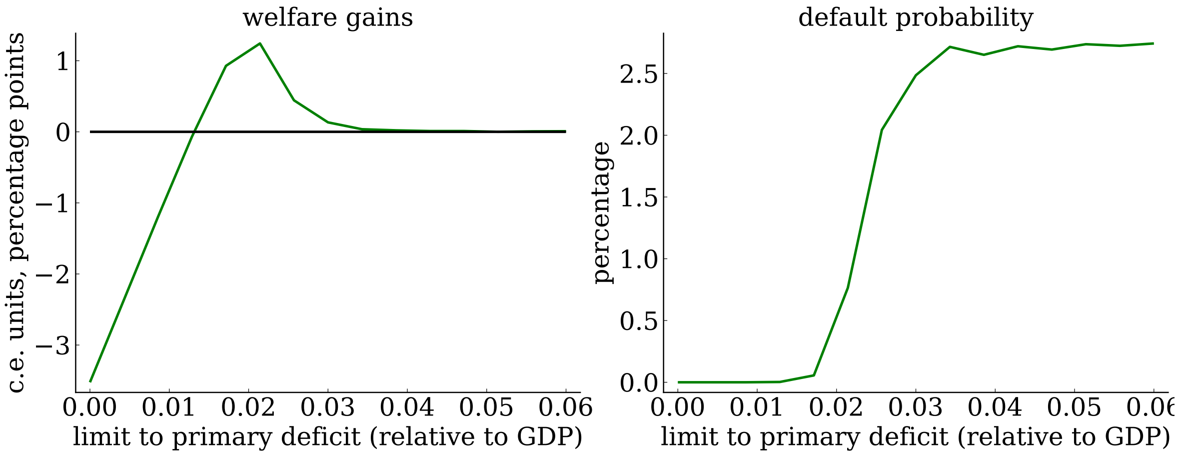
Appendix

A Welfare gains, different primary-deficit limits

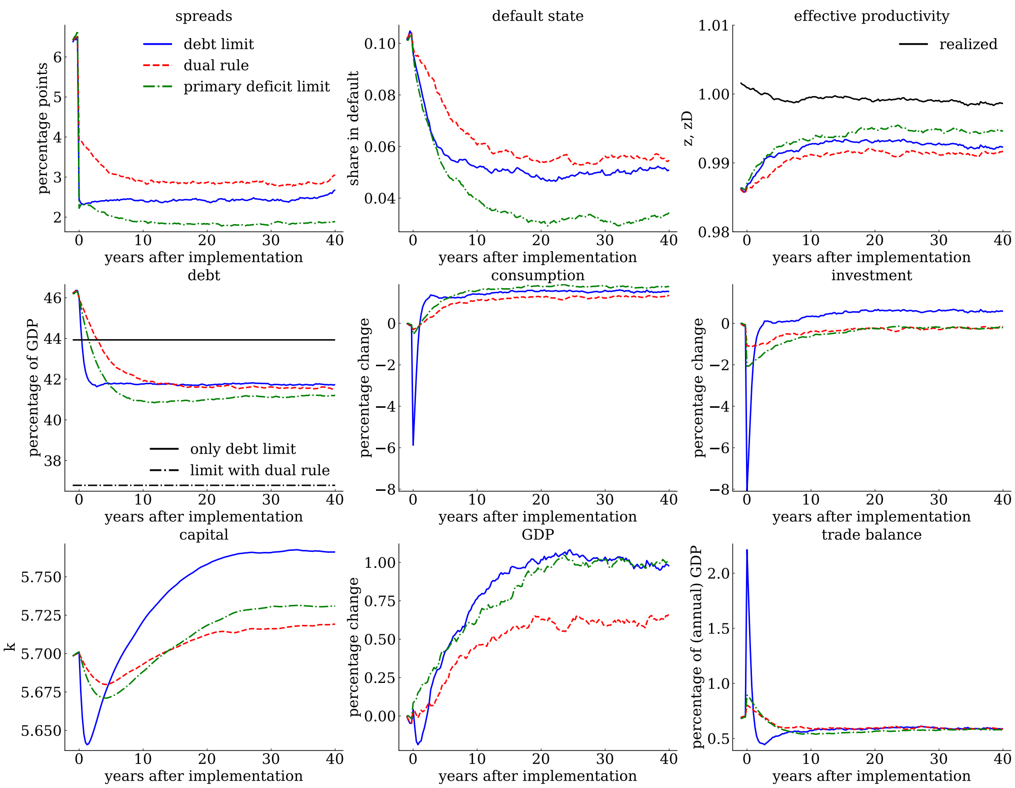
Figure 6: Welfare gains of implementing primary-deficit limits



For each value of the limit to the primary-deficit-to-GDP ratio χ_d the left graph depicts average welfare gains $\bar{\lambda}(\chi_d)$ expressed in consumption equivalent units. Each $\bar{\lambda}(\chi_d)$ is the average welfare gains $\lambda(s_t;\chi_d)$ of 10,000 draws of $s_t = (z_t, x_t)$ from the ergodic distribution in the benchmark economy without fiscal rules.

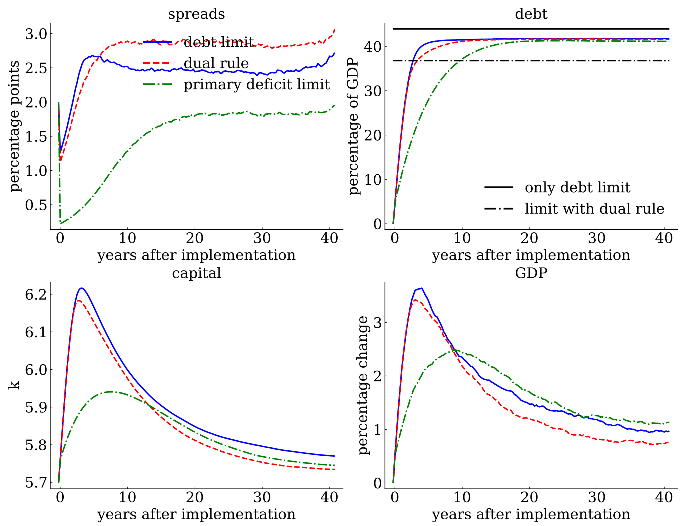
B Fiscal consolidation paths

Figure 7: Expansionary fiscal consolidation, long-run



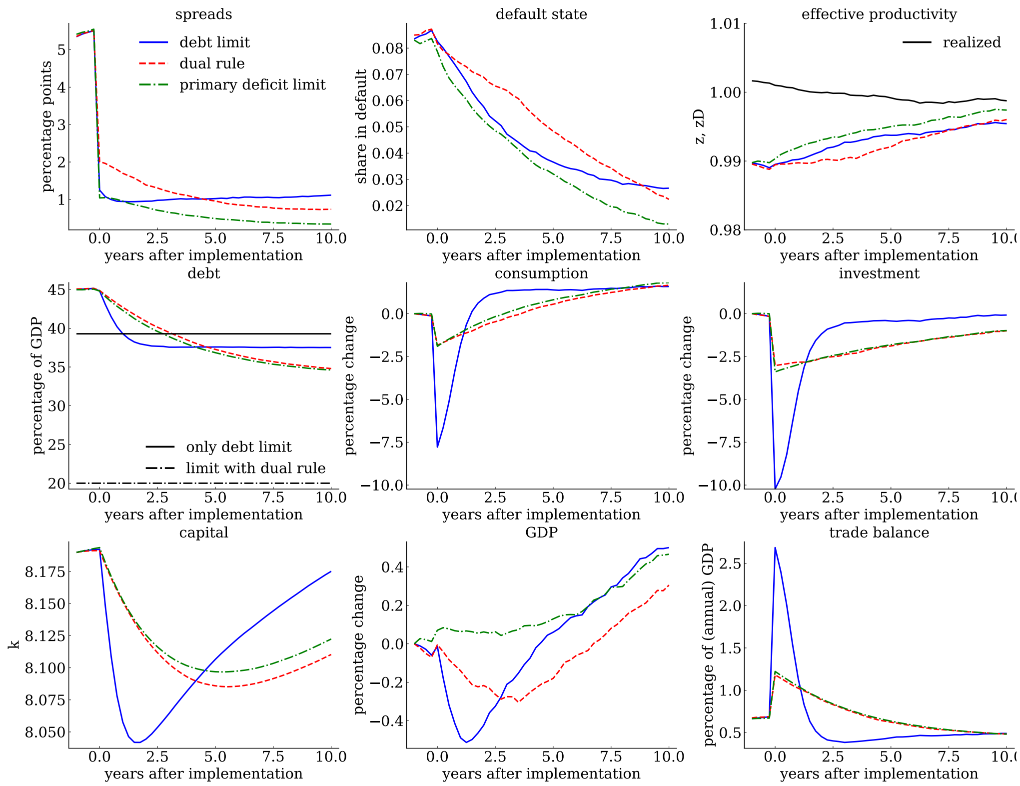
Each panel shows the average of 10,000 time series that start at one draw from the ergodic distribution in the benchmark economy without fiscal rules and implement the optimal fiscal rule in year $t = 0$. For each path, the initial state is the end-state of a simulation of 1,001 periods. For spreads we only consider paths with no default. For debt we set $B_t = B_{t-1}$ if $dt = 1$ and $B_t = 0$ when the economy is readmitted to financial markets.

Figure 8: Expansionary fiscal consolidation, zero initial debt



Each panel shows the average of 10,000 time series that start at one draw from the ergodic distribution in the benchmark economy without fiscal rules and implement the optimal fiscal rule in year $t = 0$. For each path, the initial state is the end-state of a simulation of 1,001 periods. For spreads we only consider paths with no default. For debt we set $B_t = B_{t-1}$ if $dt = 1$ and $B_t = 0$ when the economy is readmitted to financial markets.

Figure 9: Expansionary fiscal consolidation, patient households



Each panel shows the average of 10,000 time series that start at one draw from the ergodic distribution in the benchmark economy without fiscal rules and implement the optimal fiscal rule in year $t = 0$ with two different values for χ_d. For each path, the initial state is the end-state of a simulation of 1,001 periods. For spreads we only consider paths with no default. For debt we set $B_t = B_{t-1}$ if $dt = 1$ and $B_t = 0$ when the economy is readmitted to financial markets.

C Rules without commitment

In the main text we assumed that the government can commit to any fiscal rule. We interpret this assumption as reflecting the implementation of institutional guardrails that prevent a government from deviating from the rule with discretion. One example is the case of Chile, where a budget-balance rule allows for deviations that have to be contingent on the price of copper and the business cycle, which are overseen by independent agencies.[25] In this appendix we analyze whether the government has incentives to deviate from the rule and how costly would it be to prevent these deviations.

We first allow the government to deviate from the rule at the beginning of every period, assuming that the private sector (both lenders and domestic households) play a grim trigger strategy in which once the government deviates from the rule then it can never credibly implement one again. That is, after deviating the government is absorbed into the benchmark equilibrium in which lenders and households behave as if there was no fiscal rule. We assume that the government can still default and keep the rule after being readmitted to financial markets because the fiscal rule does not imply a promise not to default, so there is no reason to interpret a default as a deviation from the rule.[26]

Table 6 compares long-run statistics in the model without commitment to a debt limit with our benchmark case from before. The first two rows correspond, respectively, to the benchmark model with no rule and to the model with commitment to the optimal debt limit and no deficits in the transition $\chi_d = 0.0$. The third row corresponds to the model with the same rule without commitment.

[25] Another example is the case of the European Fiscal Compact, which requires its members to commit to a balanced-budget rule and allows temporary deviations in "exceptional circumstances", such as "an unusual event outside the control of the country concerned or a period of severe economic downturn as defined in the preventive arm of the reinforced Stability and Growth Pact" (ECB Monthly Bulletin, March 2012).

[26] A previous version of the paper analyzed the case in which a default would also trigger the inability to implement the rule in the future. Under this assumption the fiscal rule significantly increases the cost of default and generates much larger welfare gains. We choose to report the results for the case that allows defaults with the rule because it is more conservative. We thank a referee for pointing this out.

Table 6: Long-run statistics under rules with and without commitment

	$Pr(d=1)$	μ_{r-r^*}	σ_{r-r^*}	$\frac{B}{4*Y}$	$\frac{Av(c^{\text{rule}})}{Av(c^{\text{no rule}})}$	$\frac{\sigma_c}{\sigma_y}$	w.g.
no fiscal rule	0.027	0.07	0.04	0.46	1.000	1.70	-
with commitment	0.014	0.03	0.03	0.41	1.029	1.73	0.46
without commitment	0.012	0.03	0.03	0.41	1.029	1.73	0.46

The moments in the model are calculated using 10,000 samples of 1,000 periods each after dropping the first 1,000. The annualized yield on government bonds is $r_t = ((\gamma + (1-\gamma)(\kappa + q_t))/q_t)^4 - 1$ and the annualized risk-free interest rate is $r^* = 0.04$. Spreads are $r_t - r^*$. We only consider periods in good financial standing to compute statistics regarding spreads. To compute the volatility of GDP and consumption we take the natural logarithm and detrend the series using an HPfilter with a smoothing parameter of 1600.

The results are almost identical, which suggests that the gains from the fiscal rule are large enough that the government never finds it optimal to deviate from it. In the case with commitment, a more generous price schedule for government debt is an important component behind the gains from the rule. Commitment to future fiscal discipline that prevents debt dilution is priced in, which generates lower default risk and higher capital accumulation. Without a technology to commit to the rule the government will only abide by it if it has incentives to do so, which is also priced in. The prospect of no longer being able to credibly implement the rule provides enough incentives for the government to avoid states in which it would be tempted to deviate.

An important assumption in this exercise is that the government loses all of these large dynamic gains if it deviates from the rule once, which may be too harsh of a punishment. We now consider the opposite extreme in which the government can deviate from the rule every period and the private sector continues to believe that the rule will be implemented in the future.[27] Under this assumption, we simulate the model and calculate the percentage increase in consumption that would leave the government indifferent between complying with the rule and deviating once with no consequences.

The average consumption compensation that gives the government the minimum incentives to comply with the rule is 0.3 percent and is positive 94 percent of the time. It has a standard deviation of 0.2 percent, its correlation with GDP is 0.13, and with spreads is -0.09. This can be interpreted as the upper bound for the cost of upholding the rule, since considering some reputational cost would make it easier to implement, as the case with the grim trigger strategy suggests.

[27]This exercise is similar to the one performed by Hatchondo, Martinez, and Roch (2022a) who compute the cost of abandoning the rule in terms of output.

D Supportive Empirical Evidence

Table 7: Fiscal Rules and Private Investment (Country Fixed-Effects)

	Dependent variable: (I/y)			
	(1)	(2)	(3)	(4)
FiscalRule	$\mathbf{1.180}^{*}$	$\mathbf{1.159}^{*}$	$\mathbf{1.231}^{*}$	$\mathbf{1.188}^{*}$
	(0.704)	**(0.688)**	**(0.684)**	**(0.693)**
Sovereign Spreads		-0.00172^{**}	-0.00119^{**}	-0.00121^{**}
		(0.000688)	(0.000502)	(0.000521)
Public Debt			-0.0423^{**}	-0.0310
			(0.0184)	(0.0229)
Cyclical GDP				7.174^{**}
				(3.354)
Observations	782	782	782	782
Number of countries	63	63	63	63

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