ECONOMICS – WORKING PAPERS 2026/04

SOVEREIGN DEBT DYNAMICS AT THE BRINK OF DEFAULT AND THE SPECIAL ROLE OF SUPRANATIONAL LENDERS

European
Investment Bank

SOVEREIGN DEBT DYNAMICS AT THE BRINK OF DEFAULT AND THE SPECIAL ROLE OF SUPRANATIONAL LENDERS

European
Investment Bank

Sovereign debt dynamics at the brink of default and the special role of supranational lenders

EIB Working Paper 2026/04
February 2026

European Investment Bank
98 -100, boulevard Konrad Adenauer
L-2950 Luxembourg

This is a publication of the EIB Economics Department.
economics@eib.org
www.eib.org/economics

Authors
Sanne Zwart (European Investment Bank)

About the Economics Department

The mission of the EIB Economics Department is to provide economic analyses and studies to support the Bank in its operations and in the definition of its positioning, strategy and policy. The department and its team of economists is headed by Debora Revoltella, director of economics.

For further information on the EIB's activities, please consult our website, www.eib.org. You can also contact our Info Desk, info@eib.org.

Published by the European Investment Bank.

Printed on FSC® Paper.

pdf: QH-01-26-009-EN-N ISBN 978-92-861-6166-7 ISSN 2599-736X doi: 10.2867/8652135

Sovereign debt dynamics at the brink of default and the special role of supranational lenders

Sanne Zwart*

February 10, 2026

Abstract

Compared with the relatively straightforward definition of a default event, assessing sovereign debt sustainability remains a grey area. The interaction between fiscal choices, lenders' expectations and economic uncertainty creates a setting in which—particularly when a default looms—anticipation and coordination can matter as much as analysing economic fundamentals. To explore these rich debt dynamics, we develop a parsimonious model in which a government repeatedly makes fiscal and default decisions, while lenders demand bond yields that compensate for default risk. The model sheds light on when and why governments demonstrate fiscal prudence or even build fiscal buffers. It also illustrates how lenders' beliefs, by selecting the equilibrium outcome, can constrain a government's ability to issue debt—highlighting the influence of actors such as credit rating agencies that help form these beliefs. Notably, besides debt levels and lenders' expectations, the maturity profile of debt emerges endogenously as a key dimension of debt sustainability. Finally, we examine the role of supranational lenders in the international financial architecture. We find that well-designed financial support, whether to avoid crises or remedy the underprovision of commercial lending, constitutes a distinct class of debt, while markets still impose fiscal discipline on the sovereign.

Keywords: *Sovereign default, Self-fulfilling crises, Safe assets, Supranational lending*
JEL codes: *F33, F34, G12, H63*

---

[*] European Investment Bank (EIB), Luxembourg; e-mail address: s.zwart@eib.org.

The author would like to thank Giancarlo Corsetti for his insights and stimulating discussions. The paper benefitted greatly from comments and suggestions of colleagues at the EIB, in particular Koray Alper, and from participants of the 14th International Conference of the Financial Engineering and Banking Society.

1 Introduction

Debt sustainability assessments for sovereigns rest on numerous assumptions: beyond expectations about domestic economic performance and global conditions, both the government's future fiscal stance and the borrowing terms it will face in financial markets are unknown at the time of the assessment. Moreover, the decisions of all actors are interdependent. A thorough analysis must therefore extend well beyond the debt level itself, and consequently it is unsurprising that optimal fiscal choices display considerably complexity. Yet, theoretical models of sovereign default often (unintentionally) restrict such behaviour by narrowing governments' available options (*e.g.*, by imposing the discrete choice of borrowing an exogenously determined amount), simplifying the underlying drivers of default decisions (*e.g.*, by assuming a fixed and uniform utility loss in the event of default), or modelling decisions as one-off rather than recurring. In contrast, we present a stylized model that allows rich debt dynamics to emerge endogenously, in particularly when debt approaches the threshold beyond which it becomes unsustainable.

The model is built around economic uncertainty, which generates a motive for utility smoothing and for adjusting debt levels accordingly. Our approach follows the long tradition of models with multiple equilibria (Diamond and Dybvig, 1983). In this framework, financial market assessments influence the government's borrowing decisions, creating scope for lenders' beliefs to become self-fulfilling. For instance, if lenders demand a high interest rate, rolling over debt becomes more expensive for the government, increasing the likelihood of default—thereby validating the high yield demanded by lenders. Beliefs therefore determine which equilibrium prevails. Crucially, each equilibrium can be fully characterised by its implied sustainable debt limit. Unlike much of the literature, our focus is not primarily on sudden shifts between equilibria (sunspots), but instead we analyse the structural implications of the possible equilibria and their endogenous debt limits.

Our approach builds on the model of Corsetti and Maeng (2024) which explains why some sovereign crisis happen suddenly while others unfold over time. Their framework shows that while in general it is optimal to avoid the prospect of a crisis, under certain conditions a government may choose to accumulate so much debt that it effectively foreshadows a future default should a negative business cycle shock occur. We extend their model in three important ways. First, we embed it in a recurrent setting, so the government will not eventually enter a state of eternal good economic outcomes in which it can effortlessly service its debt. In other words, if the government raises debt above its sustainable maximum, it must continue dealing with the elevated debt burden even when economic conditions turn out to be favourable. Second, we model the impact of a default in a more elaborate and realistic way. By introducing a haircut and a maturity extension, post-default utility becomes dependent on on the current debt level, which reduces incentives for excessive borrowing. This allows us to better identify the conditions under which the government engages in risky borrowing and when it chooses fiscal prudence. Third, when analysing longer-term debt, we explicitly model instruments with different maturities rather than imposing an exogenous repayment profile (as in, *e.g.*, Hatchondo and Martinez (2009)). This enables us to examine how the maturity structure itself influences debt sustainability and fiscal decisions.

A first insight is that, as debt approaches the default threshold, governments tend to adopt more prudent fiscal policies, indicating that default is regarded as an undesirable, last-resort option to be avoided whenever possible (consistent with Roos (2019)). By letting debt accumulate at a slower pace, the government avoids breeching the threshold while preserving some room to absorb potential economic shocks in the near future. However, when lenders demand a high yield consistent with a possible future default, the government may indeed raises raise its debt to a point where, in the event of a recession, default becomes the preferred course of action in the next period. Interestingly, even when taking such a calculated risk, the government still aims to increase debt only to such a level from which, if economy conditions turns out favourable, it can bring debt back to below the default threshold. In this sense, its behaviour is genuinely “calculated”, not “reckless”. Adding further richness to the debt dynamics is the precautionary buffer that the government chooses to maintain so that, in the face of adverse shocks, it does not confront the prospect of default and the associated unfavourable pricing.

A second finding is that the role of the belief regime in determining the debt threshold is significant, and, by extension, that issuers of “safe assets” should value their special status. When lenders systematically factor in the possibility of default, required yields raise, sharply reducing the maximum level of debt that remains sustainable. As Wolf (2025) observes “changes in risk awareness are sure to be discontinuous: complacency one day, and panic the next.”, and in our setting such an abrupt shift can rapidly push up marginal yields and even trigger an immediate default. Crucially, being dependent on sceptical lenders may also have a structural impact by constraining the availability of market-based financing and lowering the sustainable debt threshold.

The paper thus helps explain the importance of market perceptions for debt sustainability—which has been observed or cited on several occasions, often for developing countries in a crisis context, but also for advanced countries or as part of a more structural assessment. For example, following a series of political events in the United Kingdom, the announcement of the “Mini Budget” in September 2022 triggered a sudden loss of confidence. That the perception of the country was at play is clear from the unusual step of the IMF to openly criticise the budget (Financial Times, 2022). As note elsewhere, the turmoil “was not only a function of the policy announcements, but also resulted from questioning the sense of a clear departure from the modern practices of accountability and transparency in policy-making, challenging/ignoring the advice of the very institutions that had ensured economic and financial stability" (Chadha, 2022). This episode underscores that enjoying the benefits of a high debt threshold—granted by the trust of lenders who confer safe-asset status—is far from guaranteed; a shift in perceptions remains a real and ever-present risk. Beliefs were also implicitly at the core when Ghana's then Minister of Finance asked, well before the country's eventual default, "Are the rating agencies beginning to tip our world into the first circle of Dante's Inferno?" (Financial Times, 2020). Another example comes from the Highly Indebted Poor Country (HIPC) Initiative launched in 1996 by the IMF and the World Bank which provided debt relief to ensure that no poor country faced an unmanageable debt burden (International Monetary Fund, 2023). Although the initiative reduced debt levels of eligible countries significantly, resulting in lower borrowing costs, and could therefore have permanently shifted market perceptions—particularly when combined with reforms and fiscal policies—subsequent developments suggest otherwise. After more than a decade of gradually rising debt, the first countries defaulted at debt levels similar or below their previous peaks, indicating that market sentiment had not shifted permanently. Taken together, these episodes highlight the central role of beliefs in shaping economic outcomes and, by extension, the responsibilities of the actors who influence them.

A third insight emerges from introducing longer-term debt, as the model then illustrates how the repayment profile fundamentally shapes debt sustainability. Debt maturing in the near future affects the probability of default, which in turn influences the current bond price. The model explains why, under adverse economic conditions and with a high volume of maturing debt, a government close to default may still find it optimal to borrow even more: the utility cost of fiscal consolidation is so high that mitigating the recession takes precedence over reducing default risk. Another key result is that the sustainable total debt level depends on the maturity profile. It is highest when repayments are (roughly) equally distributed across periods. Conversely, when maturities are unevenly spread, the government faces stronger incentives to default—either in the period with a large roll-over requirement or even earlier. In the latter case, a default may occur not because servicing costs are immediately unbearable, but because the government anticipates a future default and acts pre-emptively. In practice, uneven debt profiles are common, particularly for developing countries. They can reflect past financing needs, variation in (expected) interest rates or market access, or minimum bond issuance sizes for foreign currency denominated debt. For these countries, reprofiling debt maturities would both support utility smoothing and increase the sustainable debt limit.

The model also allows us to examine the rational for supranational lending and to identify the conditions under which it is effective. In particular, it provides a justification for three distinct types of supranational support: emergency lending, stand-by arrangements and longer-term lending for development or investment. The latter is an especially important contribution to the literature, as the provision of more structural financial support has received much less attention than lenders of last resort. We find that supranational support is successful and efficient when three conditions are met. First, the supranational must benefit from Preferred Creditor Status (PCS), ensuring that the government cannot default on its loans. Second, the supranational must be willing to roll-over outstanding debt each period—in particular if the country's debt is under stress—thereby maintaining non-negative net cash flows. Third, lending must occur at a preferential (below market) interest rate. Under these conditions, supranational debt does not count toward the sustainable debt threshold, effectively constituting a separate debt class. Importantly, firmly excluding supranational debt from future defaults is ultimately in the government' owns interest. At the same time, the closer supranational lending is priced to market rates, the more it crowds out commercial borrowing.

The remainder of this paper is organised as follows. Section 2 describes the general model in case of short-term debt. Section 3 discusses the equilibrium implications and interprets the results. Section 4 considers debt with longer maturities, while Section 5 analyses the role of supranational lender. Section 6 concludes.

2 Model with Short-Term Debt

2.1 Environment and Timeline

The model is based on Corsetti and Maeng (2024), which in turn builds on Calvo (1988), Cole and Kehoe (2000) and in particular Conesa and Kehoe (2017). A small open economy is populated by a continuum of identical households, a government and a continuum of risk-neutral competitive lenders. Time is discrete and indexed by $t = 0, 1, 2, ...$ To focus attention to the sovereign's behaviour, every period the representative household is assumed to consume all its income after paying tax.

The country's output is exogenous and random, given by $y_t = y(a_t) = A^{1-a_t}\bar{y}$, with $A < 1$. The parameter a_t indicates whether the economy is in a recession ($a_t = 0$) or not ($a_t = 1$). If the country is in recession, output falls from $\bar{y}$ to $A\bar{y}$. The probability of being in a recession next period is independent of the current state and is given by $p \in (0, 1)$.

The government issues non-contingent bonds with a maturity of one period and a yield of 1. Hence, under risk neutrality of lenders with discount factor β, the price of a default-risk-free bond is β. The stock of outstanding bonds to be repaid at period t is denoted by B_t. Each period, the government decides whether to repay ($z_t = 1$) or default ($z_t = 0$) on the current outstanding stock of bonds.

Crucial to equilibrium multiplicity is the assumption that lenders can coordinate on different regimes of beliefs, and these in turn may impinge on the bond price market participants are willing to offer the government. Following the literature, coordination is driven by an exogenous state ρ. The aggregate state of the economy at the beginning of the period is then summarized by $\sigma_t = (B_t, a_t, \rho_t)$.

Each period t starts out with the realization of the business cycle shock a_t and the beliefs regime ρ_t. The aggregate state σ_t is known to all agents at the beginning of the period. Lenders set the price q at which they are willing to buy sovereign bonds. This reflects the assumption that the government is not able to credibly commit to any announced debt level. Taking the bond price as given, the sovereign makes its decisions: first it chooses whether to default or to repay the outstanding bonds B_t, and second, in case of repaying, it decides the amount of bonds B_{t+1} it will issue to cover its financing needs. To simplify notation, time subscripts are dropped where possible, while the current and next period are referred to as period 0 and 1 respectively.

2.2 Government's Problem

The government takes its default and fiscal decisions based on its current level of debt, the state of the economy and the belief regime of the lenders. It also takes the bond price q offered by lenders as given.

First assume that the government has repaid its outstanding debt so that it has to choose the level of debt issuance. Denote the value for the government of being in state σ_0 by $\mathcal{V}(\sigma_0)$. The new debt level $B_1(\sigma_0)$ then yields the maximum value of repaying

$$\begin{aligned} \mathcal{V}^R(\sigma_0) = \max_{B_1} & \mathcal{U}(c,g) + \beta \mathbb{E}[\mathcal{V}(\sigma_1) \mid \sigma_0] \qquad (1) \\ \text{subject to} \quad & c = (1-\tau) y(a_0) \\ & g + B_0 = \tau y(a_0) + q B_1 \\ & g \geq \bar{g}, \end{aligned}$$

where c denotes consumption and g denotes endogenous government spending. Future debt will be subject to a limit, which is made precise in Subsection 2.4. The representative household spends all its income after paying tax at rate τ every period. We stipulate that government spending cannot fall below some critical expenditure level $\bar{g}$. Both the private consumption of the representative household and government spending yield contemporaneous utility, so that we model $\mathcal{U}(c,g)$ as a concave function in both arguments.[1]

---

[1] Public expenditure only affects future economic outcomes to the extent that the impact can be fully captured by the utility in the current period. Modelling public investment in a more realistic way would add complexity and reduce the paper's focus.

Default takes place if and only if the value of repaying is lower than that of defaulting. If the government defaults, it receives the value $\mathcal{V}^D$ that depends on the business cycle shock and the current level of outstanding debt. In particular, the debt restructuring after a default is assumed to result in a haircut of size θ and an NPV-neutral maturity extension. So, in the period of the default, no repayment is made and no new debt is raised. Hence, after the haircut, the amount of outstanding debt is $(1-\theta)B_0$, and with the NPV-neutral maturity extension the amount of debt to be repaid in the next period thus becomes $(1-\theta)B_0/\beta$.[2] The value of defaulting thus equals

$$\begin{aligned} \mathcal{V}^D(\sigma_0) = \mathcal{U}(c,g) - \zeta + \beta\mathbb{E}[\mathcal{V}(\sigma_1) \mid \sigma_0] \qquad &(2)\\ \text{subject to} \quad c = (1-\tau)y(a_0)&\\ g = \tau y(a_0),&\\ B_1 = (1-\theta)B_0/\beta,& \end{aligned}$$

where $\zeta > 0$ captures the economic[3] and the reputational costs of a default. Note that these costs can even include discounted costs from future periods, as long as they are unavoidable. We assume that $\tau y(a) > \bar{g}$ to ensure that when a default occurs during a recession, the government is able to meet the critical expenditure level. Denote the optimal decision on default by $z(\sigma_0) \in \{0,1\}$.

The value function $\mathcal{V}(\sigma_0)$, the default decision $z(\sigma_0)$ and the level of debt in the next period $B_1(\sigma_0)$ then solve the Bellman equation

$$\begin{aligned} \mathcal{V}(\sigma_0) = \max_{B_1,z} \mathcal{U}(c,g) - (1-z)\zeta + \beta\mathbb{E}[\mathcal{V}(\sigma_1) \mid \sigma_0] \qquad &(3)\\ \text{subject to} \quad c = (1-\tau)y(a_0)&\\ g + zB_0 = \tau y(a_0) + zqB_1&\\ g \geq \bar{g},&\\ z = 0 \Rightarrow B_1 = (1-\theta)B_0/\beta.& \end{aligned}$$

---

[2] We assume that the *ex-ante* set haircut θ brings debt back to a sustainable level, so that the government does not want to default again in the next period. This effectively limits the range of permissible debt levels to $\beta/(1-\theta)$ times the maximum sustainable debt level. For $\theta = 30\%$, the analysis thus covers debt up to some 40% above the debt threshold.

[3] For instance, consider the often-used function for economic output $\bar{y}A^{1-a}Z^{1-z}$ with $1-Z > 0$ indicating the share of output lost during a default. In this case, a default has a larger nominal economic impact in normal times than in a recession, and hence, the utility loss of defaulting could also be higher in normal times than in a recession. This would have the perverse effect that for some debt levels the government could prefer to default in normal times while it would repay in a recession. Alternatively, let $1-Z_0$ and $1-Z_1$ denote the GDP share lost during a recession and during normal times. The approach implicitly followed in this paper is to assume that the utility losses of a default in a recession and in normal times are identical, so $\zeta = \mathcal{U}(c,g|y=\bar{y}A) - \mathcal{U}(c,g|y=\bar{y}AZ_0) = \mathcal{U}(c,g|y=\bar{y}) - \mathcal{U}(c,g|y=\bar{y}Z_1)$.

2.3 Lenders' Problem

The model features risk-neutral lenders who are "deep-pocketed", an assumption that rules out corner solutions in each lender's problem. Optimal pricing thus must satisfy the break-even condition, so that the price equals the net-present value (NPV) of the expected return on sovereign debt. The price can thus be expressed as a combination of the risk-free price β and the expected loss

$$\begin{aligned} q(\sigma_0) &= \Big(\mathbb{P}[\text{no default} \mid \sigma_0] + \mathbb{P}[\text{default} \mid \sigma_0](1-\theta)\Big)\beta \\ &= \Big(1 - \mathbb{P}[\text{default} \mid \sigma_0]\theta\Big)\beta. \end{aligned} \tag{4}$$

Optimal pricing is dependent on the business cycle outcome a_0 and the outstanding debt B_0 as the funding requirements drive the amount the governments wants to borrow, which in turns affects the price. Lenders can also coordinate on their regime of beliefs ρ_0, which possibly impinges on the (self-validating) equilibrium price $q(\sigma_0)$ at which bonds are traded. By assumption, lenders refuse to provide financing if the government is certain to default.

2.4 Equilibrium

The notion of equilibrium considered here requires optimality of all agents' decisions within each period, so we consider equilibria with a Markov structure. An equilibrium is then described by a value function for the government $\mathcal{V}(\sigma_0)$, policy functions $B_1(\sigma_0)$ and $z(\sigma_0)$, and an equilibrium bond price $q(\sigma_0)$ such that i) given the bond price $q(\sigma_0)$, the policy functions $z(\sigma_0)$ and $B_1(\sigma_0)$ and the value function $\mathcal{V}(\sigma_0)$ solve the government's problem in (3); and ii) given $\mathcal{V}(\sigma_0)$ and the policy functions $B_1(\sigma_0)$ and $z(\sigma_0)$, the bond price $q(\sigma_0)$ satisfies the break-even condition (4) so that lenders make zero expected profits. Note that the exogenous beliefs determine the equilibrium as the bond price depends on ρ_0.

Throughout, we assume that the government can only choose debt levels in line with the default risk anticipated by the lenders, or equivalently, as in Corsetti and Maeng (2024), that lenders offer to buy bonds at price q "subject to a bound on aggregate issuance". This reflects that the market applies additional scrutiny on the government's borrowing behaviour when the country is close to defaulting.[4] This assumption avoids that, for instance, close to the debt threshold the government will take advantage of the high bond price to borrow an unsustainable amount of debt, thereby invalidating the risk-neutral requirement of lenders. More broadly, it rules out Ponzi-style equilibria where debt increases without bound.

---

[4] This could be modelled explicitly by either having lenders provide the range of debt they are willing to buy or by adding a penalty term to the utility function when excessive debt levels are chosen, reflecting reputational considerations or a bond market strike in subsequent period(s).

2.5 Beliefs

The root of equilibrium multiplicity in Calvo-type crises lies in the fact that the government, facing the bond price q, optimally adjusts its issuance policy and default decision, which creates the possibility that multiple triples of (B_1, z, q) satisfy (3) and (4). The (exogenous sunspot) state variable ρ coordinates market expectations and selects among alternative equilibria.

As in Calvo (1988), in our analysis we let lenders to hold "optimistic" ($\rho = opt$) and "pessimistic" ($\rho = pes$) beliefs, defined as follows:

- In a regime of optimism, lenders are willing to finance the government at the best possible equilibrium price, implying that they coordinate on the bond price which maximizes the government's (societal) welfare in that period. This price typically is the riskless price, but may be lower.
- In a regime of pessimistic beliefs, lenders approach the bond market entertaining systematically the possibility that debt is at risk of default. Hence, in an equilibrium with debt roll-over, they naturally coordinate their expectations on the default-risky price, provided debt is high enough for this price to be self-validating in equilibrium.

Beliefs are considered to be exogenous and hence not to be affected by the evolution of model variables or events. In particular, optimistic lenders who required a low bond price remain optimistic after a default. Indeed, the pricing had already accounted for this event (and moreover, the debt restructuring has succeeded in bringing debt back to a sustainable level). Similarly, lenders setting out with pessimistic beliefs will remain pessimistic after a default, as they see their views confirmed. All agents in the economy consider the current regime of lenders' beliefs as "constant", and a switch of belief regime, if it occurs, is completely unanticipated.

3 Lenders' Beliefs and Equilibrium Selection for Short-Term Debt

In this section, we illustrate analytically and graphically the logic of belief-driven crises in the model. First, we derive debt thresholds conditional on output and either optimistic or pessimistic beliefs. Next, we analyse the model for a specific calibration of the parameters, and we conclude by discussing the sensitivity of the results to this baseline specification.

3.1 Debt Thresholds

The structure of the model is such that the equilibrium can be characterized by critical levels of debt for which the equilibrium bond prices change discretely. These thresholds are contingent on both the state of the economy a and the regime of beliefs ρ, and will be denoted by B^a_ρ.

3.1.1 Thresholds with Optimistic Beliefs

By assumption, given optimistic beliefs, lenders hold the view that a government with a sustainable level of debt will honour its liabilities. Hence, lenders will be lending at the risk-free rate β with debt roll-over up to the maximum sustainable debt level in a recession, B^0_{opt}.

Let $\mathcal{V}^R_\rho(B_0, a)$ denote the government utility of repaying debt B_0 in the economic state a with beliefs regime ρ so that

$$\begin{aligned}\mathcal{V}^R_{opt}(B_0, a) = \max_{0 \le B_1 \le B^0_{opt}} \Big(& \mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + \beta B_1\Big) \\ & + \beta\Big(p\mathcal{V}(B_1, 0, opt) + (1-p)\mathcal{V}(B_1, 1, opt)\Big)\Big)\end{aligned}$$

and likewise, the utility of maintaining debt level B_0 is

$$\begin{aligned}\hat{\mathcal{V}}^R_{opt}(B_0, a) = & \mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - (1-\beta)B_0\Big) \\ & + \beta\Big(p\mathcal{V}(B_0, 0, opt) + (1-p)\mathcal{V}(B_0, 1, opt)\Big).\end{aligned}$$

On the other hand, the utility of defaulting $\mathcal{V}^D_\rho(B_0, a)$ is given by

$$\begin{aligned}\mathcal{V}^D_{opt}(B_0, a) = & \mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y}\Big) - \zeta \\ & + \beta\Big(p\mathcal{V}((1-\theta)B_0/\beta, 0, opt) + (1-p)\mathcal{V}((1-\theta)B_0/\beta, 1, opt)\Big). \qquad (5)\end{aligned}$$

The maximum sustainable debt level B^a_{opt} for economic state a is then derived by solving

$$\hat{\mathcal{V}}^R_{opt}(B^a_{opt}, a) = \mathcal{V}^D_{opt}(B^a_{opt}, a). \qquad (6)$$

Intuitively, in normal times, the government will always repay if it would also repay during a recession, so $B^0_{opt} < B^1_{opt}$. When the government chooses a debt level below B^0_{opt}, it will thus prefer to repay its debt regardless of the economy's state in the next period. For debt above B^0_{opt}, a default could occur, and such a level would thus not be consistent with the pricing.

3.1.2 Thresholds with Pessimistic Beliefs

Lenders who hold pessimistic beliefs are concerned with the possibility of future defaults, and hence price the bond accordingly at $(1 - p\theta)\beta$ for high debt issuance levels. To obtain the utility of repaying consistent with these beliefs, we now need to explicitly allow for the fact that the government may take a calculated risk and that, at the risky (low) bond price, B_1 may grow above the debt tolerance threshold in a recession, B^0_{pes}.

When faced by the low price, the utility of repaying and taking a calculated risk is indicated by "C" and given by

$$\mathcal{V}^C_{pes}(B_0, a) = \max_{B^0_{pes} < B_1 \leq B^1_{pes}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + (1-p\theta)\beta B_1 \Big) \\ + \beta \Big(p\mathcal{V}^D_{pes}(B_1, 0) + (1-p)\mathcal{V}(B_1, 1, pes) \Big) \Big).$$

Since issuing debt above B^1_{pes} leads to default with certainty in the next period, bond issuance is bounded by this debt level, while intuition suggests that $B^0_{pes} < B^1_{pes}$. Likewise, the utility of repaying and issuing a default-free level of debt is denoted by "R" and equals

$$\mathcal{V}^R_{pes}(B_0, a) = \max_{0 \leq B_1 \leq B^0_{pes}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + (1-p\theta)\beta B_1 \Big) \\ + \beta \Big(p\mathcal{V}(B_1, 0, pes) + (1-p)\mathcal{V}(B_1, 1, pes) \Big) \Big).$$

Imposing consistency with the low bond price under pessimistic beliefs implies that B^a_{pes}, the maximum debt under pessimistic beliefs in economic state a, solves

$$\max\Big\{ \mathcal{V}^C_{pes}(B^a_{pes}, a), \mathcal{V}^R_{pes}(B^a_{pes}, a) \Big\} = \mathcal{V}^D_{pes}(B^a_{pes}, a), \tag{7}$$

where $\mathcal{V}^D_{pes}$ is defined akin to (5).

The risky price occurs in equilibrium if the government repays its debt now and borrows to the extent that repayment depends on the economic situation, so if $B_1(\sigma_0) \in (B^0_{pes}, B^1_{pes}]$. In these cases, the government takes a calculated risk: if the recession is over in the next period, it will repay, if the recession endures, it will default. The range of current debt levels for which this occurs depends on the current state of the economy a. It is useful to denote the lowest debt value for which the government takes a calculated risk by C^a_{pes}. For current debt values $B_0 \in (C^a_{pes}, B^a_{pes}]$, the government will face a low price and takes a calculated risk. For lower values of current debt, lenders cannot insist on the low price as the government will always repay in the next period as $B_1(\sigma_0) \leq B^0_{pes}$. Hence, they will ask the risk-free price, and the related parts of the value function follow from a government problem as in (1).

As is common in this type of models, there is no closed-form solution of the maximisation problem, which complicates the analysis of the value functions. However, it is still informative to look at the properties of the general model before considering a specific calibration in the next subsection. The proposition below links the value function with the uniqueness of the thresholds.

Proposition 1. *Suppose the value functions are well-defined. They are then strictly decreasing, and in case the second derivatives are non-positive, the thresholds are uniquely defined.*

The proposition confirms that higher debt levels reduce the NPV-value for the government. It also states that if the thresholds exist, they are unique in case the value functions are decreasing with a constant or increasing rate. This is usually the case, as the value function typically inherits the concavity of the utility function, but given the feedback loop of the debt thresholds, this cannot be proven. The same feedback loop prevents deriving equilibrium properties. For example, it would be intuitively appealing to state that $B^0_{pes} < B^0_{opt}$ as with pessimistic beliefs the threshold is based on a low price and defaults can occur. However, the government now has the additional possibility of taking calculated risks which, everything else equal, works in the opposite direction by raising the value functions. Unfortunately, quantifying these effects and establishing the overall impact cannot be done,[5] and hence we resort to a specific calibration followed by a sensitivity analysis. However, intuitively it is clear why, given all parameters and the belief regime, an equilibrium is likely to be unique: the value functions are almost independent of the debt threshold at low debt values, and as the value of a default follows from the value functions for low values, they are also rather stable for high debt levels. The value functions are thus rather fixed at both the lower and the higher end, which greatly reduces the scope for multiplicity for given parameters.

3.2 Analysis

3.2.1 Calibration

We adopt the following functional form for the utility function

$$\mathcal{U}(c, g) = \log(c) + \gamma \log(g - \bar{g}).$$

In our calibration, we set benchmark parameters following Conesa and Kehoe (2017). The parameter values are shown in Table 1, and the sensitivity of the results is discussed in Subsection 3.2.4.

We normalize output $\bar{y}$ to 100 so that the units in the model, in particular for the debt level, can be interpreted as percentage of GDP in normal times. The relative weight of government utility is 0.2. Government revenue as a fraction of output is determined by the constant tax rate τ. In normal times, the government income is 36, while we set the critical government expenditure $\bar{g}$ at 25% of GDP in normal times: the higher this value, the smaller the room for discretionary spending.

A is set to 0.9 so that a recession results in a decrease in output by 10%. This relatively high value reflects that defaults typically occur when countries have en-

---

[5] This can be seen as the cost of making the model more realistic.

$\bar{y}$	Output	100
γ	Relative weight of government expenditure-related utility	0.2
τ	Government revenue as share of output	0.36
$\bar{g}$	Level of critical government expenditure	25
A	Fraction of output during recession	0.9
p	Probability of a recession	0.2
ζ	Cost of default	0.5
θ	Haircut	0.3
β	Discount factor	0.98

Table 1: Parameter values.

dured significant economic headwinds for a protracted time. During a recession, government revenues drop to 32.4, which lowers the fiscal space for servicing debt. We set $p = 0.2$ so that a recession happens on average every 5 years.

We set the cost of default for the government, ζ, at 0.5, which is calibrated to the total utility loss when after a default economic output contracts (further) by a fraction $1 - A$ (so the same reduction as in a recession) for two periods. In line with the severity of the recession, the implied impact of 20% is on the high side compared to observed output losses (Trebesch and Zabel, 2023). The haircut for lenders is set at 30%, which is lower than the Loss Given Default rates typically observed after a default to account for the wider scope of the restructuring (Graf von Luckner et al., 2023).

Finally, the discount factor is set at 0.98. This implies that with the high bond price, the interest rate on default-free bonds is $1/\beta - 1 = 2.0\%$. When a default will occur in the next period in case of a recession, the low bond price charged by lenders implies an interest rate of $1/((1 - p\theta)\beta) - 1 = 8.6\%$.

3.2.2 Optimistic beliefs

The government's sole motive to change its debt level over time is inter-temporal smoothing. This can be seen by eliminating uncertainty and setting economic output to the average $pA\bar{y} + (1 - p)\bar{y}$. With a constant marginal utility, the impact on utility of NPV-neutral borrowing is also NPV neutral (discarding Ponzi-style borrowing). However, with a concave utility function, changes in the debt level are always reducing utility, and it follows that without economic uncertainty, there are no incentives for the government to change its debt level.

When introducing economic uncertainty, it is insightful to first study the model with $\beta = 1$ so that the government can borrow or deposit any amount without costs, where we for practical reasons impose that its balance should be zero on average (perfect insurance). In this case, the additional amount the government

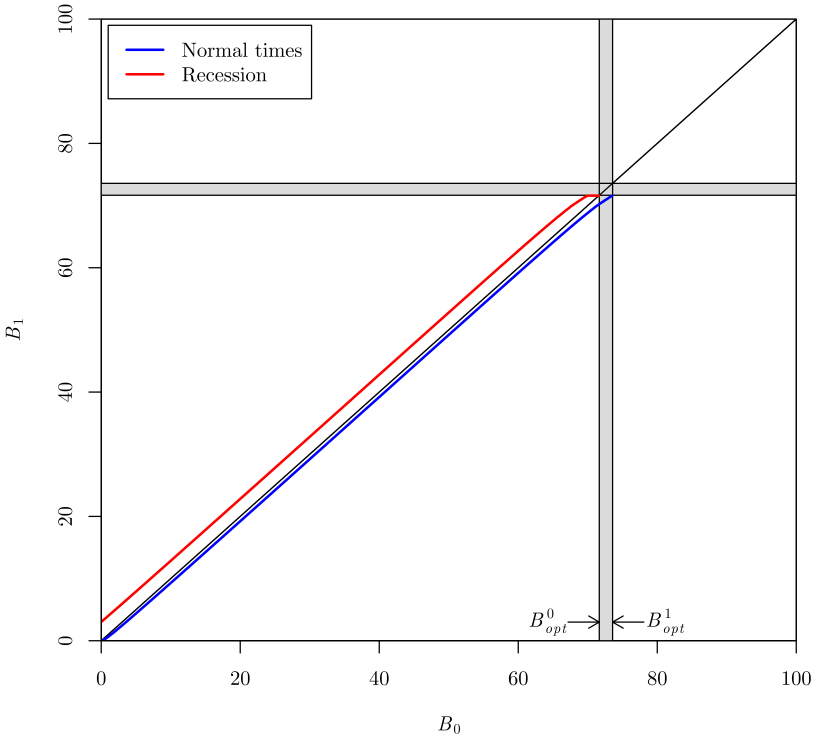

Figure 1: Policy functions with optimistic beliefs.

borrows in a recession can be derived mathematically. First note that with cost-free borrowing and depositing, the government will borrow and repay such that it will always have the same budget g, which follows from the concave utility function. During a recession, tax revenues are $\tau(1-A)\bar{y}$ lower than in normal times. As a recession happens with probability p, a share $(1-p)$ of this difference is borrowed in a recession, and a share p is repaid in case of normal times, so that on average there is no borrowing or lending. For the parameter values here, borrowing during a recession thus equals $(1-p)\tau(1-A)\bar{y} = 2.88$, while repayments during normal times equal 0.72. In the discussion below, "fiscal prudence" indicates that the government chooses to borrow less than under perfect insurance or repay more during normal times.

Figure 1 shows the policy functions for the model with uncertainty and lenders holding optimistic beliefs. Up to $B^0_{opt} = 71.6$, repaying debt is optimal even in a recession, confirming lenders' beliefs. For debt levels somewhat above B^0_{opt}, the government will default during a recession while in normal times it will repay its debt. When debt is above $B^1_{opt} = 73.5$, the government will also default in normal times.

In line with standard economic theory and the simplified case discussed above, inter-temporal utility smoothing causes the government to increase borrowing during recessions and decrease debt during normal times. The debt level grows on average by some 2.7 in a recession and declines by some 0.8 in normal times, which is very similar to the values derived above. For debt levels close to B^0_{opt}, the government slows down the pace of debt accumulation so as to not cross the threshold and to maintain some space for additional borrowing in case of persistent economic shocks in the coming periods.[6] Conversely, in normal times, the government will find it optimal to repay debt above B^0_{opt} if it is still below B^1_{opt}, so in the grey area. In this case, it prefers to implement fiscal consolidation and bring back debt below B^0_{opt} so that even in case a recession occurs in the next period, a default will be avoided. The policy functions do not result in debt levels above B^0_{opt}, and hence when starting with a debt level below this threshold, a default is ruled out in equilibrium. This confirms that bonds are only sold for the high, risk-free price, and that the low price does not occur in this equilibrium.

The debt thresholds are the levels where repaying and defaulting yield identical values (Figure 2). The value functions themselves depend on the thresholds, so graphically, the threshold is found if for a candidate value, the implied value functions for repaying and defaulting cross exactly at this candidate value. In line with Proposition 1, the value functions are downward sloping, and their concavity becomes pronounced for debt levels above the thresholds. For these debt levels, the large fiscal consolidation required to bring debt back to sustainable levels comes at an increasingly high utility loss.

3.2.3 Pessimistic beliefs

With pessimistic beliefs, lenders require the low price unless this price cannot be sustained in equilibrium. The low price fundamentally changes the derivation of the value function and debt thresholds. For example, consider the case of a recession (Figure 3). The debt threshold B^0_{pes} is now determined by the intersection of the value functions for defaulting and calculated risk-taking. A second, lower threshold arises when with a low price, the government does no longer choose a debt level which implies a calculated risk but instead prefers to fully exclude the possibility of a default in the next period. For debt below this threshold C^0_{pes}, even pessimistic lenders will only require the high bond price, and as a result, the value function is discontinuous at this threshold. The value function in normal times is derived in a similar way, and in equilibrium the two value functions need to be consistent with the four thresholds (Figure 4).

---

[6] The level of debt is public knowledge and averting a default by contracting secret debt is not possible, which is also in line with Horn et al. (2024) who find that hidden debt accumulates in boom years instead of bad times. However, there is a range of unconventional, opaque debt instruments such as private placements, central bank swaps, collateralized loans and overcollateralized repos that may fall outside the scope of standard disclosure frameworks and which, since 2021, are more frequently used by low-income countries (World Bank, 2025).

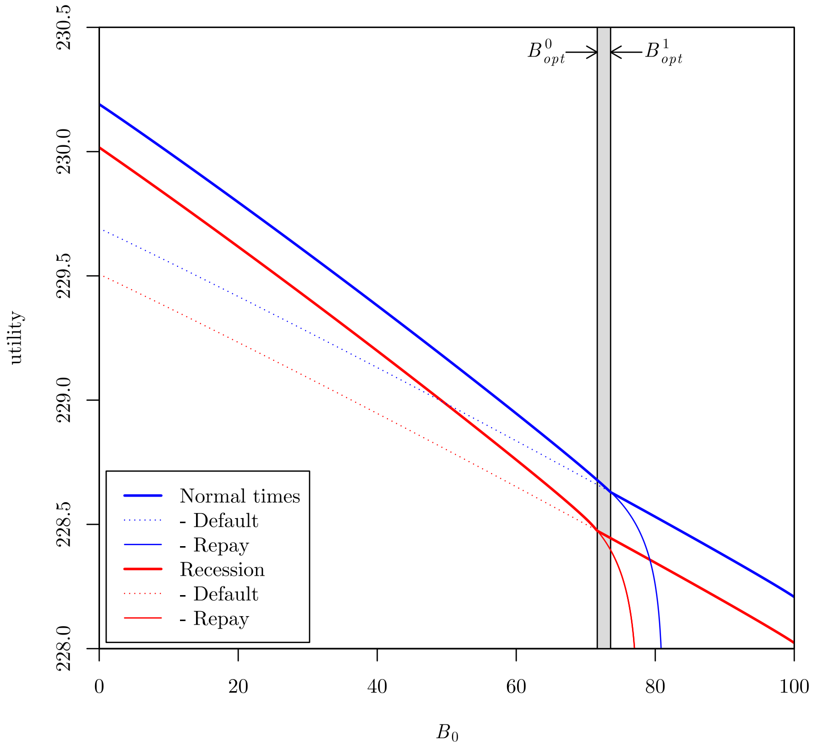

Figure 2: Value functions with optimistic beliefs.

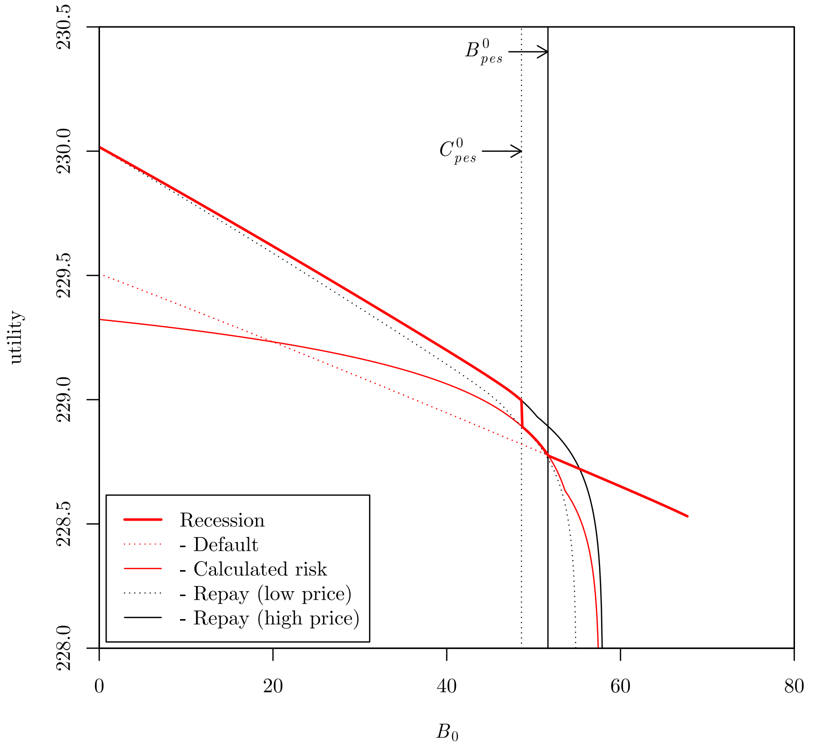

Figure 3: Derivation of the value function and thresholds in a recession with pessimistic beliefs.

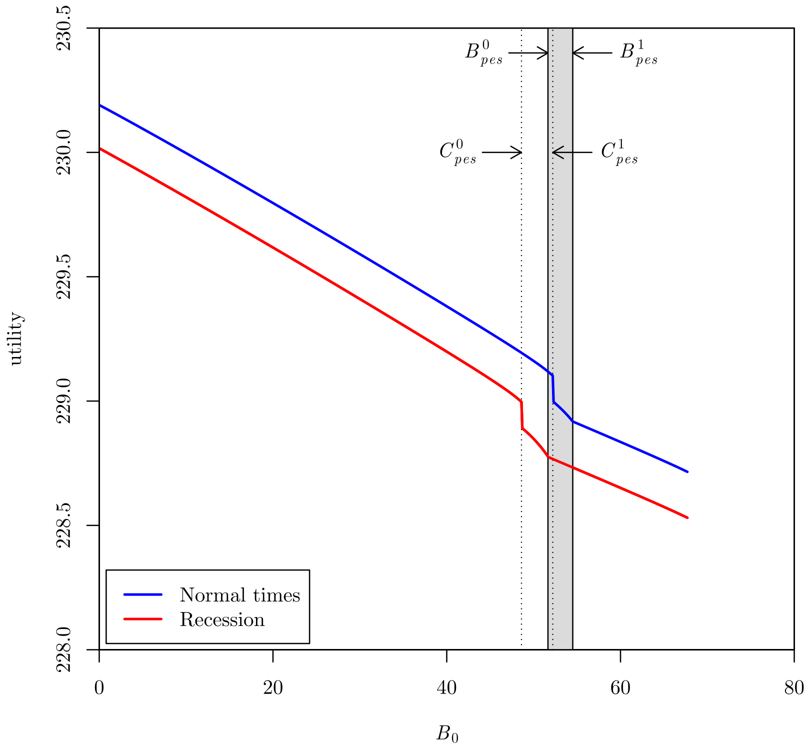

Figure 4: Value functions with pessimistic beliefs.

Figure 5 shows the policy functions for pessimistic beliefs. The government will repay if debt is below the threshold $B^0_{pes} = 51.6$. Importantly, this level is well below the maximum debt level that can be sustained with optimistic beliefs ($B^0_{pes} < B^0_{opt} = 71.6$), indicating that, in line with Corsetti and Maeng (2024) the welfare-damaging beliefs constrain the country's borrowing capacity. The difference can also be seen clearly when considering the cost of rolling over debt (interest expenditure) as share of government revenues at the debt threshold. Under optimistic beliefs, this share in a recession equals $(1-\beta)B^0_{opt}/(\tau A\bar{y}) = 4.4\%$. With pessimistic beliefs, rolling over the lower debt level would amount to $(1-(1-p\theta)\beta)B^0_{pes}/(\tau A\bar{y}) = 12.5\%$ of revenues. The lower bond price offered by lenders thus lowers the sustainable debt level, and in addition increases borrowing costs for the government. As a result, the government will voluntarily try to ensure that its debt will be even lower than the threshold so as to maintain a buffer: if its debt is below $C^0_{pes} = 48.6$ it will keep it there to benefit from the high bond price. If debt were to cross this level, the government would face a low bond price, and in turn taking a calculated risk would be preferred. Hence, C^0_{pes} could be thought of as the maximum sustainable debt level.

In normal times, the government will, as before, reduce its debt level and for higher values will even try to bring it back to C^0_{pes} to benefit from the higher bond price. However, in case debt exceeds $C^1_{pes} = 52.2$ this entails a too large utility

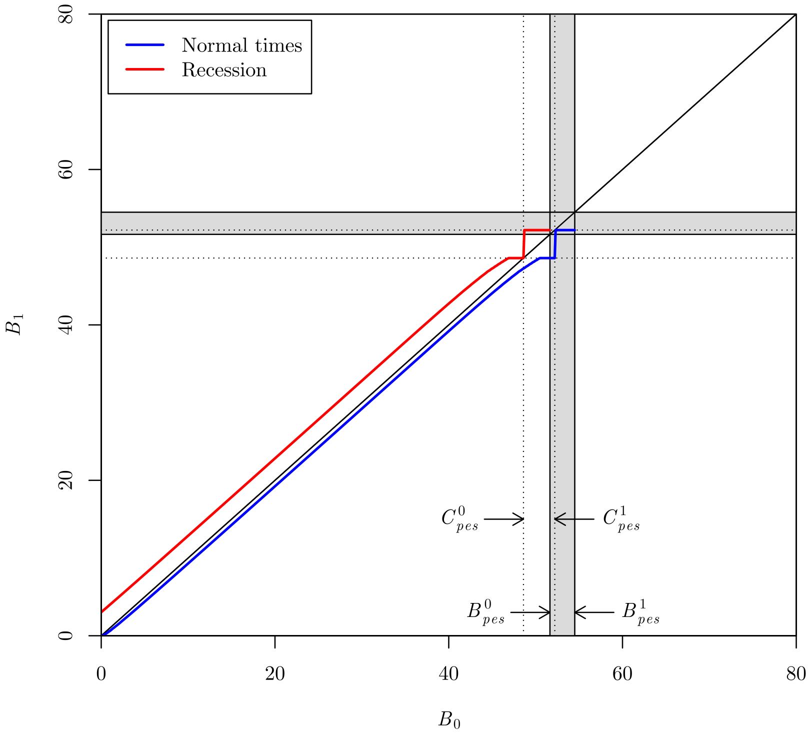

Figure 5: Policy functions with pessimistic beliefs.

loss, and the government will first bring back debt to C^1_{pes} and in case the normal times persist, it will then bring debt down to C^0_{pes} in the subsequent period. This explains why when taking a calculated risk in a recession, the government chooses C^1_{pes} as it will subsequently be able to quickly bring debt back to a sustainable level. Remarkably, these rich debt dynamics emerge endogenously.

The lower debt thresholds in case of pessimistic beliefs already affect borrowing decisions at moderate debt levels. A visual comparison of the policy functions with optimistic and pessimistic beliefs (Figures 1 and 5) suggests that the related borrowing decisions are broadly comparable. However, already from a debt level of around 41, debt will decline (in expectation) by 0.1 more each period under pessimistic beliefs, and this increases to 0.5 for a debt stock of 45. Similarly, the government will also prefer to repay somewhat more during normal times. Pessimistic lenders' beliefs thus necessitate fiscal prudence well before a possible default has come in sight.

3.2.4 Sensitivity Analysis

We now vary each of the parameters individually to understand the sensitivity of the results in the baseline scenario (Table 2). Importantly, in all calibrations, the government finds it optimal to take calculated risks in case of pessimistic beliefs.

To assess the sensitivity of results to parameter values, symmetric deviations

Scenario	C^0_{pes}	B^0_{pes}	C^1_{pes}	B^1_{pes}	B^0_{opt}	B^1_{opt}	$B^0_{opt} - B^0_{pes}$	$B^0_{opt} - C^0_{pes}$
Baseline	48.6	51.6	52.2	54.5	71.6	73.5	20.0	23.0
$A = 0.85$	42.5	46.3	47.9	50.2	65.8	68.8	19.5	23.3
$A = 0.95$	58.1	59.1	60.0	60.4	76.5	77.4	17.4	18.4
$p = 0.15$	54.6	57.5	58.2	60.2	72.9	74.8	15.4	18.3
$p = 0.25$	43.0	46.0	46.5	49.0	70.3	72.3	24.3	27.3
$\theta = 0.25$	57.4	60.4	61.0	63.4	83.2	85.6	22.8	25.8
$\theta = 0.35$	42.0	45.0	45.6	47.7	62.8	64.4	17.8	20.8
$\zeta = 0.4$	40.2	43.0	43.9	45.6	58.5	60.2	15.5	18.3
$\zeta = 0.6$	56.0	59.2	59.7	62.3	84.1	86.2	24.9	28.1
$\gamma = 0.15$	60.5	63.7	64.1	66.9	91.9	94.2	28.2	31.4
$\gamma = 0.25$	40.2	43.0	43.8	45.5	58.5	60.2	15.5	18.3
$\tau = 0.31$	22.8	24.9	26.0	27.1	35.3	37.0	10.4	12.5
$\tau = 0.41$	74.3	78.1	78.4	81.4	107.4	109.5	29.3	33.1
$\beta = 0.97$	46.1	49.1	49.7	52.0	66.8	69.2	17.7	20.7
$\beta = 0.99$	51.3	54.3	54.9	57.1	77.0	78.3	22.7	25.7

Table 2: Sensitivity analysis.

around the baseline value are considered. A first observation is that changes in parameters have a uniform effect on all thresholds as they all change in the same direction. Debt thresholds are inversely related to the severity of a recession A. For a deeper recession, a default becomes relatively more attractive given that it hits hardest for elevated debt levels. A higher probability p of a recession has a similar effect.

The haircut θ is an important parameter for default and pricing considerations. In line with intuition, a higher haircut reduces the thresholds as the lower debt level after a default makes defaulting more attractive for the government. Figure 6 shows that when θ increases, the thresholds fall rapidly. Starting from the baseline haircut of 30%, an increase by 1 percentage point reduces the debt threshold by 2 percentage points in case of optimistic lenders and by 1.5 percentage points in case of pessimistic ones. This highlights that if a government can *ex ante* credibly commit to a relatively limited haircut in case of a default, the benefits in terms of additional borrowing space are substantial. Conversely, an economic or financial shock which pushes up the haircut, could easily lower the thresholds to such an extent that it causes an immediate default.

Not surprisingly, a higher cost (utility loss) of default ζ makes repaying relatively more attractive and pushes the thresholds up. A higher importance of government consumption in the utility function γ has the same effect as a decrease in ζ which follows directly from the default decision. The large impact of a relatively small change

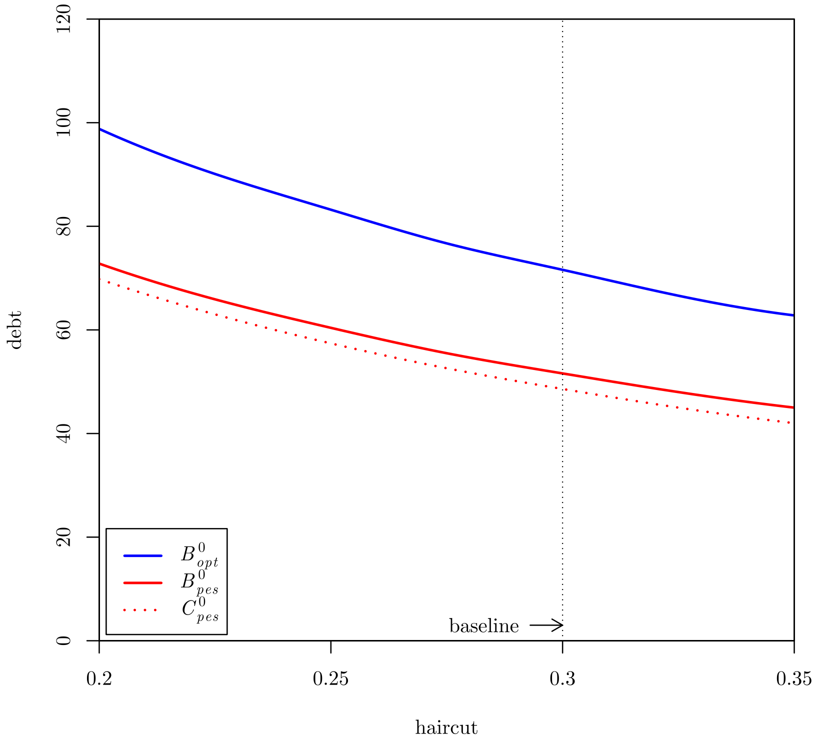

Figure 6: Debt thresholds as function of the haircut θ.

in the tax rate τ is remarkable. Clearly, by directly affecting the available fiscal space and the marginal utility of government spending, the share of government revenues is an important driver of the debt thresholds. Finally, a lower discount factor β has several effects. It makes current utility more important and thus invites higher borrowing, but it also makes debt more expensive which increases the incentives to default. The second effect dominates as the thresholds decline.

Changes in the parameters influence the distance between the thresholds B^0_{pes} and B^0_{opt}, which, together with the difference between C^0_{pes} and B^0_{opt}, measures the distorting impact of pessimistic beliefs. Typically, an increase in thresholds goes hand in hand with a widening of the gap as B^0_{opt} is affected more (consider, *e.g.*, a lower haircut, a higher default cost or a higher tax rate). However, when a recession becomes more likely, the gap widens although thresholds fall, reflecting that B^0_{pes} falls more as the value of taking a calculated risk is also directly affected by p. Importantly, the analysis confirms that for a range of parameters, lenders' beliefs can significantly reduce the available financing for a country $(B^0_{opt} - B^0_{pes})$ and the maximum level of sustainable debt $(B^0_{opt} - C^0_{pes})$.

We refer to Corsetti and Maeng (2024) for an excellent discussion of various alternative equilibrium concepts. Instead, we focus here on the importance of timing and the underlying assumption that the government cannot credibly commit to its borrowing volume. As a result, the bond price can only be a function of the current debt level B_0 and other state variables. Now suppose the government were able to credibly declare its debt level at the beginning of the period, and lenders would then set the risk-neutral break-even price. In this case, the price would be a function of the new debt level B_1 and the government would effectively choose the bond price (instead of having to accept the price set by lenders at the onset of the period). If lenders are optimistic, the outcome would be the same as before. In case of pessimistic beliefs, lenders would again concentrate on equilibria with a default. However, if the government would choose a debt level with a potential default in the next period, this would come with a large drop in the bond price and would therefore never be optimal, so the thresholds B and C coincide. For all new debt levels below the debt threshold in the recessionary state, lenders would require the high price, but the low bond price is instrumental in determining the maximum debt level, causing a discontinuity in the value function at the debt threshold. Overall, the debt thresholds would be considerably higher, namely 56.6 (instead of 51.6) in a recession and 59.0 (instead of 54.5) in normal times, reflecting that lenders are better able to align pricing with debt levels. It is thus the inability of the government to commit to an announced debt level that causes calculated risk-taking, which in turn reduces the maximum amount that can be borrowed. In the baseline scenario, the government's inability to commit explains about a quarter of the reduction in debt thresholds when lenders are pessimistic instead of optimistic.

4 Longer Debt Maturities and Richer Debt Dynamics

We now extend the model by considering longer term debt so that we can analyse how the maturing of future debt and the related possible defaults affect the decisions of lenders and the government now. As we are specifically interested in the role of the maturity profile, we explicitly model the debt maturing in a period instead of preimposing it through, for example, geometrically decreasing coupons as in Hatchondo and Martinez (2009). To keep the model tractable, we consider the simplest setting that allows for this analysis, namely having bonds with a maturity of two periods.[7] This is sufficient to create two different groups of debt, namely debt maturing this period and debt maturing in the future (i.e. next period), which are denoted by B_0 and B_1 respectively. The aggregate state variable of the economy at $t = 0$ is then given by $\sigma_0 = (B_0, B_1, a_0, \rho_0)$, and the government has to decide whether to repay or to default and in case of repayment the level of debt maturing in $t = 2$, B_2. We provide a quantitative analysis for optimistic beliefs, and a sketch for pessimistic beliefs.

---

[7] The increasing dimensionality of the state variable and the possibility of sequential defaults (Graf von Luckner et al., 2023) greatly complicate the explicit modelling of debt beyond two periods.

4.1 Model with Longer-Term Debt

Given the price requested by lenders, the fiscal decision B_2 and the default decision z are now functions of debt in both the current and in the next period. With the change in σ_0, the only change in the fiscal problem in (1) is that the inflow from bond issuance depends on B_2 instead of B_1. Similarly, a default is again resulting in a haircut with size θ and an NPV-neutral maturity extension of one period. Hence, when a government defaults, its state in the next period is $\sigma_1 = ((1-\theta)B_0/\beta, (1-\theta)B_1/\beta, a_1, \rho_1)$, and with this change, the default problem is identical to that in (2).

Importantly, the government problems in even and odd periods is identical. Moreover, if a default could be fully ruled out exogenously, the series of even and odd fiscal problems would be fully separate. However, when a default can occur, the two series are linked. They are also related if borrowing has to be chosen such that a default is ruled out, as the maximum debt threshold in a period depends on the debt maturing in the next period.

Finally, the pricing of lenders depends on the default probability until repayment, so in periods 1 and 2. The probability of a default in the first period depends on the debt that has to be repaid, B_1, but also on the amount of new debt, B_2, which in turn depends on B_0 and B_1. Similarly, the probability of a default in the second period depends on the debt level B_2 chosen and the new debt level B_3 that will be chosen in period 1, with both ultimately depending on the debt outstanding at time 0.

4.2 Analysis

The maximum debt level that the government chooses to repay now depends on the state of the economy, lenders' beliefs and the maturing debt in the next period, and is denoted by $B_\rho^a(B_1)$. We first consider optimistic beliefs and only allow the high price, so that the government will prefer to honour its debt in the current period for any combination of current and future debt below the threshold B_{opt}^a given the current state of the economy a. Lenders request the risk-free bond price, which now equals β^2 so that the risk-free, one-period interest rate remains unchanged at $\sqrt{(}1/\beta^2) - 1 = 1/\beta - 1$.

Intuitively, the total sustainable debt level will be similar to that in the one-period model. With only short-term debt, the net cost for the government of rolling-over its debt B_0 would be $(1-\beta)B_0$. In the two-period model it would be $(1-\beta^2)B_0 = 2(1-\beta)B_0 - (1-\beta)^2 B_0$. Hence, the cost has broadly doubled, implying that with equally distributed debt ($B_0 = B_1$), the maximum debt level in each period will be about half that of the single-period model.

Figure 7 shows the default thresholds under the calibration of Subsection 3.2.1

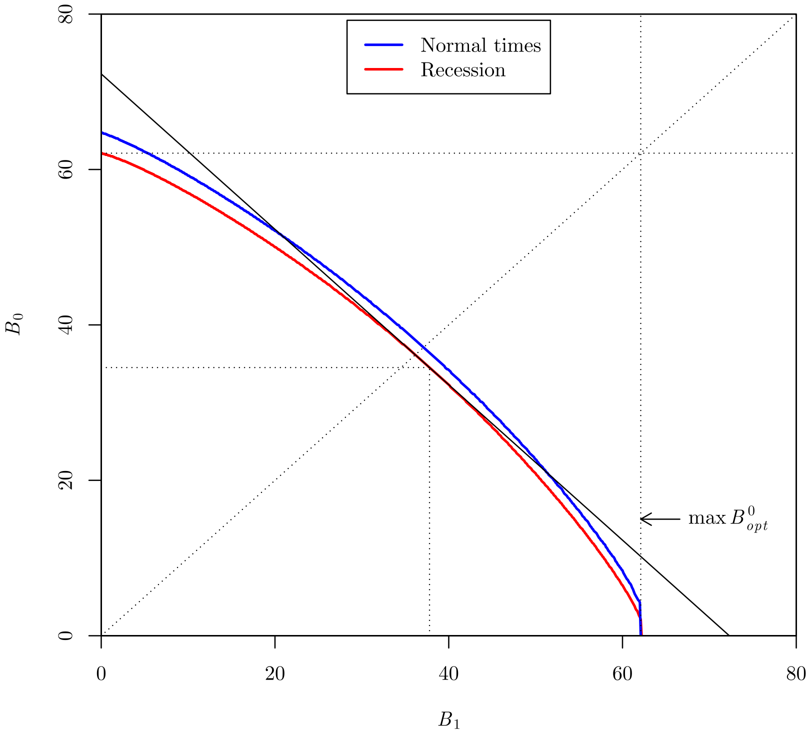

Figure 7: Default thresholds with optimistic beliefs (high price only).

and confirms that, as before, the debt threshold in a recession is lower than in normal times. The debt thresholds depend highly on the debt maturing in the next period. Importantly, the non-linear relationship implies that there is no longer a single, aggregate debt limit, but that instead the maturity profile matters for debt sustainability. The overall debt level that can be sustained is highest when debt is (broadly) evenly distributed. Indeed, the total amount is 72.4, which is slightly higher than that the maximum level with short-term debt (71.6).[8] Clearly, the distance to the maximum debt level (represented by the solid black line) increases when debt is more unevenly distributed. When a high amount of debt needs to be repaid in the current period, the high cost of rolling-over debt increases incentives to default. For high levels of B_1, it is not the current gross financing needs or their cost that prompt a default, but it is the anticipation of a default in the future which makes the government to conclude that it is better to throw in the towel already now. The benefits of reprofiling debt maturities to achieve a more even distribution thus go beyond utility smoothing by also raising the amount of debt that can be held without default risk.

When considering the fiscal decision, the maximum *new* amount of debt that can be issued without default is not given by $B^0_{opt}(B_1)$ (as was the case in the single

---

[8] The maximum debt level is achieved with B_1 slightly above B_0 as a default in the next period is not certain and depends on future economic conditions.

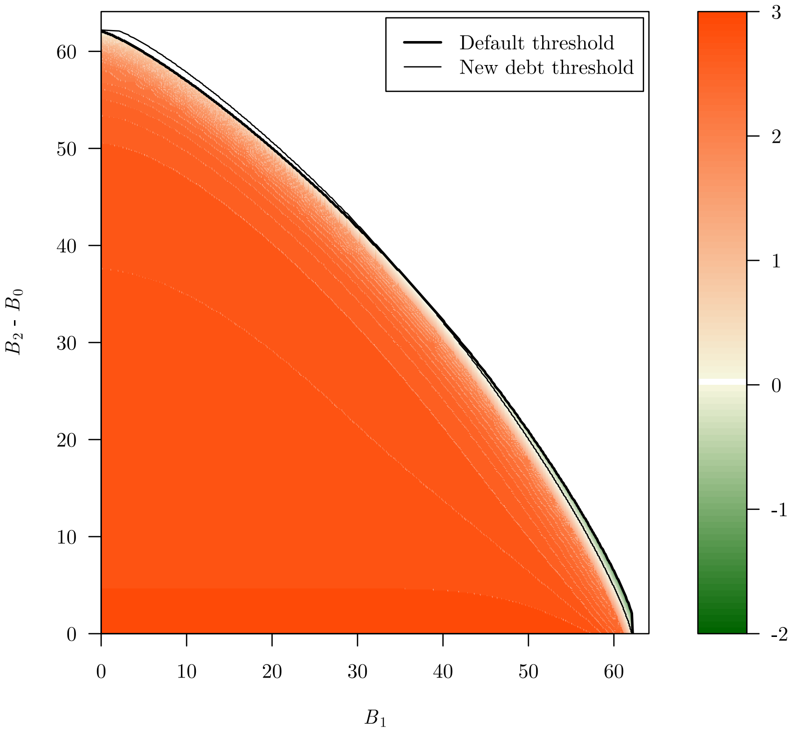

Figure 8: Net borrowing ($B_2 - B_0$) in a recession with optimistic beliefs (high price only).

period model), as this is the debt threshold for avoiding a default in *this* period. Instead, the new debt level should be chosen to avoid a default in the *next* period. Hence, the critical level is the one for which B_1 is just avoiding default in the next period, so the new debt threshold is given by $(B^0_{opt})^{-1}(B_1)$. The default threshold and its inverse are very close to each other, but not identical, as shown in Figure 8 in case of a recession.

Interestingly, the interaction between the default threshold and the new debt threshold generates rich debt dynamics. Figure 8 illustrates how the debt stock evolves during a recession:

- When B_0 and B_1 are relatively low, the preferred debt level B_2 depends essentially only on B_0 and, as before, is around $(1-p)\tau(1-A)\bar{y} = 2.88$ higher to mitigate the impact of the economic downturn. As debt approaches the threshold, however, utility smoothing increasingly gives way to default prevention, prompting the government to raise debt more gradually.
- For a high B_0 and a low B_1 that are just below the default threshold, the government narrowly avoids default but subsequently chooses to borrow more than it has just repaid, so $B_2 > B^0_{opt}(B_1) = B_0$. Despite the already elevated level of maturing debt, it opts to increase borrowing further, planning

to reduce the debt burden once economic conditions improve. In other words, the immediate recession poses the greatest challenge, as high refinancing costs intensify the government's utility loss. This underscores how profound effect of fiscal consolidation under adverse economic conditions and elevated debt servicing costs.

- Conversely, consider the case of a high debt level B_1 and a B_0 that lies just above the debt threshold but still below the default threshold. Now the government does not default, but it must reduce its debt to ensure sustainability in the next period, so $B_2 \leq (B^0_{opt})^{-1}(B_1) < B_0$. A looming default is thus viewed as a more severe problem than the recession itself, to the point that painful fiscal tightening becomes the preferred course of action.

Importantly, these debt dynamics do not depend on the specific calibration. They arise directly from the concavity of the default threshold, which implies the existence of a unique fixed-point $B^0_{opt}(B^*_1) = B^*_1 > 0$ with $B^*_1 > 0$. Around this fixed point, we necessarily have $B^0_{opt}(B_1) < (B^0_{opt})^{-1}(B_1)$ for $B_1 < B^*_1$ while the inequality reverses for $B_1 > B^*_1$.

We now allow optimistic lenders to demand a lower price in case the high price cannot be sustained in equilibrium. First, we allow the government in a recession to raise debt above the threshold $(B^0_{opt})^{-1}(B_1)$ but up to the level $(B^1_{opt})^{-1}(B_1)$. As a default would occur in the next period in case of a recession, while in normal times debt would be brought back to sustainable levels, the probability of a default is now p and the price is $(1 - p\theta)\beta^2$, which we refer to as the medium-low price (under the calibration of Subsection 3.2.1, the one-period yield is 5.2%). Figure 9 shows that the government uses this option only when current debt is relatively low. In such cases, it is willing to accept a lower price for new debt and offsets the recession-driven loss in utility by even expanding its outstanding debt. When higher debt levels need to be refinanced, however, this option becomes too expensive. Importantly, the occurrence of "slow" crises as in Corsetti and Maeng, 2024 is thus not dependent on the belief regime of lenders. The calculated risk-taking of governments can emerge naturally for longer-term debt in case of an uneven maturity profile, and the occurrence of a price below the risk-free free is no longer a distinguishing feature of pessimistic lenders.

The possibility to issue riskier debt enlarges the range of debt levels the government can sustain, and it may become optimal for the government to select these newly feasible levels. This could happen when B_1 is low while the maturing debt B_0 to be refinanced is high such that current debt in the next period, *i.e.* (B_2, B_1), would fall in the shaded area. There are three different possibilities:

- Suppose the new debt is below $(B^1_{opt})^{-1}(B_1)$, which is the highest debt level not resulting in a default in normal times under any price. Now, the government

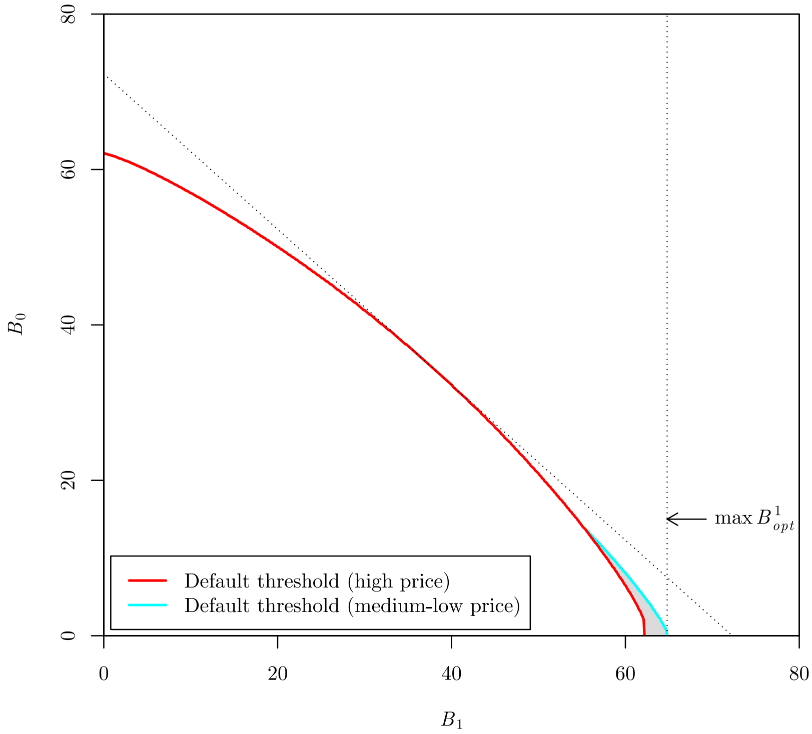

Figure 9: Default thresholds for different prices in a recession with optimistic beliefs.

will only default for the new debt levels if a recession occurs in the two following periods, and lenders would require a price of $(1 - p^2\theta)\beta^2$, which we refer to as the medium-high price (implying a one-period yield of 2.7%).

- For some higher debt levels, a default could happen in case of a recession in the second period regardless of the economic conditions in the first period. It follows that lenders would require the medium-low price.
- Finally, for even higher prices, a default would occur if a recession happens in any of the following two periods. The price in this case is thus $(1 - (p + (1 - p)p)\theta)\beta^2$, which is the two-period equivalent of the low price (implying a one-period yield of 8.0%).

The discrete decrease in pricing and the high debt levels B_0 to be rolled over cause a large drop in utility. Under the used calibration, these types of debt are not attractive for the government, so that Figure 9 shows the full equilibrium outcome in a recession.

Addressing the technicalities required to model pessimistic lenders are beyond the scope of this paper. However, building upon the results obtained for optimistic lenders and for the model with single-period debt, we can sketch the outcomes. For optimistic beliefs, the different prices can be layered on top of each other sequentially as long as debt with the medium-low price occurs for only the lower half of the permissible debt levels. However, in case of pessimistic beliefs the thresholds have to be determined simultaneously as the various possible prices determine the thresholds, even if they do not occur. Unfortunately, the discontinuities in the value function and the two-dimensional debt variable hugely increase computational complexity. Nevertheless, it is clear that the maximum debt threshold is much lower, as the lower prevailing price reduces the attractiveness of repaying compared to defaulting. The thresholds for the other prices create again layered areas on top of each other at the right hand side of the chart. Compared to the case with optimistic lenders, the area with medium-low prices is much larger and already begins for lower levels of B_1. This implies that the risky price is already offered for lower debt levels that require refinancing than in case of optimistic beliefs. Hence, there can be an area at the center of the B_0 curve where the medium-high price occurs: for higher debt levels it is too expensive to refinance at a high price, for lower debt levels the risky price will not be offered. If the low price does occur, it will be in a smaller area and at the lower end of the medium-high area as the pricing is so disadvantageous. Importantly, when debt has a relatively equally-distributed maturity profile, the price thus increases steadily when the total debt level rises.

Longer-period debt widens the potential set of belief regimes. For example, it could be the case that lenders are moderately pessimistic and ask the medium-low price unless it cannot be sustained, or alternatively that they are rather optimistic and charge the medium-high price whenever possible. Clearly, more pessimistic beliefs will cause a larger reduction in the debt thresholds. Any actor that can affect the beliefs, for example credit rating agencies, thus has an impact on debt sustainability through the prevailing beliefs and subsequently the equilibrium selection. In particular, when debt is not sustainable under all beliefs, any external signal that is perceived as having some relevance could thus lead to vastly different equilibrium outcomes. The role and responsibilities of these actors in shaping beliefs—and hence in determining equilibrium outcomes—is even more pronounced when data are scarce, debt markets shallow and alternative assessments limited,

5 Special Role of Supranational Lenders ("This Debt is Different")

The previous sections found that pessimistic beliefs reduce the debt thresholds, or conversely that the debt threshold of the government is affected by non-economic factors beyond its control. In this section we extend the model by introducing a supranational lender which can lend to the government and thereby mitigate the effect of the belief regime. We will refer to debt held by lenders as "commercial debt" and the maximum debt level as the "commercial debt threshold". We focus on the model with short-term debt for ease of exposition, but the results typically also hold in case of longer-term debt.

When lenders have pessimistic beliefs, the lower commercial debt thresholds can be interpreted as a market failure. Clearly, the market is not able to deliver the Pareto optimal outcome. In particular, the acute case of a possible crisis provides a strong incentive for intervention by a supranational lender.. Its loans are characterised here by the three main features which set it apart from market-based lending: i) the supranational benefits from Preferred Creditor Status (PCS), so the government cannot default on loans from the supranational, ii) the supranational is able and willing to roll-over the outstanding debt every period, in particular in difficult periods (maintaining positive or zero net cash flows), and iii) lending by the supranational is at a preferential (lower) interest rate. With the model described above, we can investigate the importance of these three features.

First, suppose current debt B_0 is above B^0_{pes}, which can occur if lenders' beliefs change from optimistic to pessimistic , or due to a negative shock to, for example, $\bar{y}$ or β, which causes the commercial debt threshold to be below the outstanding debt level. In this situation, a default is imminent and happens for sure in case of a recession. Now consider a supranational lender which has the policy objective to prevent the most extreme implication of the market failure, namely a default at relatively low debt levels. It therefore provides emergency liquidity of size B^s at a zero interest rate to the government and promises to roll-over the debt in subsequent periods. If B^s is sufficiently large to ensure that $B_0 - B^s < B^0_{pes}$, the amount of debt that needs to be refinanced by the market falls below the commercial debt threshold. Importantly, the zero interest rate and the automatic roll-over guarantee that the supranational lending is budget neutral in the sense that only the level of commercial debt affects the budget condition

$$\tau A\bar{y} + \big(q(B_1 - B^s) + B^s\big) - B_0 = \tau A\bar{y} + q(B_1 - B^s) - (B_0 - B^s).$$

Moreover, it follows that also in all subsequent periods, only the level of commercial debt is relevant for determining the utility of the government. Crucially, it is still not optimal for the government to default with commercial debt below B^0_{pes}. To see this, note that the debt level after a default would be $(1-\theta)(B_0 - B^s)/\beta + B^s$ as the supranational lending is not subject to a haircut, so that given the automatic roll-over at zero cost, also in this case it is the outstanding level of commercial debt that determines utility. In future periods, the supranational lending is thus neither affecting the default nor the borrowing decisions. In the current period, however, it succeeds in reducing financing needed from the market below B^0_{pes} and hence lenders conclude that the government will not default this period. The emergency liquidity provided by the supranational has thus successfully averted a default this period.[9] Importantly, the features of supranational debt ensure that beyond the

---

[9] Note that when $B_0 - B^s > C^0_{pes}$, the low bond price will prevail and additional support may

initial period, supranational debt is irrelevant for the behaviour of government and lenders.

Similarly, when the government would take a calculated risk, the supranational may step in, promising that in case of a negative business cycle shock in the next period, it will provide funding, akin to an IMF stand-by agreement. In this case, the prospect of a default is avoided, and lenders are willing to buy bonds at the high price.[10] In case of a recession in the next period, the supranational will provide a loan, which has the same effect as the emergency liquidity. Interestingly, Figure 5 shows that close to the debt thresholds, the government borrows less to offset adverse economic conditions than at lower levels, so that rising debt levels go hand in hand with fiscal tightening. This shows that to some extent the fiscal reforms that are often a condition for IMF support are also the preferred direction of the government.[11] To the extent that the IMF requirements will be exceeding (anticipated) government ambitions, they are still helpful to increase the costs of a default (*i.e.* increasing ζ), thereby allowing countries to borrow more.

Ideally, repayment of the supranational loan is made contingent on the economic situation, as in good periods the government will prefer to lower the outstanding debt, while in a recession this would lower utility too much (see Figure 5). Repayment may entail a reduction in overall debt, or a (gradual) replacement by commercial debt. Alternatively, the government could replace the debt of the supranational lender that aims to avoid a default by debt from another supranational with a different mandate, for example one related to development. In this way, the emergency support turns into support of a more structural nature.

This brings us to the third reason why a supranational could be willing to lend: it may want to address the market failure of restricted credit availability due to lenders' self-fulfilling negative beliefs. Supranational lending then aims to support the country where the lower commercial debt threshold becomes binding. In this case, supranational lending aims to mitigate the underprovision of commercial debt due to lenders' beliefs.[12] Crucially, this is not only underprovision of credit in a purely quantitative way, but also unavailability of credit without the consequent prospect of a possible default. Interestingly, intervention by the supranational can

---

be needed next period.

[10] Mimir and Önder (2025) find that credit lines of 10% of GDP reduce bond spreads by 120 basis points and halve the default risk.

[11] An interesting extension of the model would be the introduction of a penalty term related to a reduction in government spending to capture the unpopularity of fiscal tightening. However, this would make fiscal expenditure in the previous period an additional state variable, which increases computational complexity.

[12] The supranational could essentially lend any amount to the government and roll-it over in subsequent periods without affecting the government's budget constraint. However, there is no clear rational for the supranational to lend such an amount that the total debt of the country exceeds B^0_{opt}.

very well occur before commercial debt reaches the threshold (so $B_0 < B^0_{pes}$). While this may not seem an optimal use of public resources in this model setting,[13] it allows the government to keep commercial borrowing well below the threshold, so that in case of business cycle shocks it does not risk a sharp reduction in utility. Clearly, the marginal pricing is still done by markets, and this scrutiny in turn ensures fiscal responsibility.

The distinctive features of supranational debt create a separate debt class next to commercial debt. It thus constitutes an additional financing source for the government without counting against the commercial debt threshold. Starting with the pricing, the zero interest rate crucially depends on the assured repayment in a default (in addition to the supranational's public mandate instead of a profit motive, as reflected by its implicit discount factor of 1). As a result, supranational debt, once issued, does not affect the government's budget. Interestingly, when supranational debt comes at a cost, it still succeeds in increasing the debt threshold. To see this, suppose for simplicity that the supranational charges market rates. For a given overall debt level, the amount of debt that remains after a default is strictly increasing in the supranational debt, as this debt is not part of the debt restructuring. The value of defaulting is thus reduced. The value of taking a calculated risk decreases to a lesser extent, and the result is a higher debt threshold. While the desired outcome is thus reached, it is essentially the government buying credibility that it is not going to default easily: it spends part of its income to make its own default more costly. In addition, the supranational lending is increasing the debt thresholds only partly. When under the baseline model calibration of Subsection 3.2.1 the supranational provides a loan of 5, the threshold for overall debt increases by less than half, namely 2.3, to 53.9. Similarly, for a loan of 10, it increases by 4.6 to 56.2. For high debt levels and with market-based pricing, about half of the supranational loan thus replaces commercial lending. Hence, the model shows that, perhaps contrary to intuition, the preferential pricing is essential for ensuring the complementarity of supranational interventions.

The possibility to offer lower pricing crucially depends on the guarantee that supranational debt will be fully repaid under all circumstances. In contrast, if it would be part of a default, the supranational would have to price this in, and while it may still offer preferential terms as it does not have a profit motive, the compensation for default risk is the main driver of the reduced price required by lenders. For the same reason, the supranational's promise to roll-over debt even when the government is close to default ensures that the government does not suddenly have to repay this borrowing and then has to refinance a debt level from the market that exceeds the threshold. So this promise excludes the possibility that the much higher refinancing costs from the market could trigger a default.

---

[13] The likely benefits of supranational lending on a country's development are not modelled here.

The various motives for supranational lending also arise in case of longer-term debt with pessimistic lenders, with the analysis being broadly similar. In addition, the supranational can now also support a country by helping to reprofile its debt, thereby smoothing future debt servicing costs.[14] When reprofiling is the exclusive purpose of the loan, it can even be effective when, instead of an automatic roll-over, a full repayment is foreseen.

6 Conclusion

Our model with endogenous debt limits offers several insights into the interaction between economic conditions, lenders' belief and government decisions. It shows that when lenders trust a country and regard it as a safe haven, it benefits from both lower bond yields and higher debt sustainability thresholds—yet a change in beliefs can have a profound impact. The model also demonstrates how countries facing sceptical lenders are constrained in their ability to cushion exogenous economic shocks, and that this effect is amplified by the inability of a government to credibly commit to any announced debt level. Lenders' beliefs thus drive the equilibrium selection and in turn affect the welfare of a country and its citizens. However, for low debt levels, deriving the degree of trust by the markets and establishing which equilibrium prevails is not straightforward in reality. Crucially, the price cannot be used to distinguish between equilibria, since all prices can potentially occur in any equilibrium, and yields will always increase when default risk rises. Instead, a more fundamental analysis is needed at the level of the debt threshold, linking it to country-specific characteristics. In this regard, it is noteworthy that government revenue as a share of GDP emerges as one of the most important determinants of the debt threshold. Disentangling this structural factor from market perceptions is essential—but not simple.

Several of the model's results carry important implications for bond design and public debt management. Fiscal prudence, let alone tightening, entails a particularly large utility loss in case of adverse economic conditions. While timely servicing and repayment of debt are obligations agreed upon at issuance, one can argue that, for shocks beyond the government's control, repayments should be reduced or delayed. This strengthens, for example, the case for expanding the use of climate-resilient debt clauses (*e.g.* European Investment Bank (2023); World Bank (2023)), which allow principal and interest payments to be deferred following environmental or climate-change related disasters. At present, such clauses are mainly embedded in supranational lending to small states and small island economies; extending them to

---

[14] Arguably, there is even a reason for intervention in case of optimistic lenders as defaults may occur now, although one could also claim that the market is as supportive as possible and that any negative shock could have been anticipated.

commercial debt would further help to mitigate the impact of exogenous shocks and to avoid a severe deterioration in debt sustainability. In turn, this would support more favourable lender perceptions. Alternatively, disaster-related risk could be covered by guarantee schemes —potentially offered by supranational lenders—and linked to specific commercial bonds. When lenders are willing to pay a premium to ensure repayment under such arrangements, the overall resilience and sustainability of sovereign debt increases.

The findings also underscore the strong incentives for governments to be able to commit credibly to prudent fiscal behaviour in the future. Building such a reputation takes time, but in the short term, constitutional limits on debt level and annual borrowing increases can reassure lenders, improving both pricing and debt thresholds. Measures that raise the costs of default likewise strengthens lenders' confidence that repayment is the preferred course of action across a wide range of debt levels. Another possibility concerns the haircut and other modalities of debt restructuring, which are typically determined only after a default occurs. This *ex-post* approach creates uncertainty for all parties and may inadvertently make default appear overly attractive to policy-makers. Instead, these parameters could also be established *ex-ante*, similar to banks' resolution plans or "living wills" (Federal Reserve Board, 2023)—effectively extending the principle behind climate-resilient debt clauses one step further.

The existence of multiple equilibria highlights the influential role of actors who shape market perceptions, with implications not only for pricing but also for debt sustainability. Among the various sources of information, credit rating agencies in particular need to be aware of the feedback loop inherent in their assessments, and several proposals have sought to address this issue (*e.g.* Shen and Kraemer (2022); Sustainability-linked Sovereign Debt Hub (2024)). Separating the evaluation of fiscal fundamentals—such as tax revenues and expenditures, which are not directly affected by market prices—from the assessment of future borrowing costs would help counter claims that their assessments are self-fulfilling. Likewise, providing a realistic best-case scenario for future debt-service costs would help clarify the extent to which the overall assessment depends on the prevailing market perceptions. Interestingly, the new African rating agency, as proposed by the African Union (see African Union (2024)), could potentially contribute to such diversification by issuing assessments that may be more optimistic than those of traditional agencies. A better understanding of the range of possible outcomes would be valuable for sovereign debt assessments. However, it remains to be seen to what extent this new agency would be able to shape lenders' decisions in practice.

A final message concerns the distinctive nature of supranational debt: it is in the government's interest to ensure that this debt remains fundamentally different from commercial debt. Due to its specific features, supranational debt allows a country's total borrowing to exceed the threshold that would otherwise apply to market-based debt. Crucially, market discipline still constrains the government's behaviour. Tinkering with the features of supranational debt so that it resembles commercial debt more closely would make new interventions become both more costly and less efficient.

Appendix A. Proof

Proof of Proposition 1. For notational simplicity, we only indicate dependence of the various functions on a and the debt levels. We start with showing that the value functions of repaying are strictly decreasing. Consider $\underline{\mathrm{B}}$ and $\bar{B}$ with $\underline{\mathrm{B}} < \bar{B}$. Then

$$\begin{aligned}
\mathcal{V}^R_\rho(\underline{\mathrm{B}}, a) &= \max_{B_1}\Big(\mathcal{U}(\underline{\mathrm{B}}, B_1, a, \rho) + \beta\mathbb{E}[\mathcal{V}_\rho(B_1, a)]\Big)\\
&\geq \mathcal{U}(\underline{\mathrm{B}}, B_1(\bar{B}, a, \rho), a, \rho) + \beta\mathbb{E}[\mathcal{V}_\rho(B_1(\bar{B}, a, \rho), a]\\
&> \mathcal{U}(\bar{B}, B_1(\bar{B}, a, \rho), a, \rho) + \beta\mathbb{E}[\mathcal{V}_\rho(B_1(\bar{B}, a, \rho), a]\\
&= \mathcal{V}^R_\rho(\bar{B}, a),
\end{aligned}$$

where the strict inequality follows from the concavity of the utility function. It now follows that the value functions of defaulting $\mathcal{V}^D_\rho$ are also strictly decreasing.

To derive the uniqueness of the thresholds for positive beliefs in case of concave value functions, note that

$$\begin{aligned}
\mathcal{V}^R_{opt}(0, a) &= \max_{B_1}\Big(\mathcal{U}(0, B_1, a, opt) + \beta\mathbb{E}[\mathcal{V}_{opt}(B_1, a)]\Big)\\
&\geq \mathcal{U}(0, 0, a, opt) + \beta\mathbb{E}[\mathcal{V}_{opt}(0, a)\\
&> \mathcal{U}(0, 0, a, opt) - \zeta + \beta\mathbb{E}[\mathcal{V}_{opt}(0, a)\\
&= \mathcal{V}^D_{opt}(0, a).
\end{aligned}$$

This shows that defaulting is not optimal for low debt levels. For high debt levels, the value function decreases increasingly fast due to the concavity of the utility function. Hence, in case an equilibrium exists, it is unique as $\mathcal{V}^D_{opt}$ is decreasing slower than $\mathcal{V}^R_{opt}$ for every point B_0 so that $\mathcal{V}^R_{opt}$ and $\mathcal{V}^D_{opt}$ only cross once. For negative beliefs, uniqueness follows in a similar way. □

Appendix B. Algorithm for Computing Value Functions

In this section, we present the algorithm that computes the debt thresholds in optimistic and pessimistic worlds.

B.1 Grid Spacing and Convergence Criteria

For the debt levels, a grid with spacing of 0.1 is used in the model with short-term debt. For debt with longer maturity, a smart grid is used with standard spacing of 1 and spacing of 0.1 in a band around the debt threshold.

The maximisation problems are carried out with an accuracy of 0.0001. Value function iterations are continued until the largest absolute difference between two subsequent approximations falls below 0.001. In case of optimist beliefs, debt thresholds are considered to have converged if in two subsequent approximations they yield identical values when rounded down to the grid values. In case of pessimistic beliefs, a small absolute difference for the unrounded thresholds is also considered sufficient. In normal times, this limit is always set to 10% of the grid spacing (i.e. 0.01), while in a recession it is set to the most stringent of 10%, single or double grid spacing for which the algorithm finds a solution.

B.2 Short-term Debt and Optimistic Beliefs

The value functions for optimistic beliefs can be characterised by

$$\begin{aligned}\mathcal{V}(B_0, a, opt) = \max\Bigg\{ & \max_{0 \leq B_1 \leq B^0_{opt}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + \beta B_1 \Big) \\ & + \beta \Big(p\mathcal{V}(B_1, 0, opt) + (1-p)\mathcal{V}(B_1, 1, opt) \Big) \Big), \\ & \mathcal{V}^D_{opt}(B_0, a) \Bigg\}.\end{aligned}$$

The value functions and thresholds can numerically be obtained as follows:

1. Guess the maximum debt level B^0_{opt} and the value functions $\mathcal{V}(B_0, 0, opt)$ and $\mathcal{V}(B_0, 1, opt)$. Obtain an estimate of B^1_{opt}.
2. Perform value iteration on $\mathcal{V}(B_0, 0, opt) = \mathcal{V}^R_{opt}(B_0, 0)$ on the domain $(0, B^0_{opt})$ and on $\mathcal{V}(B_0, 1, opt) = \max\{\mathcal{V}^R_{opt}(B, 1), \mathcal{V}^D_{opt}(B, 1)\}$ until convergence of the value functions and the estimates of B^1_{opt}.
3. Solve the government problem to obtain a new estimate of B^0_{opt} (see (6)). If close enough, stop, otherwise go to step 2.

B.3 Short-term Debt and Pessimistic Beliefs

The value functions $\mathcal{V}(B_0, 0, pes)$ and $\mathcal{V}(B_0, 1, pes)$ with a low price can be characterised by

$$\begin{aligned}\mathcal{V}(B_0, a, pes) = \max\Bigg\{ & \max_{0 \le B_1 \le B^0_{pes}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + (1-p\theta)\beta B_1\Big) \\ & \quad + \beta\Big(p\mathcal{V}(B_1, 0, pes) + (1-p)\mathcal{V}(B_1, 1, pes)\Big)\Big), \\ & \max_{B^0_{pes} < B_1 \le B^1_{pes}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + (1-p\theta)\beta B_1\Big), \\ & \quad + \beta\Big(p\mathcal{V}^D_{pes}(B_1, 0) + (1-p)\mathcal{V}(B_1, 1, pes)\Big)\Big) \\ & \mathcal{V}^D_{pes}(B_0, a)\Bigg\},\end{aligned}$$

and the value function with a high price by

$$\begin{aligned}\mathcal{V}(B_0, a, pes) = & \max_{0 \le B_1 \le B^0_{pes}} \Big(\mathcal{U}\Big((1-\tau)A^{1-a}\bar{y}, \tau A^{1-a}\bar{y} - B_0 + \beta B_1\Big) \\ & \quad + \beta\Big(p\mathcal{V}(B_1, 0, pes) + (1-p)\mathcal{V}(B_1, 1, pes)\Big)\Big).\end{aligned}$$

The value functions and thresholds can numerically be obtained as follows:

1. Guess the maximum debt levels B^0_{pes} and C^0_{pes}, and the value functions $\mathcal{V}(B_0, 0, pes)$ and $\mathcal{V}(B_0, 1, pes)$. Obtain an estimate of B^1_{pes} and C^1_{pes}.
2. Perform value iteration on $\mathcal{V}(B_0, 0, pes) = \mathcal{V}^R(B_0, 0, pes)$ on the domain $(0, C^0_{pes})$, $\mathcal{V}(B, 0, pes) = \mathcal{V}^C(B, 0, pes)$ on the domain (C^0_{pes}, B^0_{pes}), and $\mathcal{V}(B, 1, pes)$ (assuming a high price if, with a low price, $\mathcal{V}^R(B, 1, pes) > \mathcal{V}^C(B, 1, pes)$ and a low price otherwise) until convergence of the value functions and the estimates of B^1_{pes} and C^1_{pes}.
3. Solve the government problem to obtain new estimates of B^0_{pes} and C^0_{pes} (see (7) and the definition of C^0_{pes}). If close enough, stop, otherwise go to step 2.

B.4 Longer-term debt and Optimistic Beliefs

The algorithm takes advantage by the insight obtained from the model with short-term debt that in normal times the debt level will be lowered. Hence, it only considers debt combinations that are permissible in a recession. The value functions are now functions of current and next period debt, so the grid is two-dimensional, and the threshold B^0_{opt} is a function of B_1 (and so is B^1_{opt}). The debt threshold and the value functions are updated alternatively until convergence is reached. The value functions can then be extended beyond the threshold B^0_{opt} assuming defaulting in a recession and repaying in normal times until it is preferable to default even if normal times, which yields the threshold B^1_{opt}.

References

African Union (2024). "Retreat to Finalise Establishment of the Africa Credit Rating Agency". In: *APRM Press Releases.* URL: `https://aprm.au.int/index.php/en/news/press-releases/2024-03-25/retreat-finalise-establishment-africa-credit-rating-agency`.

Calvo, Guillermo A. (1988). "Servicing the Public Debt: The Role of Expectations". In: *American Economic Review* 78.4, pp. 647–661.

Chadha, Jagjit S. (2022). "Monetary andFiscal Policy Redux-The Mini-Budget". In: *National Institute Economic Review* 262, pp. 1–7. DOI: `10.1017/nie.2023.8`.

Cole, Harold L. and Timothy J. Kehoe (2000). "Self-Fulfilling Debt Crises". In: *The Review of Economic Studies* 67.1, pp. 91–116.

Conesa, Juan Carlos and Timothy J. Kehoe (2017). "Gambling for Redemption and Self-Fulfilling Debt Crises". In: *Economic Theory* 64.4, pp. 707–740.

Corsetti, Giancarlo and Seung Hyun Maeng (2024). "Debt Crises, Fast and Slow". In: *Journal of the European Economic Association* 22.5, pp. 2148–2179. DOI: `10.1093/jeea/jvad076`. URL: `https://doi.org/10.1093/jeea/jvad076`.

Diamond, Douglas W. and Philip H. Dybvig (1983). "Bank Runs, Deposit Insurance, and Liquidity". In: *Journal of Political Economy* 91.3, pp. 401–419.

European Investment Bank (2023). *Key Climate Action Highlights of the EU Contribution to the Paris Summit for a New Global Financing Pact.* URL: `https://www.eib.org/en/press/all/2023-243-key-climate-action-highlights-of-the-eu-contribution-to-the-paris-summit-for-a-new-global-financing-pact`.

Federal Reserve Board (2023). *Living Wills (or Resolution Plans).* URL: `https://www.federalreserve.gov/supervisionreg/resolution-plans.htm`.

Financial Times (2020). "Ken Ofori-Atta: 'What does an African finance minister do now?'" In: *Financial Times.* URL: `https://www.ft.com/content/1ab41f68-7e30-11ea-82f6-150830b3b99a`.

— (2022). "IMF urges UK to re-evaluate tax cuts in biting attack on fiscal plan". In: *Financial Times.* URL: `https://www.ft.com/content/06962055-6b3d-4712-814f-acea3cb9e082`.

Graf von Luckner, Clemens et al. (2023). "Sovereign Debt: 200 Years of Creditor Losses". In: *National Bureau of Economic Research Working Paper* 32599. DOI: `10.3386/w32599`.

Hatchondo, Juan Carlos and Leonardo Martinez (2009). “Long-Duration Bonds and Sovereign Defaults”. In: *Journal of International Economics* 79.1, pp. 117–125.

Horn, Sebastian et al. (2024). *Hidden Debt Revelations.* NBER Working Paper 32947. National Bureau of Economic Research. DOI: `10.3386/w32947`. URL: `https://www.nber.org/papers/w32947`.

International Monetary Fund (2023). *Debt Relief Under the Heavily Indebted Poor Countries (HIPC) Initiative.* URL: `https://www.imf.org/en/About/Factsheets/Sheets/2023/Debt-relief-under-the-heavily-indebted-poor-countries-initiative-HIPC`.

Mimir, Yasin and Yasin Kürsat Önder (2025). *Concessional Credit Lines for Sovereigns in Financial Distress.* ESM Working Paper Series No. 70. Luxembourg: European Stability Mechanism, p. 31. DOI: `10.2852/6797543`. URL: `https://www.esm.europa.eu/publications/concessional-credit-lines-sovereigns-financial-distress`.

Roos, Jerome E. (2019). *Why Not Default?: The Political Economy of Sovereign Debt.* Princeton, NJ: Princeton University Press, p. 416. ISBN: 978-0691180106.

Shen, Dennis and Moritz Kraemer (2022). “How rating agencies could support African governments in overcoming debt crises”. In: *LSE Blog.* URL: `https://blogs.lse.ac.uk/africaatlse/2022/07/04/how-rating-agencies-could-support-african-governments-in-overcoming-debt-crises/`.

Sustainability-linked Sovereign Debt Hub (2024). *Sovereign Credit Ratings: Unblocking Capital Flows for Development by Upgrading the Current Rating Regime.* URL: `https://assets.website-files.com/6304b688a389d80520fb16c4/6655ad352bf2085d6318dd8a_SovereigncreditRatings%203.pdf`.

Trebesch, Christoph and Michael Zabel (2023). “The Output Costs of Hard and Soft Sovereign Default”. In: *European Economic Review* 158, p. 104514. DOI: `10.1016/j.euroecorev.2023.104514`. URL: `https://doi.org/10.1016/j.euroecorev.2023.104514`.

Wolf, Martin (2025). *It’s time to sound the alarm on growing fiscal and financial risk.* Accessed: 2025-12-22. URL: `%5Curl%7Bhttps://www.ft.com/content/fd094d3e-01b4-4f1c-838c-bc1ffb493a02?shareType=nongift%7D`.

World Bank (2023). *Climate Resilient Debt Clause (CRDC) Product Note.* URL: `https://thedocs.worldbank.org/en/doc/6857abe91ef32973cfab7f689e9f00fe-0340012023/original/CRDC-Product-note-EN.pdf`.

— (2025). *Radical Debt Transparency.* Tech. rep. International Bank for Reconstruction and Development / The World Bank. URL: `https://documents1.worldbank.org/curated/en/099439106192540687/pdf/IDU-a86e3bb4-3446-4716-9131-085141b81950.pdf`.

SOVEREIGN DEBT DYNAMICS AT THE BRINK OF DEFAULT AND THE SPECIAL ROLE OF SUPRANATIONAL LENDERS

European
Investment Bank

pdf: ISBN 978-92-861-6166-7

2026-0051