

Optimal Default in a Small Open Economy: Senegal’s Hidden Debt Crisis

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Abstract

Hidden public liabilities can reprice sovereign risk abruptly upon revelation. We study optimal default following such a revelation in a quantitative sovereign default model and apply the framework to Senegal’s 2024 debt audit, which revised government debt upward by 50 percentage points of GDP. The revelation enters as an exogenous upward shift in the inherited debt stock within a small open economy with long-duration debt and default costs disciplined by Senegal’s monetary-union constraints. Under our baseline calibration, the corrected debt stock exceeds the model’s repayment region, implying that default would have been optimal from 2023 onward—before the audit was conducted. Since Senegal has continued to repay, we also consider a no-default calibration that matches post-revelation spread dynamics. Rationalizing repayment requires income dynamics more volatile and less persistent than historical estimates, consistent with optimism about mean reversion or gambling for redemption. This calibration places Senegal near the default boundary, where a 3 percent adverse income shock would make restructuring optimal within a year. Both calibrations yield the same conclusion: the hidden-debt revelation moved Senegal from moderate fiscal risk to acute vulnerability.

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1 Introduction

In March 2024, a newly elected Senegalese government commissioned an audit of its fiscal accounts and discovered that its predecessor had accumulated more than 10 billion dollars in liabilities not reflected in official statistics. Central-government debt, reported at roughly 70 percent of GDP, was revised upward by 45 percentage points overnight. The IMF suspended its program. Rating agencies downgraded Senegal’s sovereign credit. Eurobond spreads surged into distressed territory. Yet the authorities declined to restructure, invoking the sovereign’s “right” to decide whether and how to address the debt problem. This episode is an extreme realization of a broader phenomenon: hidden public liabilities that compress the policy space between fiscal adjustment and default the moment they are revealed. *When is it optimal for a government facing a large hidden-debt revelation and very high spreads to default rather than repay?*

Governments routinely owe more than they record on their official balance sheets. Off-budget borrowing, guarantees, and arrears allow them to shift expenditures across time and to soften political constraints. Still, they also create hidden liabilities that are only imperfectly understood by markets and international institutions. Standard models of sovereign default (Eaton and Gersovitz, 1981; Arellano, 2008) assume that public debt is fully observable and that spreads reflect fundamentals in real time. In practice, much of the variation in spreads around crises is driven by news about the stock of obligations that were previously unmeasured or misreported (Horn et al., 2024). Hidden debt is therefore not just a measurement error; it is a state variable that shapes incentives to default.

This paper develops a quantitative model of optimal sovereign default following a hidden-debt revelation and applies it to Senegal’s 2024 shock. We model the revelation as an initial condition: an audit discloses obligations excluded from official statistics, and the government inherits the enlarged debt stock. Senegal’s membership in the West African Economic and Monetary Union (WAEMU) sharpens the tradeoff considerably; the fixed CFA franc peg rules out devaluation and monetary financing, so the entire burden of adjustment falls on fiscal policy or restructuring.

Our main finding is that, under the income process estimated from Senegal’s tradable sector, default would have been the optimal policy since 2023. The hidden-debt revelation alone was sufficient to push the corrected debt-to-GDP ratio past the model’s default threshold of 107 percent — a crossing that occurred between 2022 and 2023, before the audit was even conducted. Since Senegal has not defaulted as of early 2026, we also characterize the conditions under which continued repayment is rational. A no-default calibration that matches post-revelation spread dynamics requires market-implied income shocks that are more volatile and less persistent than histori-

cal data suggests, reflecting either optimism about mean reversion, perhaps driven by anticipated oil revenues and governance reforms, or a form of gambling for redemption (Conesa and Kehoe, 2017) in which the government delays restructuring in the hope that favorable shocks restore sustainability. Under this calibration, Senegal is solvent but fragile: an adverse income shock of 3 percent would lead to an expected time to default of less than one year.

We obtain these findings in a small open economy model with long-term bonds, CES preferences over tradable and non-tradable goods, downward nominal wage rigidity, and output costs disciplined by Senegal’s monetary union environment, and building on Arellano (2008), Chatterjee and Eyigungor (2012), and Bianchi and Sosa-Padilla (2024). Hidden debt enters as a one-time upward shift in the initial debt stock. The tradable income process is estimated from World Development Indicators data on Senegal’s agriculture and industry value added over 1980–2024, and the model is calibrated to match the pre-revelation Senegalese government bond risk premium observations, proxied by the J.P. Morgan Emerging Markets Bond Index Global (EMBIG) for Senegal, at officially reported debt. However, because the hidden liabilities existed throughout the pre-revelation period, those spreads may already embed non-public information about the true debt stock — in which case the reported debt level is not the state variable markets were actually pricing. To address this, our no-default calibration holds debt fixed at the corrected post-revelation level and exploits variation in real income, and EMBIG spreads to identify the output cost and the market-implied income process jointly. Both calibrations reach the same conclusion: Senegal moved from a position of moderate fiscal risk to a regime of acute vulnerability following the revelation of its hidden debt.

The rest of the paper is organized as follows. Section 2 documents the Senegalese debt shock and the evolution of sovereign spreads before and after the revelation. Section 3 develops the model and defines the recursive equilibrium. Section 4 presents the calibration and quantitative results. Section 5 concludes.

2 Motivation and Background

2.1 Hidden Sovereign Debt Revelations

Hidden public debt arises when governments take on obligations that are not transparently recorded in headline debt statistics. Common channels include borrowing by public enterprises with implicit guarantees, off-budget funds, rolling bank loans, and the systematic understatement of fiscal deficits (Horn et al., 2024). These practices can be politically attractive in the short run: they allow governments to finance spending

surges or election-year transfers while appearing to respect formal fiscal rules.

Economically, however, hidden debt has two key consequences. First, it breaks the link between observed debt ratios and the true intertemporal budget constraint. Investors and international institutions may underestimate a country’s vulnerability, leading to excessively low spreads in tranquil times. Second, the eventual revelation of hidden liabilities can be a large negative shock to the sovereign’s perceived net worth. When revelation occurs, spreads jump, and the government faces a compressed menu of painful choices: tighten policy aggressively, attempt to grow out of the imbalance, or restructure and default.

Most sovereign-debt models abstract from this distinction between reported and true debt. In the data, though, episodes in which new administrations or audit institutions uncover large hidden liabilities are common (Horn et al., 2024; Reinhart and Rogoff, 2009), and they are often followed by sharp revisions in debt ratios, rating downgrades, and spread spikes. The Senegalese episode is an extreme realization of this mechanism.

2.2 Senegal’s Hidden-Debt Shock

In Senegal, a change of administration in 2024 led to a comprehensive audit of the fiscal accounts and public borrowing. The audit revealed sizable off-budget borrowing through commercial banks, special deposit accounts, and quasi-fiscal operations, and it revised the central government debt-to-GDP ratio from the mid-70s to well above 100 percent. The Court of Accounts and internal reports documented over-financing of the budget, hidden bank loans outside normal procedures, and incomplete recording of a large sukuk issuance. Taken together, these elements imply more than \$10 billion in hidden liabilities and a debt ratio that climbs into the 110- 120 percent range in the years following the pandemic.

A key measurement issue throughout the paper is that the debt revision combines liabilities with different contractual and pricing characteristics. Our quantitative model abstracts from this composition and maps the revelation into a single inherited debt object. To keep that abstraction transparent, this section distinguishes between reported external debt, corrected external debt, and corrected total public debt wherever the data allow, and the quantitative section explicitly states which debt concept is used for each calibration target.

The scale of under-reporting can be quantified by comparing Senegal’s debt reports across different vintages of the World Bank’s International Debt Statistics. Figure 1 illustrates this pattern for the 2013–2024 period. When initially reported in the 2024 vintage, external public and publicly guaranteed debt appeared relatively stable. However, the 2025 vintage—published after the audit—revealed substantial upward

revisions throughout the entire period. The blue bars in Figure 1 show additional debt stocks that were added through revisions, with the gap between initially reported and revised figures widening significantly in recent years. By 2024, several billion dollars in external obligations not reported contemporaneously appeared in the statistics only retrospectively, illustrating the systematic nature of debt under-reporting that preceded the full revelation.

The revision had two immediate macroeconomic consequences. First, the existing IMF program, approved in 2023 on the basis of understated data, was suspended once the scale of misreporting became apparent. Second, rating agencies began to downgrade Senegal’s sovereign rating, and bond markets repriced Senegalese risk sharply upward. The sovereign, which had been borrowing at spreads comparable to other frontier issuers in the region, suddenly found itself priced as a distressed credit. [Ndiaye and Kessler \(2026\)](#) provides further background information and a descriptive analysis of Senegal’s hidden debt shock.

The episode is particularly striking because it occurred within the institutional constraints of a monetary union. Senegal is a member of the West African Economic and Monetary Union (WAEMU), which uses a common currency pegged to the euro and administered by a regional central bank. This arrangement anchors inflation but rules out unilateral exchange-rate devaluation and monetary financing ([Arellano et al., 2026](#)). A country that experiences a large debt shock in this environment cannot inflate its way out of trouble; the burden of adjustment falls on fiscal policy, structural reforms, and, potentially, debt restructuring. At the same time, the regional banking system holds a large fraction of domestic sovereign paper, so any restructuring that starts with domestic claims risks spilling over into bank capital, deposits, and ultimately the currency peg.

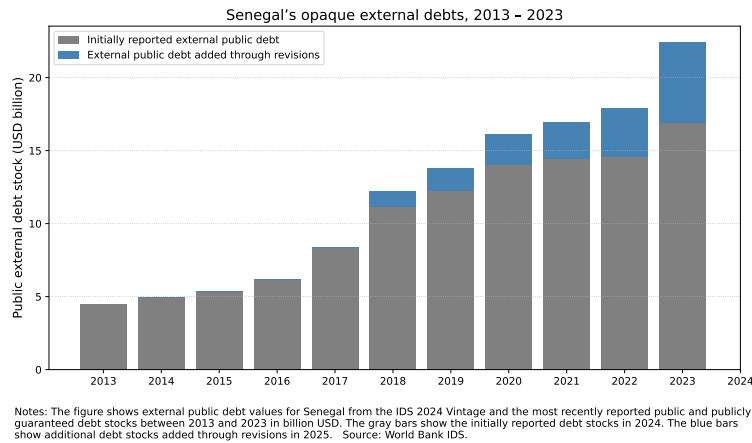


Figure 1: Senegal’s Hidden Debt, 2013-2024

Against this backdrop, the Senegalese authorities have emphasized the objective

of preserving external market access and avoiding an outright default, at least in the short run. Public statements have emphasized the sovereign’s right to decide whether and how to tackle the debt problem and have signaled a reluctance to initiate a restructuring, even as spreads moved into double-digit territory. This policy stance raises a natural question: given a large revelation of hidden debt and very high spreads, when is it optimal for a sovereign to continue servicing its debt, and when is it optimal to restructure?

2.3 Consequences of Senegal’s Hidden Debt Revelation

Figure 2 plots a time series of Senegal’s sovereign spread over U.S. Treasuries, as measured by an index of hard-currency sovereign bonds, from late 2023 to late 2025. The EMBIG series is reconstructed from secondary-market data and is intended as a proxy for the risk premium on Senegalese government bonds rather than as a definitive measure. Two vertical lines mark key dates: the formal publication of the audit that crystallized the hidden-debt shock, and a later public statement by the authorities signaling that Senegal would not restructure its external obligations.

Figure 2 highlights three features that guide the model. First, spreads were relatively moderate prior to the revelation, despite pre-existing concerns about deficits and public enterprises, suggesting that markets did not fully price in the hidden liabilities. Second, spreads jumped sharply once the audit crystallized the scale of hidden obligations, and the IMF program was suspended. Third, and most importantly for our purposes, spreads remained elevated even after policymakers publicly committed to repayment and ruled out restructuring — a signal that markets continued to assign substantial default probability despite the government’s stated intentions. These three patterns are difficult to reconcile with a model in which debt is always fully observed, and default is triggered solely by contemporaneous income shocks. They are, however, natural in a framework in which the revelation of hidden liabilities constitutes a discrete upward shift in the debt stock that permanently alters the government’s default calculus, independent of any deterioration in income.

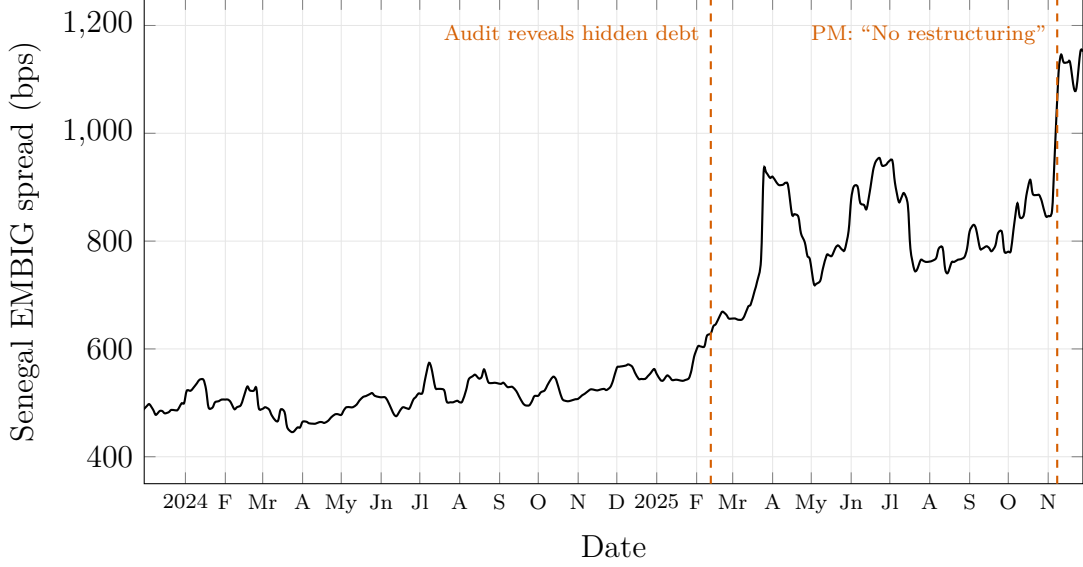


Figure 2: Senegal’s Sovereign Spread and Key Events.

3 Model

We consider a small open economy inhabited by a representative household and governed by a benevolent government that lacks commitment over future fiscal policies. The government borrows from a continuum of competitive, risk-neutral international lenders by issuing long-term non-contingent bonds. The model begins immediately after the revelation of hidden liabilities documented in Section 2, so that the hidden debt enters as an initial condition rather than an ongoing state variable. We first describe the economic environment, then formulate the government’s problem, the lenders’ pricing decisions, and the recursive equilibrium, building on the quantitative literature on sovereign default (Arellano, 2008; Bianchi and Sosa-Padilla, 2024).

3.1 Households and Firms

Preferences. The representative agent in the borrowing economy has preferences given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t), \quad (1)$$

where β denotes the subjective discount factor and c_t represents consumption. The utility function is strictly increasing and concave and takes the standard CRRA form $u(c_t) = (c_t^{1-\sigma} - 1)/(1 - \sigma)$ where c_t is a CES composite between tradable and non-tradable consumption goods:

$$c_t = \left[\alpha (c_t^T)^{\frac{\gamma-1}{\gamma}} + (1-\alpha) (c_t^N)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}} \quad (2)$$

We will use $u(c_t^T, c_t^N)$ to denote the utility as a function of the two consumption goods. Each period, households supply inelastically \bar{n} hours to the labor market. However, due to downward nominal wage rigidity, households may not be able to sell all the hours they supply. As a result, total hours worked, $n_t \leq \bar{n}$, is taken as given by households. Households also endowed with a stochastic endowment of the tradable good $y^T \in \mathcal{Y}$, receive a real wage rate w_t in units of tradables and collect profits ϕ_t^N . The households' budget constraint, expressed in terms of tradables, is thus given by

$$c_t^T + p_t^N c_t^N = y_t^T + \phi_t^N + w_t n_t + T_t, \quad (3)$$

where T_t is the lump-sum transfers from the government, and p_t^N denotes the price of non-tradables. Assuming that the law of one price holds and that the price of tradable goods in foreign currency is constant and normalized to one, these prices can also be interpreted in terms of foreign currency.

Production. The non-tradable good is produced by a continuum of firms in a perfectly competitive market. Each firm produces a non-tradable good according to a linear production technology given by $y_t^N = n_t$ and obtains profits $\phi_t^N = p_t^N n_t - w_t n_t$. Given the linear production function, we obtain that in equilibrium, $p_t^N = w_t$.

Monetary union and nominal rigidities. Senegal is a member of WAEMU, whose common currency, the CFA franc, is pegged to the euro at a fixed rate.¹ The union's central bank cannot devalue its currency to reduce the real value of a member country's external obligations. As a result, the nominal exchange rate e , expressed in units of the domestic currency per unit of the foreign currency, is assumed to be fixed.

Following [Schmitt-Grohé and Uribe \(2016\)](#), we also assume that there exists a minimum wage in nominal terms; i.e., $W_t \geq \bar{W}$. Defining $\bar{W} = \frac{\bar{w}}{e}$, we arrive at $w_t \geq \bar{w}$. Thus, if the market-clearing wage exceeds \bar{w} , equilibrium employment equals the aggregate endowment of labor. Otherwise, hours are determined by labor demand, $n_t < \bar{n}$ and $w_t = \bar{w}$. These conditions can be summarized as

$$(w_t - \bar{w})(n_t - \bar{n}) = 0 \quad (4)$$

¹The CFA franc peg is maintained by France's guarantee of convertibility, conditional on member states maintaining adequate reserves and fiscal discipline.

3.2 Government

The government operates under a fixed exchange rate regime, issues long-term bonds, and provides lump-sum transfers to households.

Debt structure. The government issues non-contingent bonds to international lenders. Following [Hatchondo and Martinez \(2009\)](#), each bond issued at date t promises to pay $(1 - \delta)\delta^s$ units of the consumption good at date $t + s + 1$ for $s = 0, 1, 2, \dots$, where $\delta \in [0, 1]$ is the coupon decay parameter. The Macaulay duration of this payment stream is $D = (1 - \delta)^{-1}$. When $\delta = 0$, bonds are one-period; as $\delta \rightarrow 1$, they approach perpetuities. Thanks to the recursive coupon structure, the evolution of the face value of outstanding debt can be represented by the following law of motion:

$$b_{t+1} = \delta b_t + i_t, \quad (5)$$

where i_t denotes new bond issuances in period t and δb_t is the stock of debt that remains outstanding after coupon payments $(1 - \delta)b_t$ are made.

Government budget constraint. The government finances lump-sum transfers to households T_t using revenue from bond issuances. Letting $d_t \in \{0, 1\}$ denote the default decision, with $d_t = 1$ indicating default, the government budget constraint is

$$T_t = \begin{cases} q_t i_t - (1 - \delta) b_t & \text{if } d_t = 0 \quad (\text{repayment}), \\ 0 & \text{if } d_t = 1 \quad (\text{default}), \end{cases} \quad (6)$$

where q_t denotes the price at which the government issues new bonds in period t . Under repayment, the government receives revenue $q_t i_t$ from new issuances and pays the maturing coupon $(1 - \delta)b_t$. Using the law of motion (5) to substitute $i_t = b_{t+1} - \delta b_t$, the budget constraint under repayment can equivalently be written as

$$T_t = q_t [b_{t+1} - \delta b_t] - (1 - \delta) b_t. \quad (7)$$

Upon default, the government repudiates all obligations and cannot issue new debt in the default period, so transfers are zero.

Hidden debt revelation. The economy begins at $t = 0$ immediately following the revelation of hidden liabilities. The logic is that the previous administration accumulated obligations $h \geq 0$ that were excluded from officially reported debt statistics. The initial state is therefore $(b_0 + h, y_0)$, where b_0 is the pre-revelation official debt stock and h is the revealed hidden debt.

3.3 International Lenders

A continuum of competitive, risk-neutral international lenders can borrow and lend at a constant gross risk-free rate $R^f = 1 + r^f$. Each lender is small and takes the bond price schedule as given. Competition drives lenders' expected returns to the risk-free rate, so bond prices reflect the probability-weighted expected payoffs discounted at R^f .

The standard asset pricing condition for bonds requires that the price at which the government issues debt in period t satisfies

$$q_t = \frac{1}{R^f} \mathbb{E}_t \left\{ (1 - \hat{d}_{t+1}) [(1 - \delta) + \delta q_{t+1}] + \hat{d}_{t+1} \kappa_{t+1} [(1 - \delta) + \delta q_{t+1}^0] \right\}, \quad (8)$$

where \hat{d}_{t+1} is the equilibrium default decision in period $t + 1$, and $q_{t+1} = q(b_{t+2}, y_{t+1}^T)$ is the equilibrium bond price in $t + 1$ conditional on repayment, where b_{t+2} denoting the government's borrowing decision at $t + 1$ and with $q_{t+1}^0 = q(0, y_{t+1}^T)$. The first term inside the expectation captures the payoff when the government repays in $t + 1$: the bondholder receives the current coupon $(1 - \delta)$ plus the market value of the remaining bond δq_{t+1} . The second term inside the expectation captures the payoff in default: a fraction κ_{t+1} of the bond value is recovered.

Recovery rates. Following [Cruces and Trebesch \(2013\)](#) and [Benjamin and Wright \(2018\)](#), recovery rates are decreasing in the debt burden and income at the time of default. In period $t + 1$, conditional on default, the recovery rate is given by

$$\kappa_{t+1} = \max \left\{ \kappa_{\min}, \kappa_{\max} - \xi_b \frac{b_{t+1}}{y_{t+1}^T} - \xi_y \max\{y_{t+1}^T - \bar{y}^T, 0\} \right\}. \quad (9)$$

The parameter $\xi_b > 0$ captures the empirical regularity that higher debt burdens lead to larger haircuts, while $\xi_y > 0$ reflects the finding that defaults during good times are associated with larger creditor losses. For the baseline calibration, we use a flat recovery rate $\kappa = 0.50$, broadly consistent with recent restructurings ([von Luckner et al., 2024](#)).² We also report results under the endogenous specification (9) as a robustness check. The sovereign spread is defined as the excess yield on sovereign bonds over the risk-free rate:

$$s_t = \delta + \frac{1 - \delta}{q_t} - R^f. \quad (10)$$

²Ghana's 2024 external bond restructuring involved a 37% nominal haircut, corresponding to a recovery rate $\kappa = 0.63$; Zambia's post-default restructuring delivered materially lower nominal losses than 50%, with estimates varying by instrument and method. The baseline recovery rate of $\kappa = 0.50$ represents the most conservative assumption in our analysis: higher recovery would make lenders more willing to extend credit, thereby lowering the endogenous borrowing limit and reducing the default threshold. Therefore, our results provide a lower bound on Senegal's default probability.

Because international lenders are risk-neutral, variations in spreads are only attributable to default risk and recovery rates.

3.4 Equilibrium

In equilibrium, market-clearing for non-tradable goods requires that output is consumed domestically:

$$c_t^N = y_t^N = n_t. \quad (11)$$

Using the households' optimality condition equating the marginal rate of substitution to the relative price of non-tradables, the firms' optimality condition ($p_t^N = w_t$ under linear technology), the non-tradable goods market clearing condition (11), and the wage rigidity constraint $w_t \leq \bar{w}$, we can derive the demand for non-tradable goods³

$$y_t^N \leq \left(\frac{1 - \alpha}{\alpha \bar{w}} \right)^\gamma c_t^T. \quad (12)$$

which states that employment and thus non-tradable output are increasing functions of tradable consumption when the economy is not at full employment. We can now define a competitive equilibrium for given government policies.

Definition 1 (Competitive equilibrium given policy). *Given initial debt $\{b_0 + h\}$ and set of government policies $\{T_t, b_{t+1}, d_t\}_{t=0}^\infty$, a competitive equilibrium is a sequence of allocations $\{c_t^T, c_t^N, n_t\}_{t=0}^\infty$ and prices $\{p_t^N, w_t, q_t\}_{t=0}^\infty$ such that:*

- (i) $\{c_t^T, c_t^N, n_t\}_{t=0}^\infty$ solve households' and firms' problems at given prices;
- (ii) government policies $\{T_t, b_{t+1}, d_t\}_{t=0}^\infty$ satisfy the government budget constraint (6);
- (iii) the bond pricing equation (8) holds;
- (iv) the market for non-tradable goods clears: $c_t^N = n_t$; and
- (v) the labor market satisfies: $w_t \geq \bar{w}$, $n_t \leq \bar{n}$ and the slackness condition (4).

³When the wage floor binds, non-tradable output is proportional to tradable consumption, and the CES aggregate reduces to a constant multiple of c^T . Under CRRA preferences, this rescaling does not alter the government's policy rankings, so the default and borrowing rules are isomorphic to a one-good model at the calibrated parameters. The nominal rigidity nonetheless affects welfare levels and the mapping from debt to consumption. It disciplines the output cost of default in a monetary union with a closed exchange rate channel: a given fiscal contraction generates larger employment losses than under a flexible rate, amplifying the cost of the austerity path and thus lowering the threshold at which default is preferred.

3.5 Government Problem

In each period, the government chooses between repayment and default. Let $V(\tilde{b}, y^T)$, with $\tilde{b} = b + h$, denote the value function of a government in good credit standing:

$$V(\tilde{b}, y^T) = \max \left\{ V^R(\tilde{b}, y^T), V^D(y^T) \right\}, \quad (13)$$

where $V^R(\tilde{b}, y^T)$ is the continuation value under repayment and $V^D(y^T)$ is the value of default.

Repayment. A government that repays services its maturing coupons $(1 - \delta)\tilde{b}$, chooses end-of-period debt $b' \geq 0$, and the household consumes the residual:

$$V^R(\tilde{b}, y^T) = \max_{b' \geq 0} u \left(c^T(\tilde{b}, b', y^T), y^N \right) + \beta \mathbb{E}_{y^{T'} | y^T} V \left(b', y^{T'} \right) \quad (14)$$

subject to

$$c^T(\tilde{b}, b', y^T) = y^T - (1 - \delta)\tilde{b} + q(b', y^T)[b' - \delta\tilde{b}], \quad (15)$$

$$y^N \leq \left(\frac{1 - \alpha}{\alpha \bar{w}} \right)^\gamma c^T. \quad (16)$$

where $q(b', y^T)$ is the equilibrium bond price schedule and $b' - \delta b$ is net new issuance. The price q depends on the government's future borrowing and default decisions, so the budget set is itself an equilibrium object.

Default. When a government defaults, it repudiates all outstanding obligations and bears two costs. First, it incurs a loss of tradable output which falls to $y^T - \Phi(y^T)$ with

$$\Phi(y^T) = \varphi_0 y^T + \varphi_1 \max\{y^T - \bar{y}^T, 0\}^2. \quad (17)$$

following (Chatterjee and Eyigungor, 2012). When $\varphi_0 > 0$ and $\varphi_1 > 0$, a proportional cost applies at all income levels, and the cost rises more than proportionately with output above the threshold \bar{y}^T , capturing the asymmetry in default punishment first emphasized by Arellano (2008). This asymmetry plays two distinct roles in our quantitative analysis. First, it disciplines the *level* of equilibrium debt and spreads. Because default is severely punished in high-income states, lenders rationally expect the sovereign to repay when output is above trend, which sustains low spreads and encourages aggressive borrowing.⁴ When output falls, the punishment weakens, default

⁴This amplification channel is also present in the WAEMU: regional banks hold a large share of their assets in government securities, so default during a credit boom inflicts disproportionate banking-sector losses. Default at high income also signals deep solvency problems, triggering capital flight and threatening

risk rises, and spreads widen, eventually triggering default if income remains depressed. Second, the curvature parameter φ_1 governs the *volatility* of spreads, a moment that proportional cost specifications cannot match. A higher φ_1 makes the probability of default more sensitive to output fluctuations, generating the large swings in spreads observed in the data.

Second, there is an exclusion from international credit markets. During exclusion household consumes its reduced tradable endowment, $c^T = y^T - \Phi(y^T)$, and each period the government can regain market access with probability $\theta \in (0, 1)$, re-entering with zero debt. The value of default is therefore

$$V^D(y^T) = u(y^T - \Phi(y^T), y^N) + \beta \mathbb{E}_{y^{T'}|y^T} [\theta V(0, y^{T'}) + (1 - \theta) V^D(y^{T'})] \quad (18)$$

subject to

$$y^N \leq \left(\frac{1 - \alpha}{\alpha \bar{w}} \right)^\gamma [y^T - \Phi(y^T)]. \quad (19)$$

The government defaults whenever $V^D(y^T) \geq V^R(\tilde{b}, y^T)$. The *default set* at debt level b collects the endowment realizations for which default is weakly preferred:

$$D(\tilde{b}) = \{y^T \in \mathcal{Y} : V^D(y^T) \geq V^R(\tilde{b}, y^T)\}. \quad (20)$$

4 Quantitative Analysis

In this section, we evaluate the quantitative implications of the model. We first describe the model's calibration, and then assess whether it predicts default as the optimal outcome given the hidden debt revelation.

4.1 Calibration

We calibrate the model to match Senegal's sovereign spread dynamics both before and after the hidden-debt revelation. The model period is one quarter. The process for tradable output is modeled as a stationary first-order autoregressive process. We estimate the parameters (ρ_y, σ_y) from the World Development Indicators. The tradable output is measured as the sum of agriculture, forestry, and fishing, and industry, including construction, over the period 1980–2024. The estimates process is

$$\ln y_{t+1}^T = 0.957 \ln y_t^T + 0.025 \varepsilon_{t+1}, \quad \text{where } \varepsilon_{t+1} \sim \mathcal{N}(0, 1), \quad (21)$$

the currency peg. Further channels include reputational costs and the risk of exclusion from BCEAO liquidity facilities for violating WAEMU fiscal convergence criteria.

Table 1: Calibrated Parameters

Description	Parameter	Value	Source/Target
<i>Preferences</i>			
Risk aversion	σ	2.0	Standard
Discount factor	β	0.96	Standard
CES tradable weight	α	0.26	Share of tradable output
Elasticity of substitution	γ	0.44	Stockman and Tesar (1995)
<i>Debt structure</i>			
Coupon decay	δ	0.30	Calibrated
Risk-free rate	r^f	0.01	U.S. Treasury (quarterly)
<i>Default costs</i>			
Re-entry probability	θ	0.10	Gelos et al. (2011)
Linear output cost	φ_0	0.091	Pre-revelation EMBIG spread
Quadratic output cost	φ_1	2.0	Pre-revelation EMBIG spread
<i>Tradable income process</i>			
Persistence	ρ_y	0.957	Estimated
Innovation std. dev.	σ_y	0.025	Estimated
<i>Recovery</i>			
Flat recovery rate	κ	0.50	Africa benchmark
<i>Initial conditions (Senegal)</i>			
Pre-revelation b/y	b_0	0.75	Official statistics (pre-audit)
Hidden debt	h	0.45	Court of Accounts audit
Corrected b/y (2025)		1.20	Revised statistics

The coupon decay parameter is calibrated along with the output cost so that the model matches the pre-revelation EMBIG spread at the officially reported debt level $b/y = 0.75$ and the variation in EMBIG spreads for Senegal. This calibration yields an output cost $\varphi_0 = 0.091$, and $\delta = 0.3$,⁵ and delivers a model-implied one-period yield⁶ spread at reported debt and median income of about 300 basis points, consistent with the 2021–2022 Senegal EMBIG. We then evaluate what happens at the retroactively corrected debt levels, which incorporate the hidden liabilities that accumulated over this period, and deliver a prediction about when default would have been optimal. The remaining parameters are set as follows. The quadratic output cost is set to $\varphi_1 = 2$,

⁵Relative to standard calibrations in the sovereign default literature, this coupon decay implies a shorter effective duration of debt. Accordingly, we interpret it primarily as a pricing calibration, rather than as a direct empirical measure of Senegal’s actual debt maturity structure.

⁶Because the implied duration is short, we report the one-period yield spread rather than a longer-maturity yield-to-maturity calculation. The latter would produce substantially higher spread levels at the same bond price, as default risk compounds over more periods. We therefore interpret our baseline default threshold as an upper bound: calibrating to the same EMBIG targets under a longer-maturity yield mapping would lower the threshold and strengthen the case for default at the corrected debt levels.

consistent with the amplified costs of default within a monetary union, where banking-sector contagion and the loss of regional central bank facilities compound the direct trade-disruption channels documented in [Borensztein and Panizza \(2009\)](#).

The re-entry probability $\theta = 0.1$ implies an average exclusion duration of 10 quarters, at the upper end of the estimates in [Gelos et al. \(2011\)](#). We set the elasticity of substitution between tradable and non-tradable consumption γ to 0.44, in line with the cross-country estimates of ([Stockman and Tesar, 1995](#)), and the weight on tradable goods in the CES aggregator is set to $\alpha = 0.26$ to match the share of tradable output in the total value of production as observed in Senegal. The minimum wage \bar{w} is normalized to unity. The flat recovery rate $\kappa = 0.50$ is broadly consistent with recent restructurings ([von Luckner et al., 2024](#)). [Table 1](#) reports all parameter values.

4.2 Results

Model predicts default is optimal. The baseline calibration, which matches the pre-revelation EMBIG spread at the reported debt level using the estimated income process, yields a default threshold of $b^* = 1.068$ at the median income. [Figure 3](#) plots the repayment and default value functions. The threshold falls well below the retroactively corrected debt levels that prevailed from 2023 onward, implying that default would have been the optimal policy had the true debt stock been known at the time.

[Table 2](#) traces the model’s implications year by year. At the officially reported debt levels (61 to 75 percent of GDP during 2018–2022), the model generates modest spreads of 44–301 basis points, broadly consistent with the pre-revelation EMBIG. At the retroactively corrected debt levels — incorporating the hidden liabilities that accumulated throughout this period — the model implies distressed spreads and, from 2023 onward, outright default. The corrected debt-to-GDP ratio crossed the default threshold of 107 percent between 2022 and 2023, before the audit was conducted and the IMF program was suspended.

[Figure 4](#) displays the default set in the (b, y^T) plane. The staircase-shaped boundary reflects the countercyclical nature of default: lower income realizations expand the set of debt levels at which default is optimal. At the reported debt of 75 percent of GDP (white dashed line), Senegal lies safely in the repayment region. At the corrected post-revelation debt level of 120 percent (yellow dashed line), Senegal falls deep inside the default region for all income states at or below the median.

The baseline result is stark: the model predicts that a government that knew its true debt stock would have optimally defaulted starting in 2023. This conclusion is robust to the recovery rate assumption: under $\kappa = 0.40$, the default threshold rises modestly to $b^* = 1.124$ as lenders price in larger restructuring losses, but default remains optimal

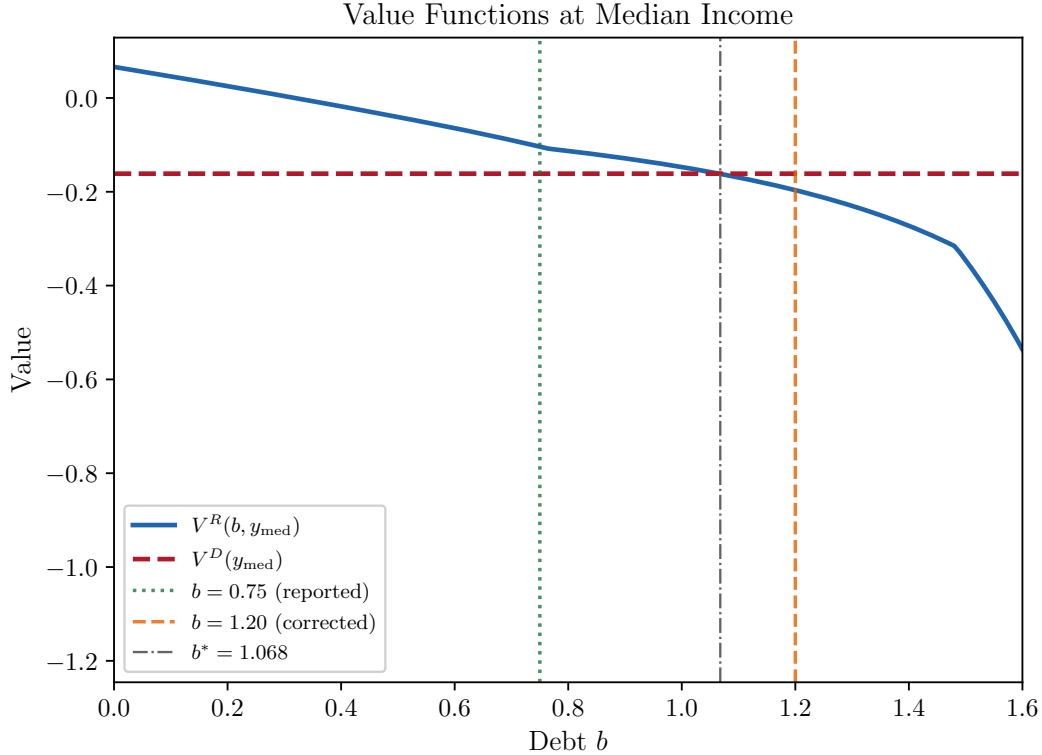


Figure 3: Repayment value $V^R(b, y_{med})$ and default value $V^D(y_{med})$ in the baseline calibration. The default threshold is $b^* = 1.068$. Vertical lines mark officially reported debt ($b/y = 0.75$) and corrected post-revelation debt ($b/y = 1.20$).

at all corrected debt levels from 2023 onward.

Rationalizing non-default. Senegal has not defaulted. Through late 2025 and into 2026, the authorities have continued servicing external obligations and have signaled their intention to avoid restructuring. To study the stability of this outcome, we consider a no-default calibration in which the model rationalizes continued repayment and matches the observed spread dynamics.

The alternative calibration has two key elements. The first is the income-change identification strategy. Because the hidden liabilities predate the audit, using the reported debt level $b/y = 0.75$ has limitations, as Senegal’s EMBIG spread may reflect non-public information about the hidden debt during the 2019-2024 period. Therefore, we evaluate the model’s spread schedule at the true debt stock and use variation in real income across two dates to identify an alternative default region that rationalizes Senegal’s failure to default at the end of 2025/beginning of 2026. We target two EMBIG moments, both evaluated at the 2025 corrected debt-to-GDP ratio of 123 percent, but at different income states: August 2022 (spread ≈ 675 basis points) at income 4.3 percent above the median, and November 2025 (spread $\approx 1,150$ basis points) at median

Table 2: Baseline Model: Reported vs Corrected Debt

Year	Debt/GDP (%)		EMBIG (bp)	Model spread (bp)		Default at corr.
	Reported	Corrected		At reported	At corrected	
2018	61	62	—	44	44	No
2019	64	82	—	45	1,487	No
2020	69	90	—	74	1,780	No
2021	73	99	477	301	1,780	No
2022	75	105	600	301	1,782	No
2023	—	118	561	—	>10,000	Yes
2024	—	128	512	—	>10,000	Yes

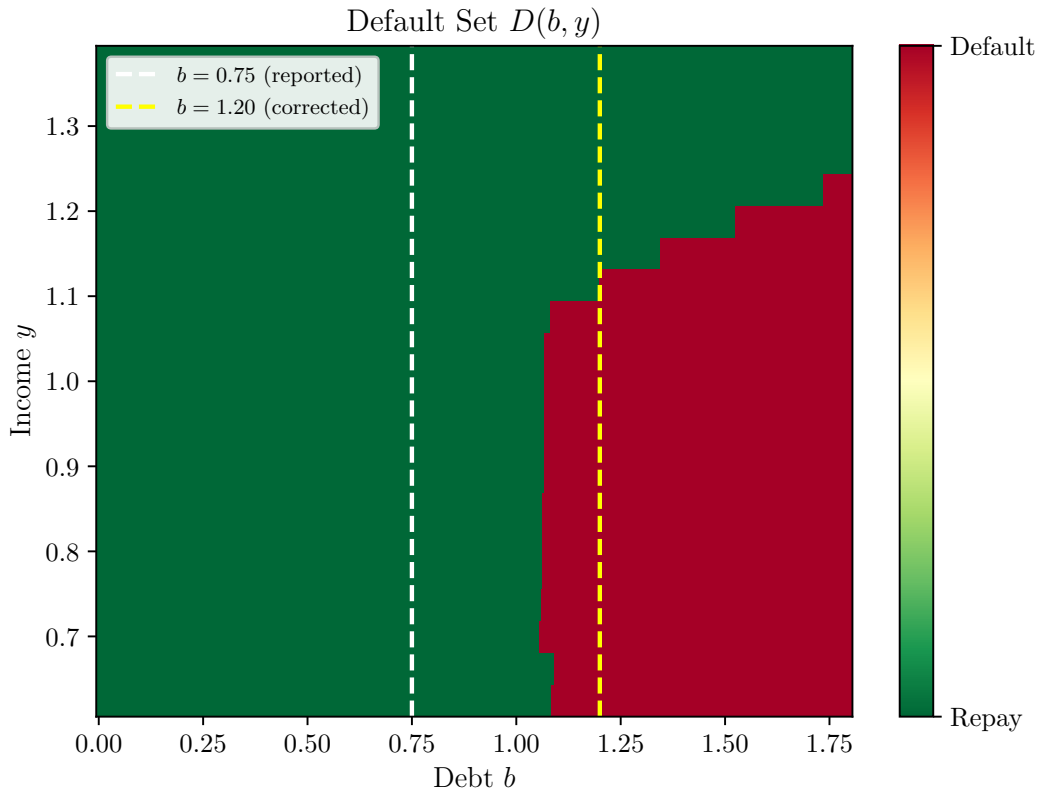


Figure 4: Default set in the baseline calibration. Green: repayment. Red: default. White dashed: reported debt $b/y = 0.75$. Yellow dashed: corrected debt $b/y = 1.20$. The default threshold at median income is $b^* = 1.068$.

income.⁷ The 4.3 percent income decline between the two dates reflects the cumulative

⁷Note that the corrected debt stock in August 2022 was approximately 105 percent of GDP, not the 2025 level of 123 percent that we use as the fixed debt state. We evaluate both moments at 123 percent for two reasons. First, the 2025 corrected stock is the most precisely measured since it is the outcome of the audit process. Second, using 123 percent for both moments is the more conservative assumption for the no-default calibration: it requires the model to rationalize a relatively modest spread of 675 basis points at a high debt

deterioration from below-trend growth, fiscal consolidation, and the contractionary feedback from the revelation.⁸ Both moments are read off the same equilibrium spread schedule, disciplined by the output cost φ_0 and coupon decay δ .

The second element is income optimism. The baseline income process, estimated from WDI data on Senegal's tradable sector, has quarterly persistence $\rho_y = 0.957$ and innovation standard deviation $\sigma_y = 0.025$. Under these parameters, quarterly income transitions are too concentrated to generate the intermediate spread levels (500–1,200 basis points) observed in the EMBIG. Matching the spread dynamics requires an income process with lower effective persistence ($\rho_y = 0.794$) and correspondingly higher innovation volatility ($\sigma_y = 0.083$).

The gap between the estimated income persistence ($\rho_y = 0.957, \sigma_y = 0.025$) and the market-implied persistence in the No-default calibration ($\rho_y = 0.794, \sigma_y = 0.083$) that rationalizes non-default admits two complementary interpretations. The first is that the market prices additional sources of risk (higher variance) that the production-side AR(1) does not capture: terms-of-trade volatility for a commodity-dependent economy, fiscal uncertainty following the revelation, and the possibility of further undisclosed liabilities. The second, on the lower persistence, is that the government behaves as if negative income shocks are more transitory than the historical data suggests. That is, it is more optimistic about mean reversion than the econometric estimate warrants. This optimism may reflect genuine expectations about structural improvements, new oil and gas revenues, governance reforms under the incoming administration, alternative sources of financing, or anticipated concessional support from bilateral and multilateral creditors. It may also reflect a form of "gambling for redemption" in which the government delays restructuring in the hope that favorable shocks will restore debt sustainability without the costs of default. Under either interpretation, the lower effective persistence makes the government more willing to endure the short-term pain of debt service at elevated spreads, because it assigns a higher probability to states in which income recovers, and the debt burden becomes manageable.

The No-default calibration yields a default threshold of $b^* = 1.24$ at the median income, placing Senegal's post-revelation debt of 123 percent within the repayment zone but close to the boundary.

The calibrated model produces spreads of 645 basis points at above-median income and 1,240 basis points at median income, both at $b/y = 1.23$. The first moment is close

level, which pushes against finding fragility rather than toward it.

⁸The 4.3 percent income difference corresponds to the cumulative shortfall of Senegal's GDP relative to its pre-COVID trend growth of approximately 6.52 percent per year (2014–2018 average). GDP growth averaged 3.9 percent in 2022, 4.3 percent in 2023, and 6.1 percent in 2024, and accumulates to below 5.3% income growth through 2024. The National Statistical Agency of Senegal has not yet officially published a definitive estimate of Senegal's 2025 growth rate. Growth projections for 2025 were above trend. Therefore, we select a cumulative slow growth in the 2022-2025 period of $\approx 4.3\%$ below trend income.

to the August 2022 target of approximately 675 basis points; the second overshoots the November 2025 target of approximately 1,150 basis points by about 90 basis points, reflecting the difficulty of matching both points on the spread schedule. The spread at $b/y = 1.23$ is highly sensitive to income: it ranges from 645 basis points at $y = 1.043$ (above median) to 2,211 basis points at $y = 0.957$ (below median), with the entire post-revelation EMBIG evolution explained by movement along this single curve as macroeconomic conditions deteriorated.

Table 3 reports the implications of adverse income shocks starting from Senegal’s recent state (November 2025, $b/y = 1.23$, median income). At the median income, Senegal’s quarterly probability of default is 21.1%. Each percentage point of tradable GDP loss adds approximately 225 basis points to sovereign spreads and raises the quarterly default probability by approximately 3.25 percentage points. A 20 percent increase in oil prices—costing approximately 4 percent of GDP given Senegal’s energy import dependence and subsidy commitments—would raise spreads from 1,240 to approximately 2,139 basis points and increase the default probability from 21.1 to 34.2 percent.⁹

As a robustness check, we lower the recovery rate to $\kappa = 0.40$ and recalibrate the no-default model to the same two EMBIG moments. The default threshold is unchanged at $b^* = 1.24$,¹⁰ but spreads at $b/y = 1.23$ increase. The higher spreads reflect the greater losses creditors would incur in a restructuring, thereby tightening borrowing conditions even when the default decision itself remains unchanged.

Table 3: Income Shock Scenarios (No-Default Calibration, Nov 2025, $b/y = 1.23$)

Scenario	Income y	Spread (bp)	Δ Spread (bp)	Default prob. (%)
Current (Nov 2025)	1.000	1,240	—	21.1
−3% tradable GDP	0.970	1,914	+674	30.9
−4% (oil shock, +20%)	0.960	2,139	+899	34.2
−5% tradable GDP	0.950	2,426	+1,186	37.8
−8% (severe recession)	0.920	3,376	+2,136	49.3

The two calibrations bracket Senegal’s situation. The baseline, anchored to the

⁹A 20 percent increase in oil prices raises Senegal’s fuel import bill by approximately 3 percent of GDP (fuel imports averaged 14–17 percent of GDP during 2022–2024, according to the World Development Indicators series. Including the efficient cost of energy subsidies, the total impact on the government’s effective income is approximately 3–4 percent of GDP.

¹⁰In general equilibrium, a lower recovery rate reduces bond prices and tightens borrowing conditions, which lowers the value of repayment and would ordinarily shift the default threshold downward. In our recalibration, however, the output cost φ_0 adjusts upward to 0.093 to re-match the target spread moments, partially offsetting the tightening effect on repayment values; the net result is that the default threshold remains at $b^* = 1.24$.

estimated income process, predicts that default would have been optimal from 2023. The no-default calibration, which rationalizes continued repayment through market-implied income dynamics, places Senegal within the repayment zone but near the boundary. Under either interpretation, the revelation of hidden debt moved Senegal from a position of moderate fiscal risk to a zone of acute vulnerability, where an adverse income shock of 3 percent or more would make restructuring the optimal policy.

4.3 Discussion

The tension between the two calibrations is informative. The baseline, disciplined by the pre-revelation EMBIG and the estimated income process, finds that default is optimal at the corrected debt levels. The no-default calibration, which matches the post-revelation spread dynamics, requires market-implied income dynamics that are more volatile and less persistent than those suggested by historical production data. Our takeaway from the two calibrations is that either default was optimal upon the revelation of Senegal’s hidden liabilities, or the country is in a fragile equilibrium that any moderate adverse shock could tip over.

Several forces outside the model may explain why Senegal has not defaulted despite the baseline prediction. One such force is potential official or quasi-official support. If market participants expect bilateral financing, IMF re-engagement, or regional support mechanisms to lower rollover risk, the sovereign may optimally continue repaying even at debt levels that would otherwise trigger restructuring. Our reduced-form no-default calibration can therefore be interpreted as summarizing the size of the support wedge needed to reconcile the observed spreads with continued repayment.

A second interpretation is political and institutional. A new administration that came to power on a platform of fiscal rectitude may attach unusually high political costs to an immediate restructuring, especially when the hidden liabilities are associated with its predecessor. Likewise, within WAEMU, maintaining market access may have value beyond the level captured by standard output costs because a default can spill over to banks, regional liquidity conditions, and the perceived durability of the peg.

We acknowledge that modeling hidden debt as an initial condition is a deliberate simplification that abstracts from the dynamics of accumulation and discovery. The paper’s primary contribution is to characterize the optimal policy response conditional on revelation having occurred, rather than to explain why or when revelation happens. The baseline finding that default would have been optimal from 2023 — before the 2024 audit — is a statement about the corrected debt stock, not a claim that revelation itself triggers default: it establishes that the hidden liabilities, had they been publicly known, would have placed Senegal in the default region throughout this period. Endogenizing the revelation through a monitoring game, as in [Cole and Kehoe \(2000\)](#), is a natural

extension but is not necessary for studying the optimal policy response conditional on the revelation having occurred.

5 Conclusion

This paper studies optimal sovereign default following the revelation of hidden public liabilities, using Senegal’s 2024 debt shock as a laboratory. Our baseline calibration, disciplined by pre-revelation spreads, implies that default would have been optimal from 2023—a year before the audit was conducted. A no-default calibration that rationalizes continued repayment requires income dynamics more volatile and less persistent than historical estimates, consistent with optimism about resource revenues or gambling for redemption, and places Senegal near the default boundary: an adverse income shock of 3 percent would bring the expected time to default below one year. The gap between the two calibrations measures the size of the wedge—official support, political costs of restructuring, regional spillover concerns—needed to sustain repayment at the corrected debt levels. Narrowing that gap through improved fiscal disclosure is a precondition for preserving the policy space that sovereigns need to avoid unnecessary crises.

References

- Arellano, Cristina**, “Default Risk and Income Fluctuations in Emerging Economies,” *American Economic Review*, 2008, 98 (3), 690–712. [2](#), [3](#), [7](#), [12](#)
- , **Yan Bai**, and **Gabriel Mihalache**, “Monetary policy and sovereign risk in emerging economies (nk-default),” *The Quarterly Journal of Economics*, 2026, p. qjag012. [5](#)
- Benjamin, David and Mark L. J. Wright**, “Recovery Before Redemption: A Theory of Delays in Sovereign Debt Renegotiations,” *Journal of International Economics*, 2018, 111, 41–59. [10](#)
- Bianchi, Javier and César Sosa-Padilla**, “Reserve accumulation, macroeconomic stabilization, and sovereign risk,” *Review of Economic Studies*, 2024, 91 (4), 2053–2103. [3](#), [7](#)
- Borensztein, Eduardo and Ugo Panizza**, “The Costs of Sovereign Default,” *IMF Staff Papers*, 2009, 56 (4), 683–741. [15](#)
- Chatterjee, Satyajit and Burcu Eyigungor**, “Maturity, Indebtedness, and Default Risk,” *American Economic Review*, 2012, 102 (6), 2674–2699. [3](#), [12](#)

- Cole, Harold L and Timothy J Kehoe**, “Self-Fulfilling Debt Crises,” *The Review of Economic Studies*, 2000, 67 (1), 91–116. [20](#)
- Conesa, Juan Carlos and Timothy J Kehoe**, “Gambling for redemption and self-fulfilling debt crises,” *Economic Theory*, 2017, 64 (4), 707–740. [3](#)
- Cruces, Juan J and Christoph Trebesch**, “Sovereign Defaults: The Price of Haircuts,” *American Economic Journal: Macroeconomics*, 2013, 5 (3), 85–117. [10](#)
- Eaton, Jonathan and Mark Gersovitz**, “Debt with Potential Repudiation: Theoretical and Empirical Analysis,” *The Review of Economic Studies*, 1981, 48 (2), 289–309. [2](#)
- Gelos, R. Gaston, Ratna Sahay, and Guido Sandleris**, “Sovereign Borrowing by Developing Countries: What Determines Market Access?,” *Journal of International Economics*, 2011, 83 (2), 243–254. [14](#), [15](#)
- Hatchondo, Juan Carlos and Leonardo Martinez**, “Long-Duration Bonds and Sovereign Defaults,” *Journal of International Economics*, 2009, 79 (1), 117–125. [9](#)
- Horn, Sebastian, David Mihalyi, Philipp Nickol, and César Sosa-Padilla**, “Hidden debt revelations,” Technical Report, National Bureau of Economic Research 2024. [2](#), [3](#), [4](#)
- Ndiaye, Abdoulaye and Martin Kessler**, “A Strategic Compass for Navigating Senegal’s Debt Crisis,” *CEsifo Working Paper*, 2026. [5](#)
- Reinhart, Carmen M and Kenneth S Rogoff**, *This Time is Different: Eight Centuries of Financial Folly*, Princeton University Press, 2009. [4](#)
- Schmitt-Grohé, Stephanie and Martin Uribe**, “Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment,” *Journal of Political Economy*, 2016, 124 (5), 1466–1514. [8](#)
- Stockman, Alan and Linda Tesar**, “Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements,” *American Economic Review*, 1995, 85, 168–185. [14](#), [15](#)
- von Luckner, Clemens M Graf, Josefin Meyer, Carmen M Reinhart, and Christoph Trebesch**, “Sovereign haircuts: 200 years of creditor losses,” Technical Report, National Bureau of Economic Research 2024. [10](#), [15](#)