Sovereign Risk Weights, Bank Capital Floors, and Monetary Transmission

Abstract

We study how sovereign risk weights shape monetary-policy transmission to bank credit in an emerging-market small open economy. In a New Keynesian DSGE model calibrated to Brazil, a representative bank holds long-duration government bonds and floating-rate debt indexed to the Selic rate while facing a regulatory capital floor. A monetary tightening lowers long-bond prices, generating mark-to-market losses that erode bank capital. With low sovereign risk weights, these losses reduce capital without commensurately reducing risk-weighted assets; once the floor binds, the bank contracts private credit.

The central result is an activation frontier in sovereign exposure and the effective capital buffer. On its slack side, tightening has muted balance-sheet effects; on its constrained side, credit contracts sharply, by an order of magnitude more under zero than under full sovereign risk weights. Using supervisory data, a direct-securities upper bound places Brazil near the threshold, while a repo-inclusive proxy lies inside the constrained region. Selic-indexed debt attenuates the channel by reducing duration exposure. For the same cumulative disinflation, front-loaded tightening generates larger losses than gradual tightening, especially when bank portfolios are tilted toward long-duration debt.

In a two-constraint extension, bank-capital stress makes the borrower collateral constraint more likely to bind and more persistent. Deleveraging, however, reduces risk-weighted assets and partially relaxes the bank floor. The constraints are complementary in the incidence and persistence of borrower collateral stress, but their interaction attenuates peak credit and output losses. The mechanism requires neither sovereign default nor risk mispricing; the sovereign risk weight remains the key policy margin.

Keywords: sovereign debt; monetary transmission; duration risk; bank capital; risk-weighted assets; occasionally binding constraints; emerging markets.

JEL classification: E44, E52, E58, F41, G21, H63.

1 Introduction

Banks in many economies hold a large and growing share of their assets in domestic government debt. In emerging markets this home bias is especially pronounced: domestic sovereign exposures often exceed one fifth of banking-system assets and a large multiple of regulatory capital (International Monetary Fund, 2025b; World Bank, 2024; Wezel et al., 2026). This concentration ties the solvency of the banking system to the value of government debt, a link commonly described as the sovereign–bank nexus. The nexus is usually analyzed through the lens of default risk: when sovereign creditworthiness deteriorates, banks that hold government bonds suffer losses that impair their capacity to lend (Bocola, 2016). Yet much of the valuation risk embedded in bank sovereign portfolios has nothing to do with default. It is interest-rate risk: long-maturity bonds lose market value when the policy rate rises, even when the probability of default is unchanged. The events of 2022–2023 in advanced economies were a reminder that duration losses on safe government securities, not credit events, can be the proximate driver of banking-sector stress.

Brazil provides a sharp empirical motivation for this question. During the 2021–2022 monetary-tightening cycle, the target for the Selic rate (the Central Bank of Brazil's policy rate) rose cumulatively by 1,175 basis points, from 2.00 to 13.75 percent; the peak was then maintained until August 2023 (Banco Central do Brasil, 2026c). At the same time, Brazilian banks carried securities portfolios that were large relative to both their balance sheets and their loss-absorbing capital. In the March 2026 IF.data cross section of 129 banking institutions, securities held in the proprietary portfolio accounted for 23.3 percent of total assets and 273 percent of regulatory reference capital (*Patrimônio de Referência*, PR) (Banco Central do Brasil, 2026a). Even relatively modest mark-to-market losses on the duration-bearing portion of these portfolios can therefore be economically large relative to bank capital.

On the asset basis relevant for our model (credit plus securities), the direct TVM measure corresponds to an exposure share of 35.1 percent, while a broader proxy that includes repo-related positions raises effective exposure to about 45 percent. The direct TVM measure is an upper bound on pure sovereign exposure, because it also contains private securities, whereas the repo-inclusive measure captures positions largely collateralized by federal government debt. These benchmarks place the Brazilian banking system around the region in which the model's capital constraint changes regime (Figure 1). The empirical question is therefore not simply whether monetary tightening produces valuation losses, but when those losses become large enough, relative to sovereign exposure and the effective capital buffer, to force an adjustment in private credit.

This paper asks whether the regulatory treatment of sovereign exposures—specifically the low or zero risk weights that prudential frameworks commonly assign to domestic

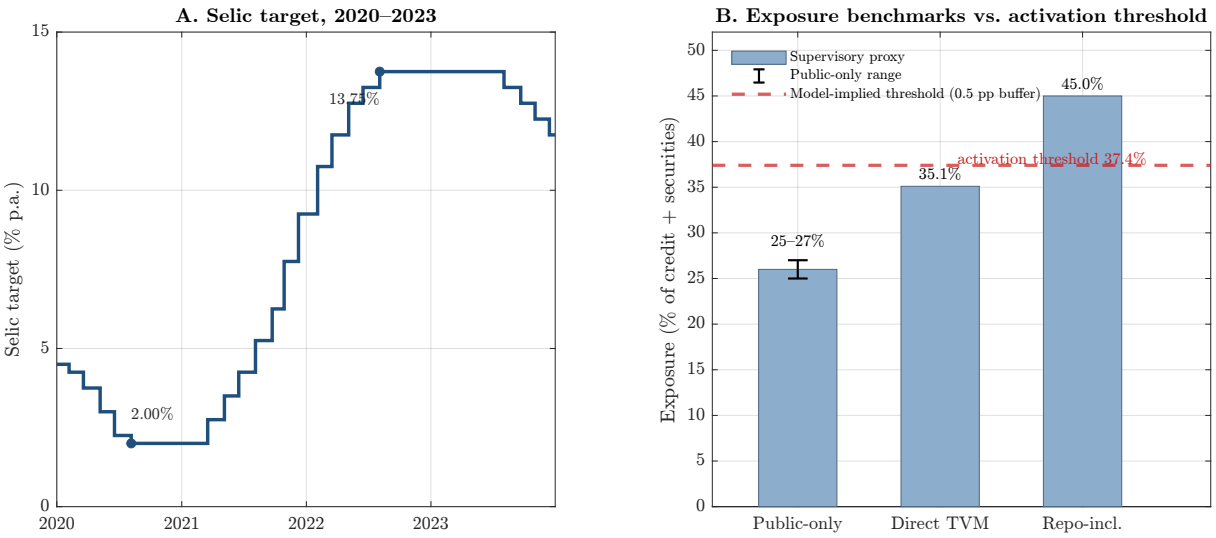


Figure 1: Brazilian monetary tightening and proximity to the activation frontier. Panel A plots the Selic target from January 2020 to December 2023 using Banco Central do Brasil SGS series 432. Panel B compares supervisory exposure proxies with the model-implied activation threshold associated with a 0.5 percentage-point effective capital buffer. Direct TVM and repo-inclusive exposures are upper-bound proxies, while the public-only estimate is reported as a 25–27 percent range. The activation threshold is generated by the model, not observed in supervisory data.

government debt—makes the banking system safer, or whether it can instead create a hidden fragility that conventional monetary policy activates. The question matters because the regulatory privilege of sovereign debt is widespread and consequential, and because rising public debt and the normalization of policy rates have placed both duration exposure and bank balance sheets under simultaneous pressure (OECD, 2026).

The mechanism we study is the following. A monetary tightening lowers the price of the long-duration sovereign bonds held by banks. The resulting mark-to-market losses erode bank capital K^b. If sovereign debt carries a low regulatory risk weight, these losses reduce the numerator of the capital ratio without commensurately reducing the risk-weighted denominator RWA. The capital ratio $capratio_t = K_t^b/\text{RWA}_t$ therefore falls toward its regulatory floor ν_{min}. When the floor binds, the bank must shed risk-weighted assets; if sovereign debt is zero-weighted, the asset that adjusts is private credit b^I. A contraction of private lending thus emerges as the direct consequence of the interaction between sovereign valuation losses, privileged regulatory treatment, and a hard capital floor:

$$\text{Selic rate} \uparrow \Rightarrow\ p^B \downarrow \Rightarrow\ K^b \downarrow \Rightarrow\ capratio_t \to \nu_{min}\ \Rightarrow\ \text{floor binds}\ \Rightarrow\ b^I \downarrow .$$

Three features distinguish this mechanism from the existing literature. First, its trigger is monetary policy acting through bond duration, not a sovereign-default shock or a disaster that destroys physical capital. Second, the relevant nonlinearity is a hard, occasionally binding capital floor: the credit contraction is a regime switch, not a smooth marginal

response, and we solve for it with the OccBin method of Guerrieri and Iacoviello (2015). Third, the mechanism requires no mispricing or behavioral distortion. The valuation losses are mechanical, sovereign debt is correctly priced, and private agents understand the regulatory environment perfectly. The fragility instead arises from the interaction between bond duration and the regulatory capital floor.

The paper makes three main contributions organized around the activation frontier, and a fourth result from a two-constraint extension.

1. An activation frontier. Our central result is that the regulatory-duration channel is threshold-like rather than always-on. Whether a monetary tightening is a muted balance-sheet event or a credit crunch depends jointly on the bank's sovereign exposure and its effective capital buffer: the floor binds only when duration losses are large enough, relative to the buffer, to exhaust regulatory capital. We trace the resulting activation frontier and show that it is steeply upward-sloping in the (exposure, buffer) plane: raising the effective buffer shifts the exposure threshold sharply to the right. Under the model-consistent exposure concept, the upper-bound direct-securities benchmark places Brazil near this frontier, while the repo-inclusive proxy lies inside the constrained region. Modest changes in exposure, debt duration, or the effective buffer can therefore move the banking system between the two regimes.

2. A regulatory discontinuity. We identify a discontinuity governed by the sovereign risk weight ω, the share of sovereign exposure that enters risk-weighted assets. When $\omega = 1$, a fall in the bond price reduces both bank capital and the risk-weighted denominator, and the capital ratio is largely insulated; when $\omega = 0$, the loss reduces capital but not RWA, and the floor binds. For the same monetary tightening in the constrained region of the frontier, the resulting credit contraction is an order of magnitude larger under $\omega = 0$ than under $\omega = 1$. The regulatory privilege of sovereign debt is precisely what transmits the duration loss into a credit crunch.

3. Debt composition and monetary-policy timing move the economy relative to the frontier. The most Brazil-specific feature of the environment—the large share of short-rate-indexed (Selic) debt—does not drive the result. On the contrary, a bank whose sovereign portfolio is more heavily weighted toward Selic-indexed debt experiences a smaller credit contraction. This separates two channels: a duration channel, operating through long nominal bonds, which generates the capital loss; and a floating-rate channel, operating through Selic-indexed debt, which cushions it. For the same cumulative disinflation, a front-loaded tightening generates larger duration losses and a more severe credit contraction than a gradual one. The front-loaded penalty is largest when the bank's sovereign portfolio is most exposed to duration and declines as the portfolio shifts toward floating-rate debt. Portfolio composition

and the temporal profile of monetary policy therefore move the economy toward or away from the constrained region.

4. Two occasionally binding credit constraints interact asymmetrically. We add a borrower collateral constraint and solve the model with both the bank capital floor and the collateral constraint occasionally binding. In the simulations, the presence of the bank capital floor makes the borrower collateral constraint more likely to bind and lengthens its binding spell. In the opposite direction, collateral-driven borrower deleveraging lowers the bank's risk-weighted private assets and partially restores its capital ratio. Because the same loan is the borrower's liability and the bank's risk-weighted asset, the two constraints are complementary in generating and prolonging borrower collateral stress, but their interaction is less than additive in peak credit and aggregate output losses. Adding a second financial friction therefore need not produce mechanically superadditive amplification when both constraints operate through the same balance-sheet position.

The high-exposure calibration used in some experiments below is a laboratory case that illustrates the constrained region in its strongest form; the direct-securities exposure calibration remains the empirical baseline. Brazil's most idiosyncratic feature—the importance of Selic-indexed debt—turns out, by our composition result, to attenuate rather than amplify the mechanism. As a policy corollary, we compare a credit-only, sovereign-blind institutional reference with two counterfactual informational extensions: one based on aggregate public debt and another based on the bank's sovereign-duration exposure. The grid shows that adding sovereign information to the smooth capital target has limited quantitative effects, and the two sovereign-informed rules are nearly equivalent in welfare, with consumption-equivalent differences below one basis point. The sovereign risk weight ω therefore remains the quantitatively relevant policy margin.

The paper is most closely related to Fueki et al. (2024), who study zero sovereign risk weights in a quantitative real business cycle model with imperfect information and fiscal stress. In their framework, banks underestimate disaster and sovereign-default risk, and the zero risk weight exacerbates the resulting misallocation between sovereign debt and private capital, with large welfare costs. We share their conclusion that zero risk weights can be fragile, but the mechanisms differ. Their distortion operates through mispricing—banks misperceive a disaster state that destroys physical capital—whereas ours is mechanical and requires no mispricing. Their trigger is a disaster shock; ours is a conventional monetary tightening transmitted through bond duration. Their environment is a closed, advanced economy; ours is an emerging-market small open economy in which the composition of local-currency sovereign debt yields a distinct result. Fueki et al. (2024) identify nominal rigidities, a central bank, and Taylor-type policy rules as natural extensions of their framework; our contribution places that monetary-policy dimension at

the center of the nexus, where it acts as the trigger of the regulatory-duration channel rather than as an add-on.

Our analysis also speaks to the theoretical literature on the sovereign–bank nexus and the sovereign–bank doom loop (Acharya et al., 2014; Gennaioli et al., 2014; Brunnermeier et al., 2016; Farhi and Tirole, 2018). In that literature, amplification typically operates through sovereign default risk, bailout expectations, or the joint fragility of sovereign and financial balance sheets. Our channel is different: the sovereign need not default or become riskier. A conventional monetary tightening generates duration losses on bank-held domestic public debt, and the regulatory treatment of that debt determines whether those losses translate into a hard capital-floor adjustment.

A second strand formulates regulatory constraints on bank holdings of long-term government debt within monetary DSGE models. The closest is the analysis of credit regulation and (un)conventional monetary policy in Kumar et al. (2025), where a binding constraint on long-term sovereign holdings limits the substitutability between government and private bonds; that mechanism, however, runs through a leverage/agency constraint in the tradition of Gertler and Karadi (2011) and centers on quantitative easing, not on a hard risk-weighted capital floor or the ω discontinuity we study. Recent central-bank work embeds occasionally binding capital requirements in a monetary model with non-bank intermediation (Gloria and Punzo, 2025), while addressing a different question. Relative to the canonical account of how sovereign risk impairs credit supply through bank balance sheets (Bocola, 2016), our shock is monetary and our nonlinearity regulatory rather than a default-risk premium. Our banking block builds on the DSGE banking framework of Gerali et al. (2010) and on macroprudential-capital models such as Clerc et al. (2015), but is simplified to isolate the capital-floor channel.

The two-constraint extension connects the paper to the housing-collateral mechanism of Iacoviello (2005). Our contribution is not to introduce a standard collateral accelerator in isolation, but to characterize its interaction with a bank capital floor when the same loan is simultaneously the borrower's liability and the bank's risk-weighted asset. Because the same loan is the borrower's liability and a risk-weighted asset on the bank's balance sheet, borrower deleveraging weakens household demand but also reduces risk-weighted assets and eases the bank's capital constraint.

On the empirical side, a literature documents that sovereign exposures transmit to bank lending: Bottero et al. (2020) show that sovereign-debt losses contracted credit supply and real activity in Italy, and Altavilla et al. (2017) document how bank sovereign exposures propagate sovereign stress. These findings motivate the channel we formalize. The broader policy backdrop—the post-pandemic strengthening of the sovereign–bank nexus in EMDEs (Wezel et al., 2026), rising emerging-market sovereign exposures of banks (International Monetary Fund, 2025b; World Bank, 2024), and a rebalancing of issuance toward shorter maturities that trades duration risk for rollover risk (OECD, 2026)—is the

tension our composition result speaks to.

The rest of the paper proceeds as follows. Section 2 introduces the model, the regulatory-duration mechanism, and the borrower-collateral extension. Section 3 describes the Brazilian calibration and supervisory exposure benchmarks. Section 4 presents the transmission exercises, the activation frontier, and the interaction between the two occasionally binding constraints. Section 5 summarizes the quantitative findings, and Section 6 develops their economic implications. Section 7 concludes. Appendix A reports the welfare comparison between the debt-aware and exposure-aware macroprudential rules, while Appendix B presents the physical-capital robustness analysis.

2 Model

2.1 Model structure

We build a small open-economy DSGE model calibrated to Brazil. The model combines heterogeneous households, nominal rigidities, two domestic public-debt instruments, and a representative bank subject to a regulatory capital floor.

All real quantities are expressed in units of the consumer price index. Public liabilities are denominated in domestic currency, so their real returns depend on realized inflation. This choice isolates a domestic-currency sovereign–bank channel: the relevant balance-sheet loss comes from the price of long-duration public debt, not from exchange-rate valuation effects on foreign-currency liabilities.

The economy is solved in levels around an analytical steady state. The benchmark's only occasionally binding constraint is the bank capital floor,

$$capratio_t \geq \nu_{min}, \qquad capratio_t = \frac{K_t^b}{\mathrm{RWA}_t},$$

which is solved with OccBin (Guerrieri and Iacoviello, 2015). When sovereign valuation losses are large enough to make the floor bind, private credit absorbs the regulatory adjustment in the zero-sovereign-risk-weight case that is central to our analysis. Section 2.3 then introduces an occasionally binding borrower-collateral constraint and defines the joint-constraint economy.

The banking block is deliberately parsimonious. We interpret private credit b^I as a broad risk-weighted private exposure rather than as a fully specified retail-loan contract. This keeps the identification sharp: the credit contraction comes from the interaction between sovereign valuation losses, risk-weighted assets, and the hard capital floor. The model abstracts from physical capital accumulation, so the credit contraction does not propagate mechanically to investment and capital. A richer banking or investment block can alter the real-side propagation and the location of the activation margin, but it is not

required to identify the regulatory-duration channel studied here.

2.2 Households

There are two types of households, a patient household P and an impatient household I. Both consume, supply labor, and demand housing. The central difference is the discount factor,

$$\beta_P > \beta_I.$$

The patient household saves and holds deposits, long-term government bonds, and a foreign asset. The impatient household borrows from the bank.[1]

The utility of household $j \in \{P, I\}$ is

$$U_0^j = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_j^t \left[\frac{(c_t^j)^{1-\sigma}}{1-\sigma} - \chi_l^j \frac{(l_t^j)^{1+\varphi}}{1+\varphi} + \chi_h^j s h_t^H \log h_t^j \right].$$

The marginal utility of consumption is $\lambda_t^j = (c_t^j)^{-\sigma}$, and labor supply satisfies

$$\chi_l^j (l_t^j)^{\varphi} = \lambda_t^j w_t.$$

The housing first-order condition is

$$\lambda_t^j q_t = \chi_h^j \frac{s h_t^H}{h_t^j} + \beta_j \mathbb{E}_t \lambda_{t+1}^j q_{t+1},$$

and the total supply of housing is fixed,

$$h_t^P + h_t^I = H.$$

Housing is a fixed-supply real asset in household preferences. In the benchmark, a standard loan-to-value relation is used only to pin down the steady-state scale of impatient-household borrowing. It is not imposed as a dynamic borrowing constraint: away from steady state, the borrower's debt margin is governed by the impatience wedge and the smooth borrowing adjustment cost. This preserves a clean identification of the regulatory-duration channel. Section 2.3 relaxes that assumption and introduces a dynamic borrower-collateral constraint without changing the benchmark steady state.

[1] We do not model the full menu of Treasury instruments available to households. This is a segmented balance-sheet representation: the long bond prices duration risk, while the Selic-indexed public instrument is placed on the bank balance sheet, where its composition matters for the regulatory-capital channel. In Brazil, direct retail holdings of public debt are small relative to the institutional holdings relevant for the sovereign–bank nexus; the direct retail Treasury menu is therefore not the balance-sheet margin disciplined by bank capital regulation.

2.2.1 Patient household

The patient household chooses deposits D_t, long-term government bonds B_t^P, and a foreign asset BF_t. The Euler equation for deposits is

$$\lambda_t^P = \beta_P \mathbb{E}_t \lambda_{t+1}^P \frac{R_t^D}{\pi_{t+1}}.$$

The long government bond is a nominal perpetuity with a decaying coupon. Its price is p_t^B, and its nominal payoff in the following period is

$$1 + \rho_B p_{t+1}^B.$$

The portfolio condition for the patient household is

$$\lambda_t^P p_t^B \left[1 + \kappa_{BP}(B_t^P - \bar{B}^P)\right] = \beta_P \mathbb{E}_t \lambda_{t+1}^P \frac{1 + \rho_B p_{t+1}^B}{\pi_{t+1}}.$$

The foreign asset is converted into domestic real units by the real exchange rate Q_t. The uncovered interest parity condition, with an elastic external premium, is

$$\lambda_t^P Q_t (1 + \chi_\phi BF_t) = \beta_P \mathbb{E}_t \lambda_{t+1}^P R^F Q_{t+1} \exp(\varepsilon_t^{prem}).$$

The term χ_ϕ stationarizes the net foreign asset position; without it, the net foreign asset position would contain a unit root.

2.2.2 Impatient household

The impatient household borrows b_t^I. Its debt condition is

$$\lambda_t^I \left[1 - \tau_b - \phi_{BI}(b_t^I - \bar{b}^I)\right] = \beta_I \mathbb{E}_t \lambda_{t+1}^I \frac{R_t^L}{\pi_{t+1}}.$$

The impatient household's borrowing is disciplined by an impatience wedge τ_b and a smooth adjustment cost ϕ_{BI}. This keeps the bank capital floor as the only hard constraint in the benchmark, so the main occasionally binding credit contraction is attributed to regulatory capital rather than borrower collateral. The next subsection defines the two-constraint extension used to study how borrower and bank balance-sheet regimes interact.

2.3 Borrower collateral and the two-constraint extension

The benchmark deliberately leaves impatient-household borrowing subject to a smooth adjustment cost so that any occasionally binding contraction in private credit originates from the bank capital floor. We now consider a two-constraint extension with a housing-

collateral mechanism in the spirit of Iacoviello (2005). The extension serves two purposes. First, it tests whether the benchmark's moderate aggregate effects reflect the absence of a borrower-collateral accelerator. Second, it studies how the two constraints interact when the same private loan is simultaneously the borrower's liability and the bank's risk-weighted asset. All other blocks—including the public-debt structure, bank sovereign portfolio, definition of risk-weighted assets, and monetary policy rule—remain unchanged.

The impatient household is subject to the nominal collateral constraint

$$R_t^L P_t b_t^I \leq m_t h_t^I \mathbb{E}_t \left(P_{t+1} q_{t+1} \right),$$

where m_t is the maximum loan-to-value parameter. Dividing by the current consumer price level gives

$$R_t^L b_t^I \leq m_t h_t^I \mathbb{E}_t \left(\pi_{t+1} q_{t+1} \right).$$

The left-hand side is nominally contracted debt service in current real units. The right-hand side is the expected nominal value of next-period housing collateral, also in current real units. The timing is therefore consistent with the benchmark household budget constraint, in which debt issued at t is repaid at $t+1$ at the gross lending rate R_t^L.

Let μ_t^h denote the multiplier on the borrower constraint. The debt Euler equation becomes

$$\lambda_t^I \left[1 - \tau_b - \phi_{BI}(b_t^I - \bar{b}^I) \right] = \beta_I \mathbb{E}_t \left[\lambda_{t+1}^I \frac{R_t^L}{\pi_{t+1}} \right] + \mu_t^h R_t^L,$$

and the impatient household's housing condition becomes

$$\lambda_t^I q_t = \chi_h^I \frac{s h_t^H}{h_t^I} + \beta_I \mathbb{E}_t \left(\lambda_{t+1}^I q_{t+1} \right) + \mu_t^h m_t \mathbb{E}_t \left(\pi_{t+1} q_{t+1} \right).$$

Housing therefore provides an additional collateral service whenever the constraint binds.

Define the collateral gap as

$$g_t^h = R_t^L b_t^I - m_t h_t^I \mathbb{E}_t \left(\pi_{t+1} q_{t+1} \right).$$

The complementary-slackness conditions are

$$g_t^h \leq 0, \qquad \mu_t^h \geq 0, \qquad \mu_t^h g_t^h = 0.$$

Thus $\mu_t^h = 0$ in the slack regime and $g_t^h = 0$ in the binding regime. The collateral parameter follows

$$\log \left(\frac{m_t}{\bar{m}} \right) = \rho_m \log \left(\frac{m_{t-1}}{\bar{m}} \right) + \varepsilon_t^m.$$

The experiments introduce no direct collateral shock: $\varepsilon_t^m = 0$. The constraint is activated endogenously by the Selic shock through the lending rate, inflation, housing prices, and

the borrower's housing position.

To keep the benchmark steady state unchanged, we leave private credit at its benchmark value. The distance to the collateral boundary is governed by κ_{coll}, defined by

$$\bar{m}\,\bar{q}\,\bar{h}^I = \kappa_{\text{coll}}\,\bar{R}^L\bar{b}^I.$$

The steady-state collateral buffer is

$$\mathcal{B}^h = 100\,(\kappa_{\text{coll}} - 1)\,.$$

Varying κ_{coll} changes only the distance to the borrower constraint: $\bar{b}^I$, bank capital, risk-weighted assets, sovereign exposure, and the remaining steady-state allocation are unchanged.

For the counterfactual decomposition, we solve four model configurations,

$$N:\ \text{neither constraint enforced}, \qquad B:\ \text{bank capital floor only},$$

$$H:\ \text{borrower collateral only}, \qquad BH:\ \text{both constraints enforced}.$$

These are four counterfactual configurations, rather than four period-by-period regimes. Within the BH configuration, the economy can occupy four regime combinations in each period: neither constraint binds, only the bank floor binds, only borrower collateral binds, or both constraints bind. Each configuration is solved using the same underlying model and OccBin architecture. Section 4.10 uses the four configurations to separate the unilateral effects of each constraint from their interaction.

2.4 Firms and domestic inflation

Domestic production is linear in labor,

$$y_t = A_t(l_t^P + l_t^I).$$

The benchmark abstracts from physical capital in order to isolate the bank-balance-sheet channel.[2] The real marginal cost, in units of the price of the domestic good, satisfies

$$w_t = A_t mc_t p_t^H,$$

[2]Appendix B reports a physical-capital extension in which the patient household owns capital and chooses investment. The extension leaves the long-bond price response and bank-capital losses virtually unchanged, while shifting the activation frontier modestly outward for borderline exposure–buffer configurations. The constrained-region dynamics remain essentially unchanged.

where $p_t^H = P_t^H/P_t$ is the relative price of the domestic good in the consumer price index. Firms face Rotemberg price adjustment costs, and the domestic Phillips curve is

$$\theta_p(\pi_t^H - 1)\pi_t^H = (1 - \varepsilon_p) + \varepsilon_p mc_t + \beta_P \frac{\lambda_{t+1}^P}{\lambda_t^P}\theta_p(\pi_{t+1}^H - 1)\pi_{t+1}^H \frac{y_{t+1}}{y_t}.$$

Profits are

$$\Pi_t = (1 - mc_t)y_t - \frac{\theta_p}{2}(\pi_t^H - 1)^2 y_t.$$

2.5 Monetary policy: the Selic

The monetary authority sets the nominal policy rate I_t^{pol} according to a Taylor rule on consumer-price inflation,

$$I_t^{pol} = \frac{1}{\beta_P}\pi_t^{\phi_\pi} \exp(\varepsilon_t^R).$$

In this simple version, the deposit rate equals the policy rate,

$$R_t^D = I_t^{pol}.$$

We set the deposit rate equal to the policy rate so that the Selic passes directly into bank funding costs. This keeps the monetary shock focused on sovereign valuation losses and the bank-capital constraint rather than on retail-rate pass-through.

2.6 Government and the structure of public debt

The government issues two domestic instruments denominated in local currency.

The first is a long nominal bond, B_t, with price p_t^B, paying a decaying-coupon perpetuity. This instrument carries duration risk: when the Selic rises, the price p_t^B falls, generating mark-to-market losses for banks that hold the asset.

The second is a short Selic-indexed bond, B_t^S, with price normalized to one. Its real payoff is

$$\frac{R_{t-1}^D}{\pi_t}.$$

This instrument does not carry the same duration risk as the long bond; it represents public debt sensitive to the short rate.

The government budget constraint is

$$p_t^B B_t + B_t^S = \frac{1 + \rho_B p_t^B}{\pi_t} B_{t-1} + \frac{R_{t-1}^D}{\pi_t} B_{t-1}^S + G_t - T_t.$$

The fiscal rule responds to market-valued public debt relative to output,

$$T_t = y_t \left[\frac{\bar{T}}{\bar{y}} + \phi_{TB} \left(\frac{p_{t-1}^B B_{t-1} + B_{t-1}^S}{y_{t-1}} - \frac{\bar{p}^B \bar{B} + \bar{B}^S}{\bar{y}} \right) \right],$$

and public spending follows

$$\log\left(\frac{G_t}{\bar{G}}\right) = \rho_G \log\left(\frac{G_{t-1}}{\bar{G}}\right) + \varepsilon_t^G.$$

2.7 The representative bank and the sovereign–bank nexus

The bank is a representative intermediary that holds private loans and domestic sovereign debt, funds itself with deposits and capital, and is subject to a regulatory capital floor. The block is parsimonious by design: the object of study is the interaction between sovereign valuation losses, risk-weighted assets, and the capital floor.

The bank's balance sheet is

$$b_t^I + B_t^{b,S} + p_t^B B_t^b = D_t + K_t^b.$$

The bank holds three assets—private loans b_t^I, long government bonds B_t^b, and short Selic-indexed government bonds $B_t^{b,S}$—and funds itself with deposits D_t and capital K_t^b.

The law of motion for bank capital is

$$\begin{aligned} K_t^b =& (1-\delta_b)K_{t-1}^b + \left(\frac{R_{t-1}^L}{\pi_t} - 1\right) b_{t-1}^I - \left(\frac{R_{t-1}^D}{\pi_t} - 1\right) D_{t-1} \\ &+ \left(\frac{1+\rho_B p_t^B}{\pi_t} - p_{t-1}^B\right) B_{t-1}^b + \left(\frac{R_{t-1}^D}{\pi_t} - 1\right) B_{t-1}^{b,S} - Adj_{t-1} - lossB_{t-1}. \end{aligned} \tag{1}$$

The central term is

$$\left(\frac{1+\rho_B p_t^B}{\pi_t} - p_{t-1}^B\right) B_{t-1}^b.$$

It measures the real return on the long bond relative to the value at which it was carried on the previous balance sheet. When the Selic rises and p_t^B falls, this term can become strongly negative, reducing bank capital. The Selic-indexed bond operates differently,

$$\left(\frac{R_{t-1}^D}{\pi_t} - 1\right) B_{t-1}^{b,S},$$

and can partially shield the bank during episodes of rising rates, since its return increases with the policy rate.

2.8 Risk-weighted assets and the parameter ω

The bank capital ratio is

$$capratio_t = \frac{K_t^b}{\mathrm{RWA}_t},$$

and risk-weighted assets are

$$\text{RWA}_t = b_t^I + \omega(B_t^{b,S} + p_t^B B_t^b).$$

The parameter ω measures the regulatory weight on domestic sovereign bonds. When $\omega = 1$, sovereign debt enters RWA in full. When $\omega = 0$, sovereign debt receives a zero regulatory weight, and

$$\text{RWA}_t = b_t^I.$$

This is the source of the discontinuity. If $\omega = 0$, sovereign losses reduce K_t^b but do not directly reduce the regulatory denominator. When the bank reaches the capital floor, selling sovereign bonds can change the composition of the portfolio but does not mechanically reduce RWA_t. The only asset that reduces the regulatory denominator is private credit b_t^I. Hence the adjustment to the capital floor translates into a contraction of credit.

The bank also faces a smooth macroprudential target, ν_t^{req}, with cost

$$Adj_t = \frac{\kappa_{Kb}}{2}\left(\frac{K_t^b}{\text{RWA}_t} - \nu_t^{req}\right)^2 K_t^b.$$

The hard capital floor is

$$capratio_t \geq \nu_{min}.$$

It is the only occasionally binding constraint in the benchmark. There are two bank regimes,

$$\text{slack regime:} \quad \mu_t^b = 0, \qquad\qquad \text{binding regime:} \quad capratio_t = \nu_{min}.$$

The model is solved with the OccBin algorithm (Guerrieri and Iacoviello, 2015), which treats the capital constraint as occasionally binding. In each period the economy can be in one of the two regimes. In the slack regime the bank chooses its balance sheet without the regulatory floor binding, and the floor multiplier is zero, $\mu_t^b = 0$. In the binding regime the capital ratio is pinned exactly at the floor, $capratio_t = \nu_{min}$, and the multiplier μ_t^b measures the shadow value of the constraint. The algorithm computes the equilibrium path by endogenously verifying in which periods the economy must be in the slack or the binding regime.

The nonlinearity is essential. A linear solution would allow the capital ratio to move below the regulatory floor, while the OccBin solution imposes the floor only when the computed path reaches it.

2.9 The smooth macroprudential rule

The model includes a smooth macroprudential target, ν_t^{req}, from which the bank incurs a quadratic deviation cost. The target governs the normal adjustment of required capital, while the model's occasionally binding nonlinearity is the hard capital floor ν_{min}, activated by the interaction between sovereign valuation losses and risk-weighted assets.

The Basel countercyclical capital buffer is oriented toward system-wide credit conditions and private-sector credit exposures (Basel Committee on Banking Supervision, 2026). We therefore use a credit-only specification as the stylized institutional reference and refer to it as sovereign-blind. The two sovereign-informed rules below have a narrower role. They are diagnostic counterfactuals: they ask whether adding sovereign information to a smooth capital target can materially offset the amplification generated by zero risk weights and the hard capital floor. The debt-aware rule uses aggregate public-debt information, while the exposure-aware rule uses bank-specific sovereign-duration exposure. The sovereign-blind case is nested in either rule by setting the corresponding sovereign-response coefficient to zero, $\phi_{\nu B} = 0$ or $\phi_{\nu X} = 0$.

For the quantitative exercises, we use the debt-aware specification as the baseline counterfactual. It provides a coarse aggregate fiscal signal against which to assess the incremental value of bank-specific sovereign-duration information. Under this specification, the macroprudential target responds to private credit and aggregate market-valued public debt:

$$\log\left(\frac{\nu_t^{req}}{\bar{\nu}}\right) = \rho_\nu \log\left(\frac{\nu_{t-1}^{req}}{\bar{\nu}}\right) + (1-\rho_\nu)\left[\phi_{\nu L}\log\left(\frac{b_{t-1}^I}{\bar{b}^I}\right) + \phi_{\nu B}\log\left(\frac{p_{t-1}^B B_{t-1} + B_{t-1}^S}{\bar{p}^B\bar{B} + \bar{B}^S}\right)\right] + \varepsilon_t^\nu.$$

The debt-aware rule asks whether aggregate fiscal information can help the macroprudential authority respond to the sovereign–bank channel without observing the bank's own duration exposure.

The second counterfactual is an exposure-aware rule based directly on the bank's long-bond exposure relative to its capital:

$$\log\left(\frac{\nu_t^{req}}{\bar{\nu}}\right) = \rho_\nu \log\left(\frac{\nu_{t-1}^{req}}{\bar{\nu}}\right) + (1-\rho_\nu)\left[\phi_{\nu L}\log\left(\frac{b_{t-1}^I}{\bar{b}^I}\right) + \phi_{\nu X}\log\left(\frac{p_{t-1}^B B_{t-1}^b/K_{t-1}^b}{\bar{x}_b}\right)\right] + \varepsilon_t^\nu.$$

This specification uses information more directly connected to the regulatory-duration mechanism. The debt-aware and exposure-aware rules are counterfactual policy experiments rather than descriptions of existing regulatory rules.

Section 4.11 compares the debt-aware quantitative baseline with the exposure-aware variant and places both against the sovereign-blind institutional reference. Appendix A reports the welfare comparison between the two sovereign-informed specifications.

2.10 External block

The economy imports consumption goods and exports domestic goods. The consumption basket combines domestic and imported goods, with home bias ω_c and elasticity η. Import demand is

$$cF_t = (1-\omega_c)(p_t^F)^{-\eta}(c_t^P + c_t^I),$$

and the price index satisfies

$$1 = \omega_c(p_t^H)^{1-\eta} + (1-\omega_c)(p_t^F)^{1-\eta}.$$

The relative price of imports follows a partial pass-through of the real exchange rate,

$$\log p_t^F = \log p_{t-1}^F + passthr\left(\log Q_t - \log p_{t-1}^F\right),$$

and the domestic relative price evolves with domestic and consumer-price inflation,

$$p_t^H = p_{t-1}^H \frac{\pi_t^H}{\pi_t}.$$

Exports are

$$X_t = \chi_X Q_t^{\eta^*} Y^*,$$

and the domestic-good resource constraint is

$$y_t = \omega_c(p_t^H)^{-\eta}(c_t^P + c_t^I) + X_t + G_t + \tau_b b_t^I + \frac{\theta_p}{2}(\pi_t^H - 1)^2 y_t.$$

The external block allows risk-premium shocks to trigger real depreciation, imported inflation, a Selic response, movements in the price of long bonds, and effects on the bank balance sheet.

3 Calibration

The model is calibrated at a quarterly frequency to Brazil. We describe here the choices that govern the central mechanism—debt level and concept, sovereign-portfolio composition, long-bond duration, the capital floor, and the effective capital buffer—and treat the remaining standard preference, price-setting, and open-economy parameters as conventional auxiliary parameters, chosen within standard ranges and not load-bearing for the activation-frontier result.

We calibrate the public debt stock to domestic marketable federal debt (DPMFi). The baseline $B/Y = 2.40$, equivalent to 60% of annual GDP, is calibrated to this debt concept. Brazil's gross general-government debt is higher, at around three-quarters of

GDP (International Monetary Fund, 2025a), but the relevant object for the bank balance sheet is the stock of marketable federal debt against which banks' sovereign holdings are measured.

The baseline share of short Selic-indexed debt in the bank's sovereign portfolio, $s_S = 0.50$, matches the aggregate composition of Brazilian federal public debt, which is close to one-half Selic-indexed (LFT) and one-half duration-bearing instruments (fixed-rate and inflation-linked) (Secretaria do Tesouro Nacional, 2026). The composition experiments therefore have a direct Brazilian interpretation: a higher Selic-indexed share attenuates the regulatory-duration channel, whereas a shift toward longer-duration instruments—the direction of the Treasury's stated debt-management goal—strengthens it. Higher s_S values also serve as a bank-portfolio robustness exercise: the aggregate debt composition need not coincide with banks' own securities portfolios, and the exercise shows how the mechanism changes as bank-held sovereign debt becomes shorter-duration.

The coupon-decay parameter $\rho_B = 0.95$ implies a long-bond Macaulay duration of $1/(1 - \beta_P \rho_B) \approx 16.8$ quarters, or about 4.2 years, consistent with the average maturity of Brazilian domestic marketable federal debt.

The bank's sovereign exposure is the parameter that, together with the capital buffer, governs whether the floor binds. A measurement caveat is essential here. The model has only two asset classes, private credit and sovereign debt, whereas real banks also hold reserves, interbank claims, and other assets. The model's sovereign-to-total-assets ratio is therefore not directly comparable to the empirical ratio of government securities to total bank assets, which for emerging markets averages roughly one-tenth and is classified as "high" around one-fifth of assets. The model-consistent comparison is sovereign debt relative to the sum of credit and sovereign holdings.

We anchor this exposure to supervisory data from the Banco Central do Brasil's IF.data system (Banco Central do Brasil, 2026a) for the prudential consolidation of the banking system (segments b1 and b2, 129 institutions, March 2026). The aggregate securities portfolio (TVM, *carteira própria*) is 23.3% of total assets and 35.1% of the sum of credit and securities, the model-consistent basis.

Two measurement qualifications are important. First, the TVM aggregate includes private securities (corporate bonds, securitized instruments, and equities), so the direct TVM figures are upper bounds on pure sovereign exposure. A conventional public share of bank securities of about two-thirds to three-quarters would place direct sovereign exposure near 25–27% on the model-consistent basis. Second, repo (*compromissada*) positions, which in Brazil are large and largely collateralized by federal securities, raise the broader measure of effective sovereign exposure to about 45.0% on the same basis once interbank-liquidity applications are included. We also treat this repo-inclusive measure as an upper-bound proxy.

Relative to bank capital, the securities portfolio is 273% of the reference capital (PR),

Table 1: Sovereign-exposure benchmarks and frontier placement

Benchmark	Exposure (%)	Calibration input	Placement
Direct securities (TVM)	35.1	0.068	Near the activation frontier
Public-only lower bound	25–27	0.047–0.054	On the slack side
Repo-inclusive proxy	45.0	0.098	In the constrained region
High-exposure laboratory	66.5	0.25	Deep in the constrained region

Notes: Exposure is expressed on the model-consistent basis used in the activation-frontier exercise. The frontier comparison uses the threshold 37.4% associated with an effective buffer of 0.5 percentage points. Direct TVM is an upper-bound proxy for sovereign exposure because the securities portfolio includes private securities. The public-only lower bound applies a haircut to the TVM measure. The repo-inclusive proxy additionally includes interbank-liquidity applications. The high-exposure row is retained only as a laboratory calibration for the constrained-regime experiments.

above the benchmark of roughly 200% used to flag a strong sovereign–bank nexus.

We adopt the direct securities measure as the empirical baseline, setting 0.068 so that the model's sovereign share of credit-plus-securities equals 35.1%, the upper-bound direct figure; the public-only haircut ($\approx$ 0.047–0.054) is reported as a lower-bound robustness note. The repo-inclusive measure (0.098, 45.0%) is the main robustness/policy case, and the high-exposure value (0.25, 66.5%) is retained only as a laboratory case. These four points are summarized in Table 1 and mapped relative to the activation frontier in Section 4.6.

The bank operates with a capital ratio ν_b above a hard regulatory floor ν_{min}; the difference $\nu_b - \nu_{min}$ is the buffer that duration losses must exhaust before the floor binds. This model buffer measures the effective credit-relevant distance to the floor, rather than the aggregate accounting gap between observed capital ratios and minimum requirements. That accounting distance includes conservation buffers, Tier 2 instruments, management buffers, and capital components that are not necessarily usable without restrictions; entering the capital conservation buffer, in particular, triggers restrictions on profit distribution rather than a mechanical contraction of credit (Banco Central do Brasil, 2026b). We set the baseline effective buffer to 0.5 percentage points and, because this quantity is not directly observable, report the full activation frontier for buffers between 0.5 and 2.0 percentage points (Section 4.6). The frontier, not any single buffer value, is the object of interest.

4 Experiments and transmission

This section presents the experiments generated by the model. Solid lines denote the piecewise solution with the occasionally binding capital floor; dashed lines denote the linear

solution. When the two differ, the gap measures the importance of the capital-floor regime. Not every shock activates the floor, which is a desirable feature of the exercise: the OccBin mechanism should not bite mechanically for every disturbance. For some shocks—the smooth macroprudential shock and, in the current calibration, the external risk-premium shock—the floor remains slack, and the corresponding figures are transmission diagnostics rather than banking-crisis episodes. The central mechanism appears in the shocks for which capital losses are large enough to push the bank to the regulatory floor.

Unless otherwise noted, the experiments use the high-exposure laboratory calibration and the debt-aware macroprudential specification with $\phi_{\nu B} = 0.25$. Percentage responses of real quantities are reported as $100(x_t - \bar{x})/\bar{x}$. Interest rates and inflation are reported in annualized basis points, while the capital ratio and the macroprudential target are reported in percentage points.

4.1 Government spending shock: a fiscal-stress scenario

Figures 2 and 3 trace the transmission of a government spending shock. Spending rises sharply, market-valued public debt increases, taxes respond with a lag, and the Selic rises; the higher policy rate lowers the price of the long bond, producing sizable bank losses that erode capital, push the capital ratio to the floor, and contract private credit.

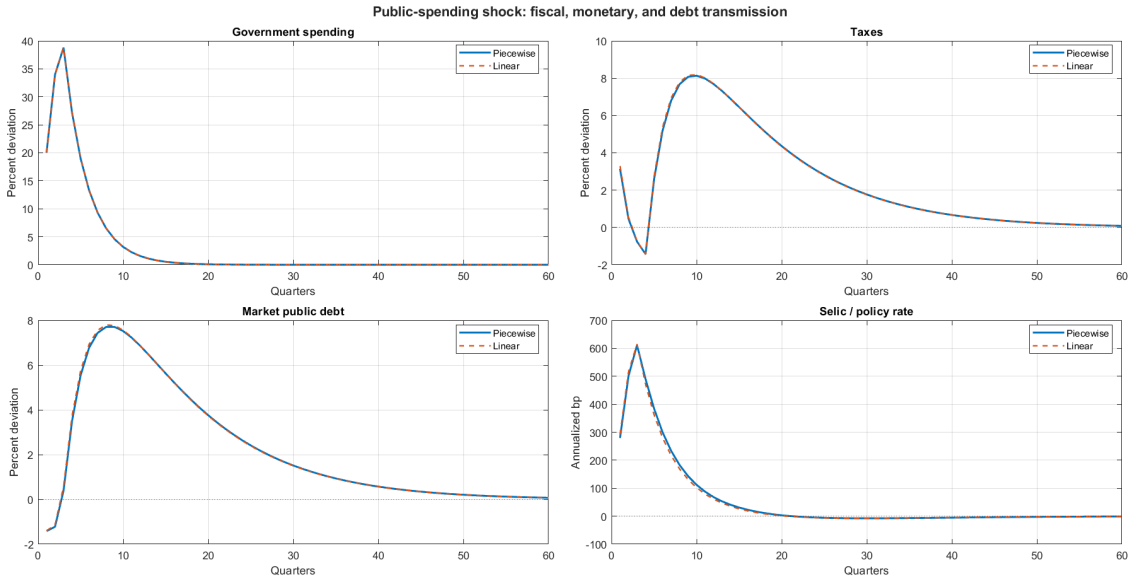


Figure 2: Government spending shock: fiscal, monetary, and debt transmission.

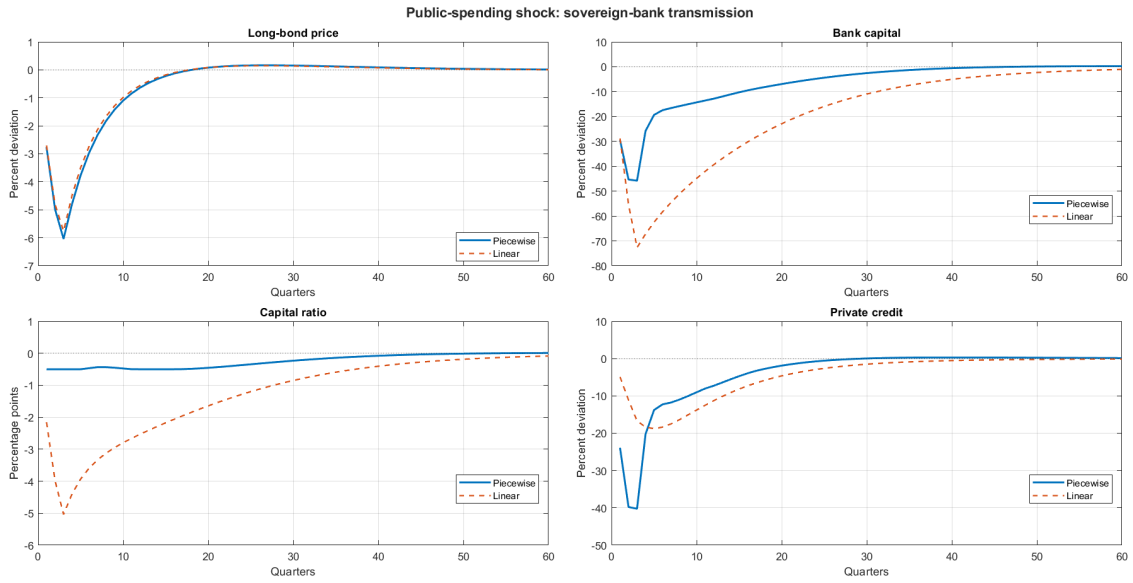


Figure 3: Government spending shock: sovereign–bank transmission.

Quantitatively, in the fiscal experiment with $\omega = 0$, the maximal contraction of private credit is about -40.2%, the maximal fall in bank capital about -45.8%, and the floor binds for 10 quarters with $\max \mu^b = 0.0623$.

The government-spending shock serves as a fiscal-stress scenario rather than as the paper's clean identification experiment. It is related to the fiscal-limits logic in which public-debt pressure makes sovereign stress state dependent (Bi, 2012). The relevant nonlinearity here, however, comes from duration losses on bank-held sovereign debt and the hard capital floor, whereas fiscal-limit models typically emphasize an endogenous default-risk premium. The experiment combines several margins: higher public spending raises market-valued debt, the monetary rule increases the Selic rate, the price of long-duration public debt falls, bank capital is eroded, and the capital floor forces a contraction in risk-weighted private exposure. It therefore illustrates how the regulatory-duration mechanism operates within a broader fiscal–monetary–financial feedback chain.

In frontier terms, the fiscal shock moves the economy toward the constrained region from the fiscal side. It raises public-debt pressure and the associated duration losses on the bank's sovereign portfolio, thereby reducing the distance to the capital floor.

4.2 Bank-loss shock: isolating the capital block

Figures 4 and 5 present a direct bank-loss shock. This experiment isolates the bank-capital block from sovereign-debt valuation effects. A direct loss reduces K_t^b, pushes the capital ratio to the floor, and generates a positive floor multiplier; the lending rate rises, private credit contracts, and the impatient borrower's consumption falls while the patient saver's consumption initially improves.

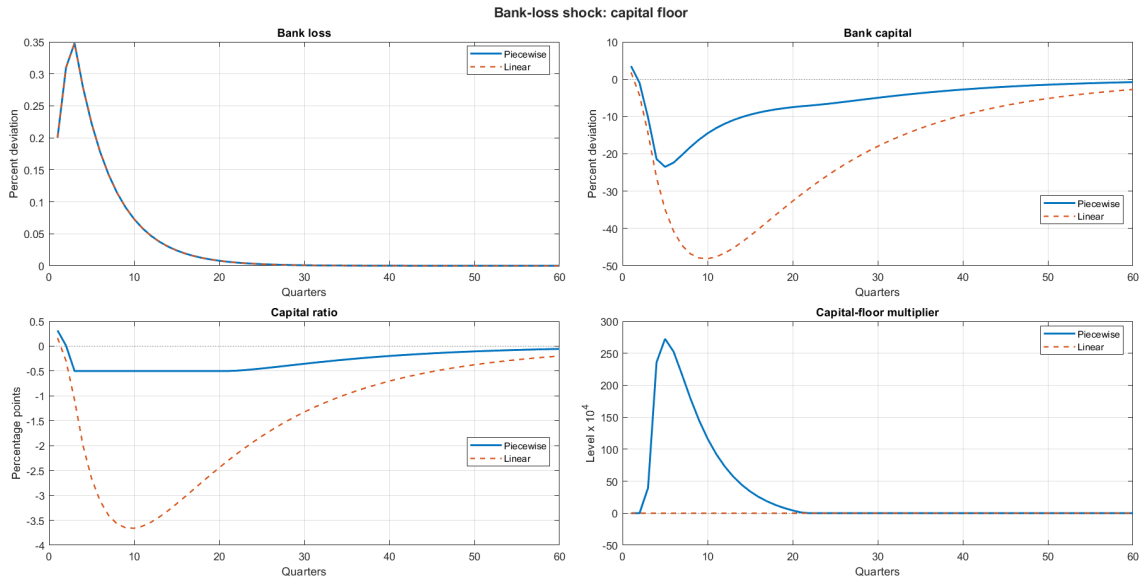


Figure 4: Bank-loss shock: bank capital and the regulatory floor.

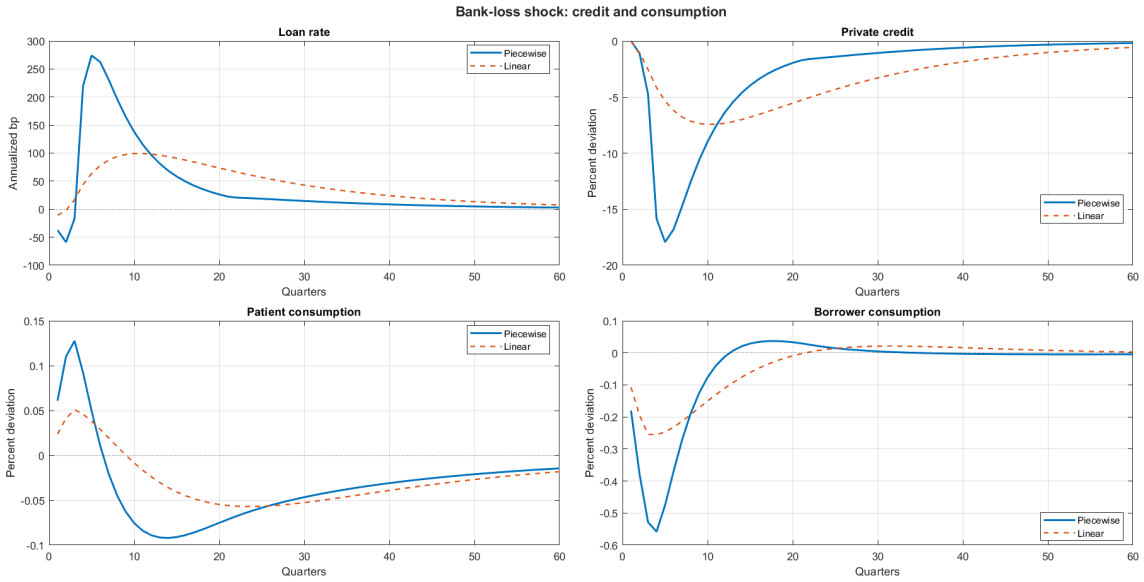


Figure 5: Bank-loss shock: credit and consumption.

The maximal credit contraction here is about -17.9%, the maximal fall in bank capital -23.5%, and the floor binds for 19 quarters with $\max \mu^b = 0.0272$. The result confirms that the OccBin block operates correctly: when capital falls enough, the bank switches to the binding regime and adjusts credit.

4.3 Macroprudential shock: smooth target versus hard floor

Figure 6 shows a direct shock to the macroprudential target ν_t^{req}. The required-capital target rises and the capital ratio adjusts, but the hard floor does not bind: the multiplier μ_t^b stays essentially zero and the effect on credit is small, about -0.16%.

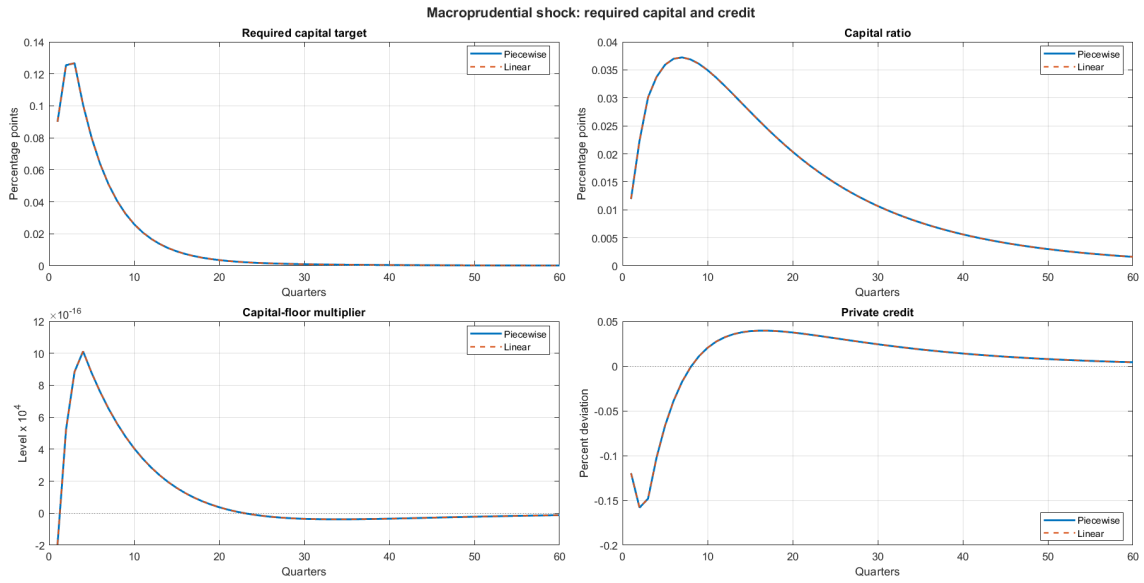


Figure 6: Macroprudential shock: required-capital target and credit.

This result matters because it distinguishes the smooth macroprudential target from the hard capital floor. Moving ν_t^{req} does not automatically activate the OccBin regime. The target affects bank decisions through a smooth cost; the floor ν_{min}, by contrast, is a hard quantitative constraint.

4.4 Selic tightening and the regulatory-duration channel

Figures 7 and 8 present the central monetary-policy experiment. A positive Selic shock raises the policy rate sharply and lowers inflation. The credit contraction therefore cannot be attributed to an inflationary expansion or a demand boom. Higher interest rates reduce the price of long-duration public debt, erode bank capital, and, once the regulatory floor binds, force the bank to contract private credit. Standard monetary transmission operates in both the linear and piecewise solutions. Their divergence measures the additional amplification generated by the bank-capital floor.

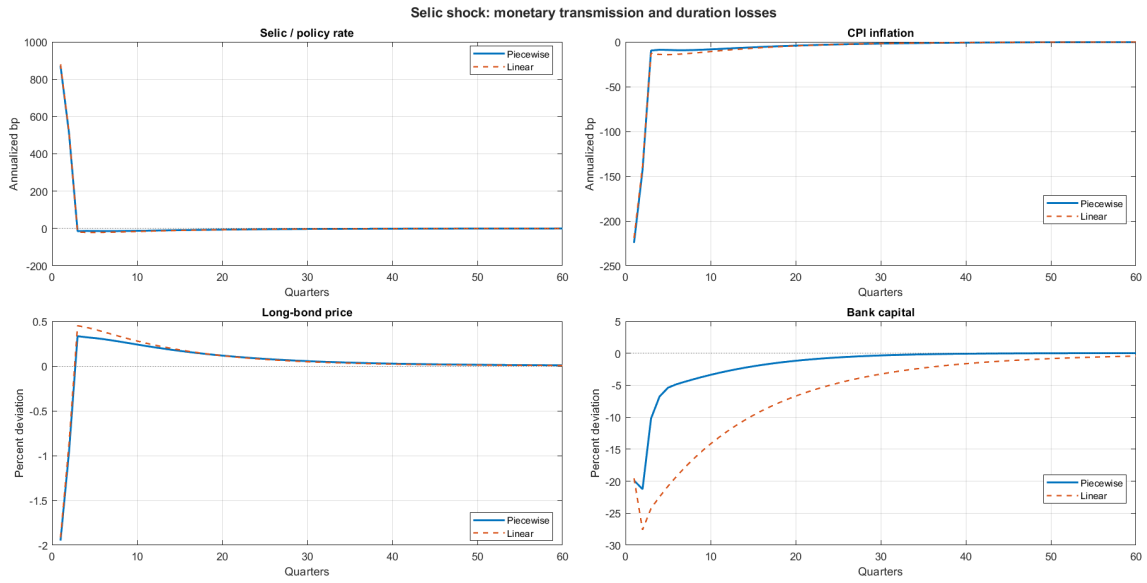


Figure 7: Selic shock: monetary transmission and duration losses.

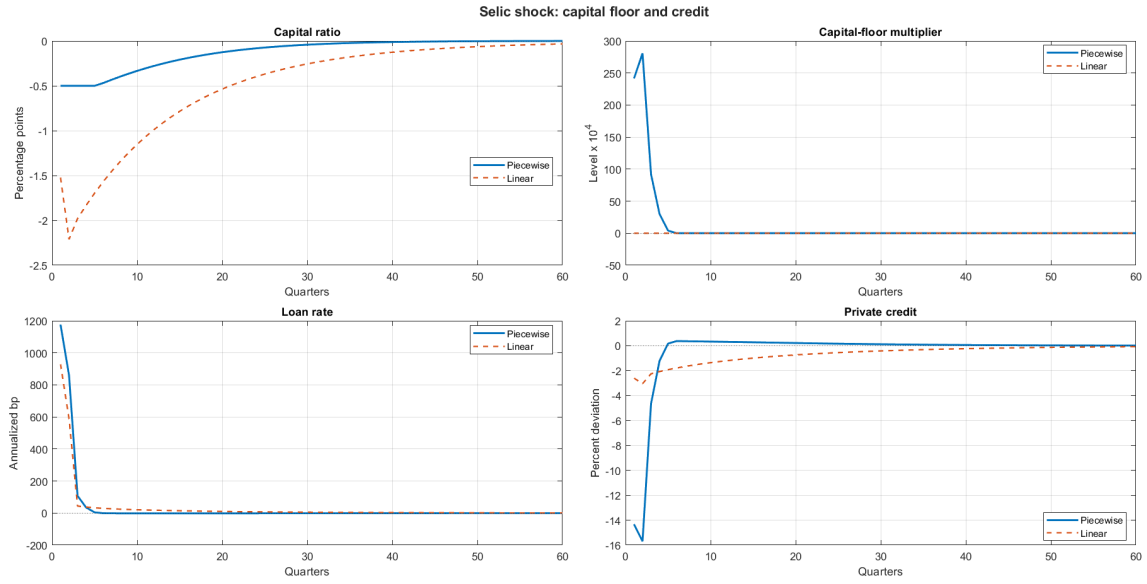


Figure 8: Selic shock: capital floor and credit.

In the baseline case with $\omega = 0$ and a share of Selic-indexed debt in the bank's sovereign portfolio equal to $s_S = 0.5$, the maximal credit contraction is about -15.70%, the maximal fall in bank capital -21.25%, and the floor binds for 5 quarters. This is the main monetary experiment, the one that cleanly identifies the regulatory-capital channel underlying the activation frontier. In simple percentage deviations the Selic shock is not the most severe in terms of credit: the fiscal shock (-40.2%) and the bank-loss shock (-17.9%) produce larger contractions. The Selic shock is the main experiment because of the cleanliness of identification—inflation falls, ruling out a demand boom, and the comparison across ω isolates the regulatory-capital channel—not because it is the largest in magnitude.

4.5 External risk-premium shock: open-economy transmission

Figures 9 and 10 show the transmission of an external risk-premium shock. The real exchange rate depreciates, the relative price of imports rises, consumer-price inflation increases, and the Selic responds; the long bond moves little, bank capital falls moderately, and credit contracts by only about -0.40%, while exports rise on impact.

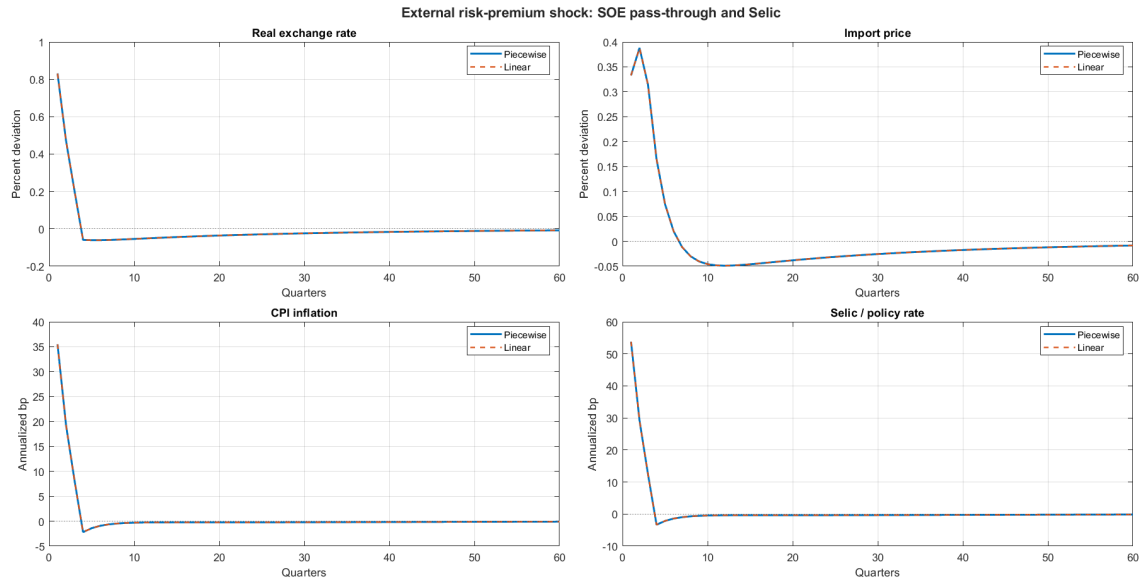


Figure 9: External premium shock: exchange-rate pass-through and the Selic.

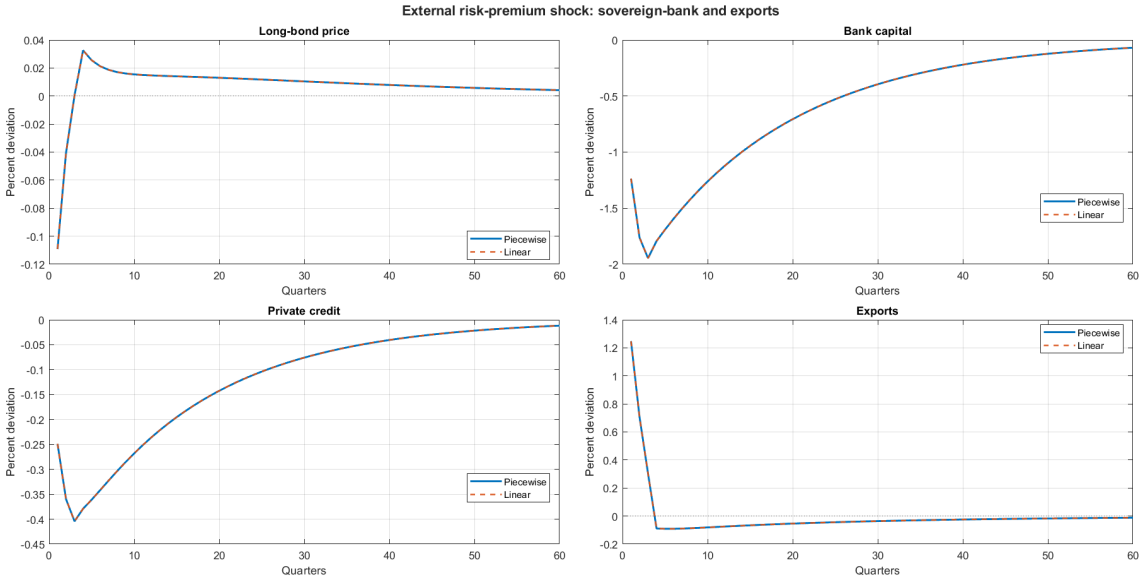


Figure 10: External premium shock: sovereign–bank channel and exports.

This shock traces open-economy transmission and exchange-rate pass-through while leaving the bank capital floor slack. This non-activation is informative: it confirms that the OccBin regime does not trigger mechanically and that the central amplification requires sufficiently large duration losses on bank-held sovereign debt.

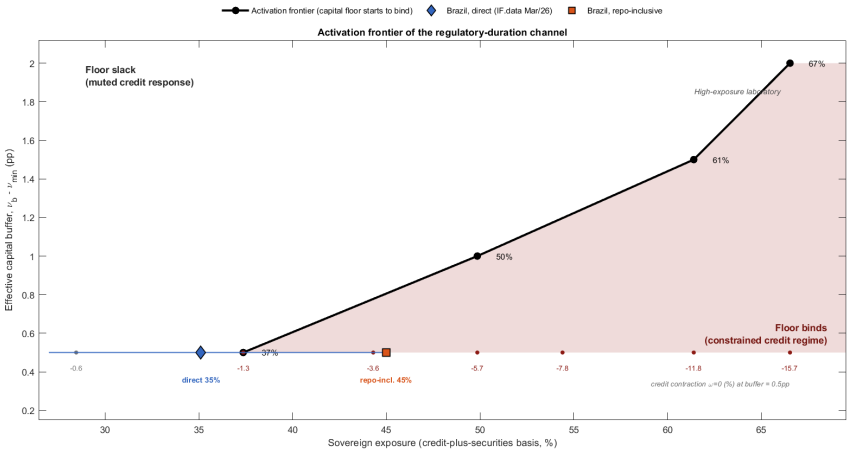


Figure 11: Activation frontier of the regulatory-duration channel. The solid line marks the combinations of sovereign exposure and effective capital buffer at which the bank capital floor starts to bind after the benchmark Selic tightening. Above and to the left, the floor remains slack and the credit response is muted; below and to the right, the floor binds and the economy enters a constrained-credit regime. Annotated values report the credit contraction under zero sovereign risk weights at a 0.5 pp buffer. The Brazil markers are from BCB IF.data (banking system b1+b2, March 2026): direct securities holdings (35% on the model-consistent basis, an upper bound on pure sovereign exposure) lie close to the frontier, while repo-inclusive exposure (45%) crosses into the constrained region. The high-exposure case used in some experiments is reported separately as a laboratory calibration; the direct-securities exposure measure defines the baseline calibration.

4.6 The activation frontier

The main result is an activation frontier separating slack and constrained-credit regimes. The regulatory-duration channel is activated only when sovereign exposure is sufficiently high and the effective capital buffer is sufficiently thin. Figure 11 traces, in the plane of sovereign exposure (horizontal) and effective capital buffer (vertical), the combinations at which the capital floor starts to bind after the benchmark Selic tightening. Above and to the left of the frontier, the floor remains slack and the credit response is muted; below and to the right, the floor binds and the economy enters a constrained-credit regime.

The frontier is steeply upward-sloping: raising the effective buffer from 0.5 to 1.0 percentage points shifts the activation threshold from about 37 to 50 percent on the model-consistent credit-plus-securities basis, and buffers of 1.5 and 2.0 percentage points move it to about 61 and 67 percent, respectively. Sovereign exposure and the effective capital buffer therefore jointly determine whether a monetary tightening remains a muted balance-sheet event or turns into a constrained-credit regime. Under the benchmark Selic shock, Brazil straddles the activation frontier: direct securities holdings place the banking system essentially on the 0.5 percentage-point buffer boundary, while repo-inclusive exposure pushes it more clearly into the constrained region (Table 1). The *compromissada* positions

Table 2: Exposure benchmarks and activation under clean monetary-policy shocks

	Clean monetary-policy shock: slack-equivalent Selic peak			
Exposure benchmark	+250 bp	+500 bp	+1,175 bp (2021–23 magnitude)	+1,500 bp
Public-only lower bound	−0.2 / N	−0.3 / N	−0.8 / N	−1.1 / Y
Direct TVM upper bound	−0.2 / N	−0.4 / N	−2.1 / Y	−3.7 / Y
Repo-inclusive proxy	−0.3 / N	−0.6 / N	−5.5 / Y	−8.1 / Y
High-exposure laboratory	−2.3 / Y	−8.0 / Y	−22.1 / Y	−29.1 / Y

Notes: Each cell reports the maximum credit contraction, in percent, and whether the bank capital floor binds (Y/N). Credit is reported as $100(x_t - \bar{x})/\bar{x}$. Column headings refer to the peak annualized Selic increase generated by the corresponding monetary-policy innovation in the slack-reference economy. The same innovation is then applied to all exposure benchmarks within a column. Actual peak Selic responses may differ across cells once the capital floor binds; in these simulations, the largest deviation from the slack-equivalent target is about 33 basis points and occurs in the high-exposure laboratory case. The +1,175 bp column anchors the magnitude of the clean shock to the cumulative increase in Brazil's Selic target rate during the 2021–2023 tightening episode, from 2.00% to 13.75% (Banco Central do Brasil, 2026c). It is not a historical decomposition of that episode.

that drive this crossing are large in Brazil and largely collateralized by federal securities, so the policy-relevant margin is not only the level of direct holdings but the effective sovereign exposure once repo positions are counted.

Table 2 adds the shock-size dimension to the activation frontier. The table applies the same clean monetary-policy innovation to all exposure benchmarks within a column. Column headings report the peak Selic increase that the innovation generates in the slack-reference economy; the entries report the maximum credit contraction and whether the bank capital floor binds.

The exposure–shock grid makes the frontier interpretation explicit. The public-only lower bound remains slack under the +1,175 bp slack-equivalent tightening and binds only under the largest shock. The direct TVM benchmark, which is an upper-bound measure of direct sovereign exposure, activates the capital floor under a tightening of the same order of magnitude as Brazil's 2021–2023 Selic episode, with a contained credit contraction of about 2 percent. Repo-inclusive exposure generates a substantially larger contraction, and the high-exposure calibration illustrates the interior of the constrained region. The result is therefore not a single Brazil number but a gradient: activation is modest at the direct upper-bound benchmark, stronger once repo exposures are included, and severe in the laboratory constrained region.

This frontier-based interpretation organizes the rest of the results. Debt composition shifts the economy horizontally relative to the frontier: a higher share of Selic-indexed debt attenuates duration losses and moves the system away from the constrained region, whereas a shift toward longer-duration instruments moves it toward the frontier. Front-loaded monetary tightening increases the severity of duration losses and pushes the system closer

to, or deeper into, the binding region. The exposure–risk-weight discontinuity (Result 1), the composition robustness (Result 2), and the timing result (Result 3) below are all views of this single frontier.

The Results 1–3 exercises below continue to use the high-exposure laboratory calibration (`Bb_share`=0.25, 66.5% sovereign exposure). They illustrate the constrained region of the activation frontier in its strongest form, where the mechanism is most visible. The direct-securities baseline, anchored to IF.data (Section 3, Table 1), places Brazil near the frontier under the benchmark Selic shock and activates the floor under a clean tightening of +1,175 bp in slack-equivalent Selic terms. The public-only lower bound remains slack at that magnitude, while repo-inclusive exposure crosses more strongly into the constrained region. The magnitudes below correspond to the constrained-region laboratory calibration, not to the direct-securities baseline itself.

4.7 Result 1: the ω discontinuity

Figure 12 illustrates how the sovereign risk weight governs the credit response once the economy is in the constrained region of the activation frontier. The same Selic shock is simulated for three values of the sovereign risk weight: $\omega = 1$, $\omega = 0.5$, and $\omega = 0$.

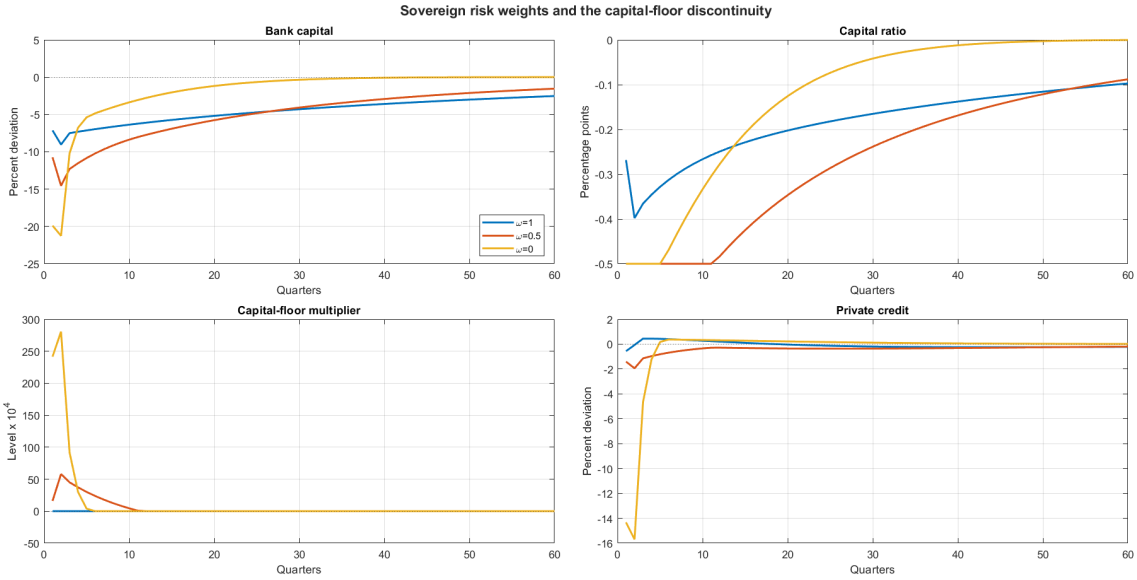


Figure 12: Sovereign risk weights and the capital-floor discontinuity.

When $\omega = 1$, sovereign debt enters RWA in full. A fall in the long-bond price then reduces both bank capital and the regulatory denominator; the floor does not bind and the credit contraction is small, about -0.57%. When $\omega = 0.5$, the floor binds for 11 quarters but the contraction remains moderate, about -1.95%, with a maximal shadow value $\max \mu^b = 0.0058$. When $\omega = 0$, sovereign losses reduce capital but not RWA; the bank hits the floor, the multiplier rises sharply, credit falls by about 15.70%, bank capital

falls by 21.25%, and $\max \mu^b = 0.0281$.

For the same monetary tightening, the credit contraction is thus roughly 28 times larger under $\omega = 0$ than under $\omega = 1$ in our calibration. The regulatory privilege of sovereign debt thus creates hidden fragility: the sovereign asset consumes no capital before the crisis, but its losses destroy capital during the crisis, and once the floor binds the adjustment falls on private credit.

The three economies compared in Figure 12 are identical in every respect except the regulatory parameter ω: they face the same Selic shock, the same policy rule, and the same exogenous monetary impulse. Because the three economies differ only in ω, the cross-case differences in credit responses identify the additional amplification generated by the regulatory treatment of sovereign debt. The $\omega = 1$ case already embeds the usual contractionary effect of higher rates on credit; the additional contraction under $\omega = 0$ is attributable to the regulatory treatment of sovereign debt in risk-weighted assets. Combined with the fall in inflation, which rules out a demand boom, this comparison isolates the regulatory-capital channel as the source of the discontinuous credit contraction.

We also note that, where the floor binds, the duration of the binding regime is not necessarily monotone in ω, but its severity is. The $\omega = 0$ case can generate fewer binding quarters than some intermediate cases while displaying much larger credit and capital losses and a much larger shadow value. Severity should therefore be assessed jointly using the duration of the binding regime, $\max \mu^b$, the capital loss, and the credit contraction, rather than the number of binding quarters alone.

4.8 Result 2: debt composition is not the source of fragility

Figure 13 presents a robustness exercise central to the international interpretation of the model. It varies the share of short Selic-indexed debt in the bank's sovereign portfolio,

$$s_S = \frac{B^{b,S}}{B^{b,S} + p^B B^b},$$

holding constant the bank's total sovereign exposure, initial capital, risk-weighted assets, and the regulatory target. The experiment thus isolates the composition between the long bond with duration and the short Selic-indexed bond.

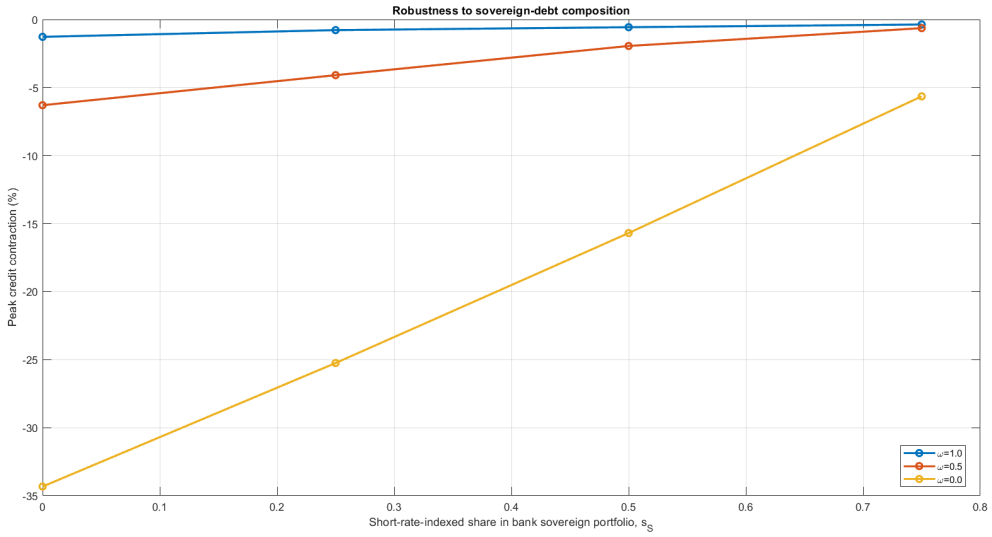


Figure 13: Robustness to the composition of the bank's sovereign portfolio.

The result is sharp. For $\omega = 0$, the maximal credit contraction is -34.33% when $s_S = 0$, -25.25% when $s_S = 0.25$, -15.70% when $s_S = 0.5$, and -5.65% when $s_S = 0.75$. Fragility therefore declines as the share of Selic-indexed debt rises. The result is not driven by the most Brazil-specific feature of the model. Selic-indexed debt cushions the contraction by reducing the bank's duration exposure; fragility is instead concentrated in long-duration bonds.

The distinction also limits the extent to which the mechanism is Brazil-specific. The Brazilian case is useful precisely because it separates two channels cleanly: the duration risk of long bonds and the floating return of Selic-indexed debt. The central ω discontinuity is more general: it arises from the interaction of sovereign duration losses, privileged regulatory weights, and the bank capital floor.

4.9 Result 3: the timing of monetary tightening

The first two results vary the regulatory and portfolio environment under a fixed monetary impulse. The third varies the shape of the monetary tightening while holding its disinflationary objective fixed. We compare a front-loaded tightening, in which the policy-rate path peaks early, with a gradual tightening that peaks later. Both paths are scaled so that cumulative disinflation, $\mathcal{D}_\pi = -\sum_{t=1}^{24} \log(\pi_t/\bar{\pi})$, computed in the linear (no-floor) solution, matches that of the baseline Selic shock. Matching the objective in the linear solution ensures that the comparison is not contaminated by the credit crunch itself; severity is then measured in the piecewise solution. The shape is a hump $s_t(\tau) = (t/\tau)e^{1-t/\tau}$, with the policy-rate peak at $t \approx \tau$ (τ small for front-loaded, large for gradual).

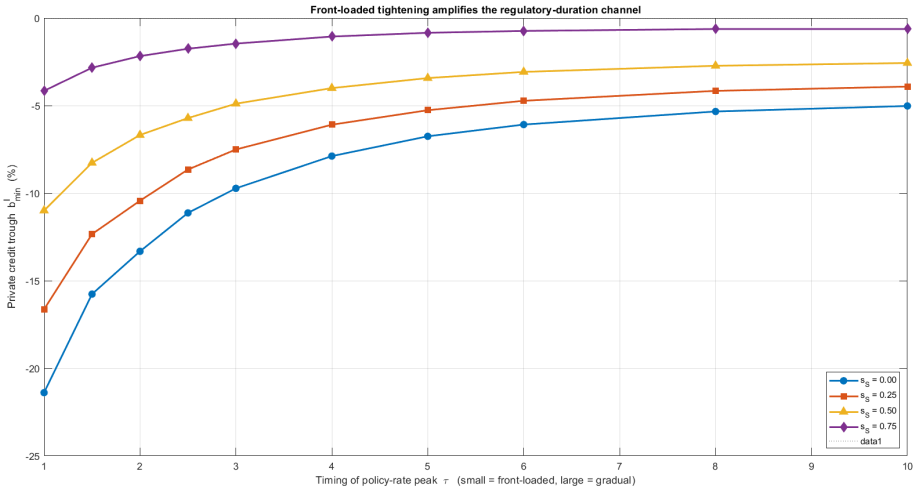


Figure 14: Timing of monetary tightening and the regulatory-duration channel. Each curve fixes a portfolio composition s_S and varies the timing of the policy-rate peak τ, holding cumulative disinflation constant. Earlier peaks (front-loaded tightening) produce deeper credit troughs, and the effect is strongest when the bank holds more long-duration debt (low s_S).

The result, reported in Table 7 and Figure 14, is that for the same cumulative disinflation a front-loaded tightening is more costly for credit than a gradual one. When banks hold only long-duration sovereign debt ($s_S = 0$), a front-loaded path reduces private credit by 13.3%, compared with 5.3% under the gradual path that achieves the same disinflation—a front-loaded penalty of about 8.0 percentage points. This penalty declines monotonically as the share of Selic-indexed debt rises: to 4.0 percentage points at $s_S = 0.5$, and to 1.5 percentage points at $s_S = 0.75$. The financial-stability cost of front-loading is therefore largest when the bank's sovereign portfolio is most exposed to duration, and is attenuated by Selic-indexed debt.

Two features reinforce the mechanism. First, the long-bond price falls by less than half a percent, yet bank capital falls by up to 19%: a small mark-to-market loss on a large sovereign exposure, against thin capital, translates into a large capital loss, which is the essence of the balance-sheet channel. Second, the inflation troughs in the linear and piecewise solutions coincide when the floor barely binds (high s_S) but diverge when it binds hard (low s_S), reflecting the feedback of the credit crunch into realized inflation. As in Result 1, the number of binding quarters is not a severity measure: the gradual path binds for more quarters but less severely.

4.10 Result 4: two-sided credit constraints

The benchmark isolates the regulatory-duration mechanism by making the bank capital floor the only hard financial constraint. This subsection asks whether the moderate aggregate output response is an artifact of omitting a borrower-collateral accelerator and,

more generally, how two occasionally binding constraints interact when both operate through the same private loan b_t^I. The borrower constraint and four counterfactual configurations are defined in Section 2.3.

The experiments use the high-exposure laboratory calibration, set $\omega = 0$, retain a Selic-indexed share $s_S = 0.5$ in the bank sovereign portfolio, and apply exactly the same Selic shock as in Section 4.4. We consider collateral buffers of 0.5, 1.0, 1.5, and 2.0 percent. These values are used to examine sensitivity near the collateral boundary; they are not direct estimates of Brazilian mortgage headroom. To keep the equation system and OccBin architecture identical across configurations, an inactive constraint is placed sufficiently far from the equilibrium path. When the borrower constraint is disabled, its steady-state collateral buffer is set to 20%; when the bank floor is disabled, $\nu_{\min}$ is placed far below the simulated capital ratio. The corresponding multipliers remain at numerical zero.

Table 3 reports peak responses and regime durations. The unconstrained reference path N produces an output trough of -1.3118%, a private-credit trough of -3.0443%, and a borrower-consumption trough of -1.3617%. With only the bank capital floor active, case B, the floor binds for five quarters, private credit falls by 15.6966%, and output falls by 1.4062%.

Table 3: Borrower collateral and bank capital under the baseline Selic shock

Collateral buffer	Regime	Capital-floor quarters	Collateral quarters	$\min y$ (%)	$\min b^I$ (%)	$\min c^I$ (%)
Common reference cases						
—	N: neither constraint	0	0	−1.3118	−3.0443	−1.3617
—	B: bank floor only	5	0	−1.4062	−15.6966	−1.4868
Borrower-collateral and dual-constraint cases						
0.5%	H: collateral only	0	4	−1.3816	−5.2008	−1.5620
0.5%	BH: both constraints	3	11	−1.4068	−14.2334	−1.5497
1.0%	H: collateral only	0	2	−1.3474	−4.4482	−1.4643
1.0%	BH: both constraints	4	6	−1.4053	−14.6583	−1.5031
1.5%	H: collateral only	0	2	−1.3122	−3.6345	−1.3629
1.5%	BH: both constraints	4	4	−1.4062	−15.0709	−1.4868
2.0%	H: collateral only	0	0	−1.3118	−3.0443	−1.3617
2.0%	BH: both constraints	4	2	−1.4062	−15.5272	−1.4868

Notes: Percentage entries are trough deviations from steady state. A constraint is counted as binding when its multiplier exceeds 10^{-6} and its associated gap is at the boundary. N is the linear path in which neither hard constraint is enforced; B retains only the bank capital floor; H retains only borrower collateral; and BH retains both constraints.

When borrower collateral operates alone, its effects decline rapidly with the initial buffer. With a 0.5% buffer, the constraint binds for four quarters and private credit falls by 5.20%. With a 1.0% buffer, it binds for two quarters and credit falls by 4.45%. At a

1.5% buffer, the output path is already almost indistinguishable from the unconstrained reference. At a 2.0% buffer, borrower collateral does not bind when acting alone.

The incidence of the constraint changes substantially when the bank floor is also present. With a 0.5% buffer, the collateral constraint binds for four quarters in H, but for eleven quarters in BH. With a 1.0% buffer, its duration rises from two to six quarters, and with a 1.5% buffer from two to four quarters. Even at a 2.0% buffer, where collateral remains slack in H, it binds for two quarters in BH. The net effect of bank-capital stress therefore pushes the borrower toward the collateral boundary despite the accompanying decline in debt and can activate a regime that would otherwise remain slack.

The feedback from borrower collateral to the bank runs in the opposite direction. The bank floor binds for five quarters in B, but for only three quarters in BH with the tightest collateral buffer and for four quarters with the remaining buffers. Private credit also falls less in BH than in B. With a 0.5% buffer, for example, the credit trough is -15.70% under the bank floor alone and -14.23% when both constraints are imposed.

To quantify the interaction, let L_x^r denote the positive peak loss of variable x under configuration $r \in \{N, B, H, BH\}$. For output,

$$L_y^r = -\min_t \left[100 \left(\frac{y_t^r - \bar{y}}{\bar{y}} \right) \right].$$

Define the peak-loss interaction as

$$\mathcal{I}_x = \left(L_x^{BH} - L_x^H \right) - \left(L_x^B - L_x^N \right).$$

A positive value means that adding the bank floor produces a larger incremental loss when borrower collateral is present and hence indicates complementarity; a negative value indicates substitution.

Table 4: Peak-loss interaction between borrower collateral and the bank capital floor

Collateral buffer	$\mathcal{I}_y$	$\mathcal{I}_{b^I}$	$\mathcal{I}_{c^I}$
	percentage points		
0.5%	−0.0692	−3.6197	−0.1374
1.0%	−0.0366	−2.4422	−0.0863
1.5%	−0.0004	−1.2157	−0.0012
2.0%	0.0000	−0.1694	0.0000

Notes: Positive entries indicate complementarity in peak losses; negative entries indicate substitution. Interactions smaller than 10^{-4} percentage points in absolute value are reported as zero.

The interaction is negative for output, private credit, and borrower consumption at the buffers for which collateral has quantitatively relevant effects. Borrower collateral therefore does not generate superadditive aggregate amplification of the regulatory-duration

mechanism. With a 0.5% buffer, output falls by 1.4062% under the bank floor alone and by 1.4068% when both constraints are present. The difference is economically negligible. At buffers of 1.5% or more, the output interaction is effectively zero. For buffers of 2.5% and above, the collateral constraint remains slack even in the dual-constraint economy.

The substitution result follows from the definition of risk-weighted assets. In the central $\omega = 0$ case,

$$\text{RWA}_t = b_t^I.$$

Holding bank capital fixed, borrower deleveraging raises the regulatory capital ratio:

$$\frac{\partial}{\partial b_t^I}\left(\frac{K_t^b}{\text{RWA}_t}\right) = -\frac{K_t^b}{\text{RWA}_t^2} < 0.$$

Consequently,

$$b_t^I \downarrow \implies \text{RWA}_t \downarrow \implies capratio_t \uparrow .$$

The borrower constraint depresses debt and household demand, but the associated decline in risk-weighted private exposure partly relieves the bank floor. This denominator effect offsets part of the additional borrower-side contraction.

The interaction is therefore asymmetric. In the simulations, the joint equilibrium response of the lending rate, inflation, housing prices, and the borrower's housing position moves the collateral gap toward its boundary, despite the direct relaxation associated with lower debt. At the same time, collateral-induced deleveraging reduces bank risk-weighted assets and attenuates capital pressure. The two constraints are complementary in the incidence and duration of borrower collateral stress, but their interaction is less than additive in peak credit and aggregate output losses.

The small output interaction is consistent with the benchmark's real structure: housing is in fixed supply, production is linear in labor, and borrower debt does not directly finance productive capital. The bank capital floor remains the dominant source of the private-credit contraction. The extension nevertheless rules out the interpretation that the benchmark's moderate real effects arise simply because borrower collateral is omitted.

4.11 Macroprudential rules: a corollary

This subsection asks a narrow policy question: can sovereign information in a smooth capital target materially weaken the hard-floor amplification documented above?

Figure 15 compares the debt-aware quantitative baseline, with $\phi_{\nu B} = 0.25$, with the exposure-aware variant evaluated at $\phi_{\nu X} = 0.25$.

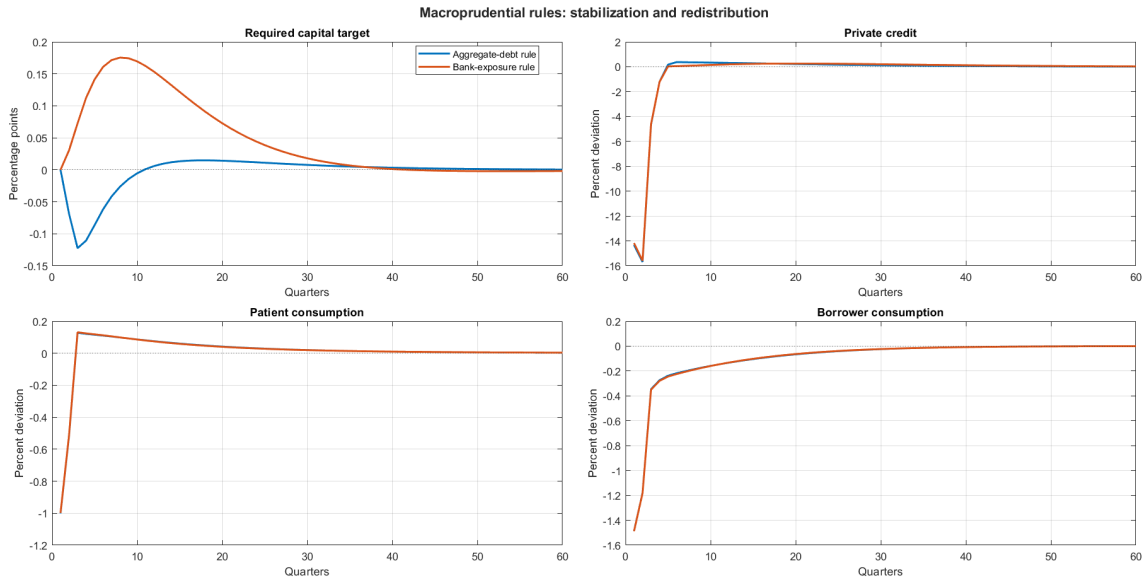


Figure 15: Smooth macroprudential rules: debt-aware baseline and exposure-aware variant.

The exposure-aware rule raises the required-capital target more in response to duration exposure, but it only marginally reduces the credit contraction under the Selic shock: the maximal fall moves from about -15.70% to -15.60%, and binding quarters fall from 5 to 4.

Figure 16 then places the two sovereign-informed specifications against their common sovereign-blind institutional reference, obtained by setting the relevant sovereign-response coefficient to zero, and checks the sensitivity of the results across a grid of response coefficients.

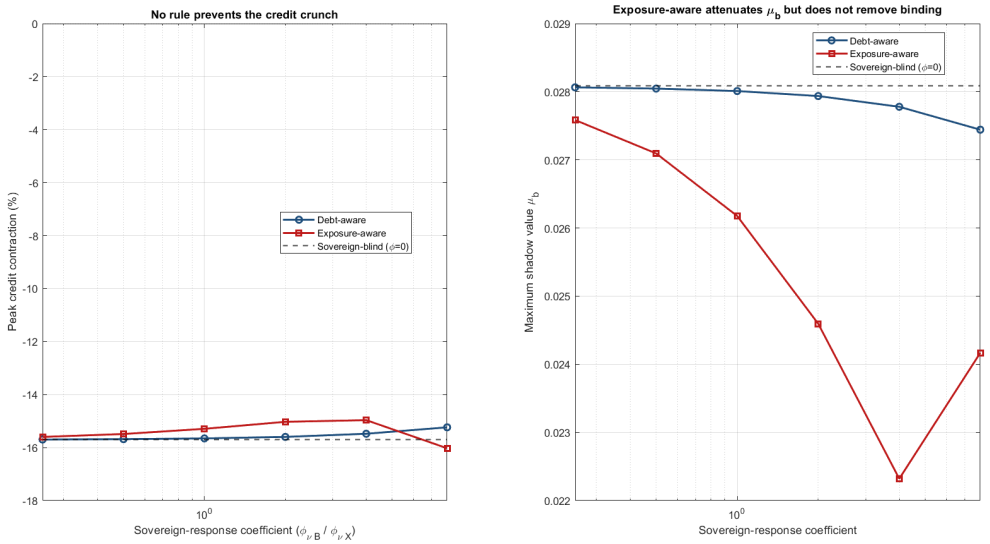


Figure 16: Grid of smooth macroprudential rules.

The grid confirms that the design of the smooth macroprudential rule is quantitatively secondary to the regulatory treatment of sovereign debt. The sovereign-blind institutional

reference generates a maximal credit contraction of −15.71%, almost identical to the −15.70% contraction under the debt-aware rule at the baseline coefficient. The exposure-aware rule reduces the floor's shadow value and shortens the binding regime for intermediate coefficients. With $\phi_{\nu X} = 4$, the credit contraction falls to −14.97%, capital falls by 20.52%, and the floor binds for 3 quarters. No rule in the grid eliminates the binding regime. Moreover, an overly aggressive exposure-aware response can be counterproductive: with $\phi_{\nu X} = 8$, the required-capital target rises sharply in the crisis state, the credit contraction worsens to −16.03%, and the floor binds again for 5 quarters. More detailed sovereign information can therefore provide some attenuation at intermediate coefficients, while the treatment of sovereign debt in RWA_t remains the main regulatory margin. The grid is reported in Table 8.

5 Quantitative summary

Table 5 summarizes the main experiments; Table 6 the robustness to portfolio composition; Table 7 the monetary-timing result; Tables 3 and 4 the interaction between the borrower and bank constraints; and Table 8 the macroprudential-rule grid. All magnitudes in this section are reported at the high-exposure laboratory calibration (`Bb_share`=0.25, 66.5% sovereign exposure), which illustrates the constrained region of the activation frontier in its strongest form; the direct-securities baseline is 0.068, located near the activation frontier in Section 4.6 and Table 1.

Table 5: Summary of the main experiments (high-exposure laboratory calibration)

Experiment	**Credit min. (%)**	**Capital min. (%)**	**Floor binds**	**max μ^b**
Government spending, $\omega = 0$	-40.2	-45.8	10	0.0623
Bank loss, $\omega = 0$	-17.9	-23.5	19	0.0272
Macroprudential-target shock, $\omega = 0$	-0.2	0.0	0	0.0000
Selic, $\omega = 0$	-15.7	-21.3	5	0.0281
External premium, $\omega = 0$	-0.4	-1.9	0	0.0000
Selic, $\omega = 1$	-0.6	-9.0	0	0.0000
Selic, $\omega = 0.5$	-1.9	-14.6	11	0.0058
Selic, exposure-aware rule, $\omega = 0$	-15.6	-21.2	4	0.0276

Note: "Floor binds" is the number of quarters the bank capital floor is binding. Credit and capital are maximal percentage deviations from steady state, $100(x_t - \bar{x})/\bar{x}$. The multiplier μ^b is reported in level. **High-exposure laboratory calibration** (`Bb_share`=0.25, 66.5% exposure); the direct-securities baseline is 0.068 (Table 1).

Table 6: Robustness to the share of Selic-indexed debt in the bank's sovereign portfolio (high-exposure laboratory calibration)

s_S	ω	Credit min. (%)	Capital min. (%)	**max μ^b**	Floor binds
0.00	1.0	-1.3	-23.1	0.0052	19
0.00	0.5	-6.3	-33.1	0.0204	20
0.00	0.0	-34.3	-39.9	0.0618	6
0.25	1.0	-0.8	-15.8	0.0018	6
0.25	0.5	-4.1	-23.7	0.0130	17
0.25	0.0	-25.3	-30.8	0.0454	5
0.50	1.0	-0.6	-9.0	0.0000	0
0.50	0.5	-1.9	-14.6	0.0058	11
0.50	0.0	-15.7	-21.3	0.0281	5
0.75	1.0	-0.4	-3.2	0.0000	0
0.75	0.5	-0.6	-5.5	0.0000	0
0.75	0.0	-5.6	-11.2	0.0098	3

Note: s_S is the share of short Selic-indexed debt in the bank's sovereign portfolio. "Floor binds" is the number of binding quarters; $\max \mu^b$ measures the severity of the binding regime. Binding quarters should not be read in isolation: a regime may stay near the floor longer but with a smaller shadow value. Economic severity is captured jointly by credit, capital, and $\max \mu^b$. **High-exposure laboratory calibration** (`Bb_share`=0.25, 66.5% exposure); the direct-securities baseline is 0.068 (Table 1).

Table 7: Timing of monetary tightening and the regulatory-duration channel (high-exposure laboratory calibration)

Path	s_S	$t_{\max I^{pol}}$	$\mathcal{D}_\pi$	$\pi^{lin}_{\min}$ (%)	$\pi^{pw}_{\min}$ (%)	$p^B_{\min}$ (%)	$K^b_{\min}$ (%)	$b^I_{\min}$ (%)	$\max \mu^b$
Front-loaded	0.00	2	0.0136	-0.160	-0.171	-0.422	-18.88	-13.32	0.0232
Gradual	0.00	7	0.0136	-0.071	-0.067	-0.084	-10.89	-5.34	0.0088
Front-loaded	0.50	2	0.0136	-0.172	-0.175	-0.523	-12.24	-6.68	0.0112
Gradual	0.50	7	0.0136	-0.070	-0.069	-0.118	-8.28	-2.73	0.0042
Front-loaded	0.75	2	0.0136	-0.181	-0.181	-0.598	-7.73	-2.18	0.0035
Gradual	0.75	7	0.0136	-0.070	-0.070	-0.144	-6.18	-0.63	0.0008

Note: Both paths are scaled so that cumulative disinflation over $H_\pi = 24$ quarters, $\mathcal{D}_\pi = -\sum_t \log(\pi_t/\bar{\pi})$, computed in the linear (no-floor) solution, matches that of the baseline Selic shock. The shape is a hump $s_t(\tau) = (t/\tau)e^{1-t/\tau}$ with the policy-rate peak at $t \approx \tau$ ($\tau = 2$ front-loaded, $\tau = 8$ gradual); $t_{\max I^{pol}}$ is the realized peak quarter. Severity is measured on the piecewise (OccBin) solution over 60 quarters, with $\omega = 0$. $\pi^{lin}_{\min}$ and $\pi^{pw}_{\min}$ are the inflation troughs in the linear and piecewise solutions; their divergence at low s_S reflects the credit crunch feeding back into realized inflation. **High-exposure laboratory calibration** (`Bb_share`=0.25, 66.5% exposure); the direct-securities baseline is 0.068 (Table 1).

Table 8: Grid of smooth macroprudential rules under the Selic shock (high-exposure laboratory calibration)

Rule	ϕ	Credit min. (%)	Capital min. (%)	max μ^b	Floor binds
Sovereign-blind	0.00	-15.71	-21.27	0.0281	5
Debt-aware	0.25	-15.70	-21.25	0.0281	5
Debt-aware	0.50	-15.68	-21.24	0.0280	5
Debt-aware	1.00	-15.65	-21.21	0.0280	5
Debt-aware	2.00	-15.60	-21.15	0.0279	5
Debt-aware	4.00	-15.48	-21.03	0.0278	4
Debt-aware	8.00	-15.24	-20.79	0.0274	4
Exposure-aware	0.25	-15.60	-21.15	0.0276	4
Exposure-aware	0.50	-15.49	-21.04	0.0271	4
Exposure-aware	1.00	-15.29	-20.85	0.0262	4
Exposure-aware	2.00	-15.03	-20.58	0.0246	3
Exposure-aware	4.00	-14.97	-20.52	0.0223	3
Exposure-aware	8.00	-16.03	-21.58	0.0242	5

Note: The exercise fixes $\omega = 0$, $s_S = 0.5$, and the Selic shock. Here ϕ denotes $\phi_{\nu B}$ for the debt-aware rows and $\phi_{\nu X}$ for the exposure-aware rows. The sovereign-blind institutional reference sets the relevant sovereign-response coefficient to zero and therefore responds only to credit. No rule eliminates the binding regime; the exposure-aware rule attenuates the floor's shadow value for intermediate coefficients but can become procyclical when too aggressive. **High-exposure laboratory calibration** (`Bb_share`=0.25, 66.5% exposure); the direct-securities baseline is 0.068 (Table 1).

Table 6 shows two things. First, for any s_S, a fall in ω raises the economic severity of the credit contraction, visible jointly in the credit, capital, and max μ^b columns. Second, for any ω, raising s_S reduces severity: Selic debt does not generate the mechanism; it cushions it. The driver of fragility is the duration of the long bonds.

The dual-constraint results show how the borrower and bank constraints interact. Bank-capital stress raises the incidence and duration of borrower collateral stress. In the opposite direction, borrower deleveraging reduces risk-weighted assets and partially relaxes the bank floor, making the peak-loss interaction less than additive. The output trough consequently remains essentially unchanged relative to the bank-floor-only economy, even when the borrower begins only 0.5% away from the collateral boundary.

6 Economic interpretation

The results support four propositions.

6.1 Proposition 1: the regulatory privilege of sovereign debt can create fragility

The conventional intuition is that a low risk weight on domestic sovereign debt makes that debt safer from a regulatory standpoint. The model reveals an opposing force. When $\omega = 0$, sovereign bonds do not enter RWA; yet their price losses still reduce bank capital. The privileged asset consumes no capital before the crisis but destroys capital during it. Once the floor binds, the bank must shed risk-weighted assets, and private credit is the main margin of adjustment.

6.2 Proposition 2: Selic-indexed debt is not the source of fragility

The most Brazil-specific feature of the model is a large share of Selic-sensitive public debt. The composition robustness shows that this share cushions, rather than amplifies, the mechanism: with $\omega = 0$, raising s_S from 0 to 0.75 reduces the maximal credit contraction from -34.33% to -5.65%. The crisis is most severe when the bank's sovereign portfolio is composed only of long bonds. The channel is therefore not specific to Selic-indexed debt: the central mechanism is sovereign duration risk on the bank balance sheet, combined with privileged regulatory treatment and a hard capital floor.

6.3 Proposition 3: the relevant policy margin is the sovereign risk weight

The rule grid shows that adding aggregate public-debt information to the credit-only institutional reference has almost no effect at the baseline coefficient. Bank-specific sovereign-duration information provides somewhat greater attenuation at intermediate coefficients: it lowers the floor's shadow value and shortens the binding regime. It does not eliminate the credit contraction, however, and an overly aggressive response becomes counterproductive by raising the required-capital target when bank capital is already impaired. The treatment of sovereign debt in risk-weighted assets remains the quantitatively important regulatory margin. The first-order policy question is how sovereign risk weights interact with duration losses and hard capital floors.

6.4 Proposition 4: more financial constraints need not imply greater peak amplification

The joint-constraint experiment reveals an asymmetric interaction. Bank-capital stress moves borrowers toward their collateral limit and lengthens the collateral regime. Yet collateral-driven deleveraging lowers the bank's risk-weighted private assets and partly restores its capital ratio. In the $\omega = 0$ experiment, the same loan is the borrower's liability

and a risk-weighted asset entering the bank's regulatory denominator. The constraints are therefore complementary in the incidence and duration of borrower collateral stress, but their interaction is less than additive in peak credit and output losses. The relevant question is therefore not simply how many financial constraints are present, but how adjustment at one boundary changes the state variable governing the other.

7 Conclusion

This paper studies how the regulatory treatment of domestic sovereign debt shapes the transmission of monetary policy to bank credit. A monetary tightening reduces the market value of long-duration public debt held by banks and erodes bank capital through mark-to-market losses. If sovereign debt carries a low or zero risk weight, the loss reduces the numerator of the capital ratio without a comparable fall in risk-weighted assets. Once the capital floor binds, the bank restores its regulatory ratio by reducing risk-weighted private credit.

The main result is that this regulatory-duration channel is threshold-like. It becomes quantitatively important only when sovereign exposure is sufficiently high and the effective capital buffer sufficiently thin for duration losses to exhaust the distance to the floor. This activation frontier organizes the paper's results. Zero sovereign risk weights amplify credit losses in the constrained region; a larger share of Selic-indexed debt reduces duration exposure and moves the bank away from that region; and a front-loaded tightening is more costly for credit than a gradual tightening delivering the same cumulative disinflation because it concentrates duration losses early.

The two-constraint extension shows that the borrower and bank constraints interact asymmetrically. Bank-capital stress makes the borrower collateral constraint more likely to bind and lengthens its binding spell. The feedback is not mechanically superadditive, however. Collateral-driven borrower deleveraging reduces the bank's risk-weighted private assets and partially relieves the capital floor. The two constraints are therefore complementary in the incidence and duration of collateral stress, but their interaction is less than additive in peak credit and output losses. Even when the borrower begins only 0.5% away from the collateral boundary, adding the borrower constraint leaves the aggregate output trough virtually unchanged relative to the bank-floor-only economy.The result rules out the interpretation that the benchmark's moderate real effects are merely an artifact of omitting household collateral.

The Brazilian calibration illustrates the mechanism in a domestic-currency emerging-market setting with large public-debt holdings by banks and a debt structure that mixes long-duration and short-rate-indexed instruments. The absence of foreign- currency sovereign debt is deliberate: the exercise isolates duration losses on the local-currency public-debt instruments that dominate the Brazilian setting rather than combining them

with exchange-rate valuation or sovereign-default channels. Under the model-consistent exposure measure, the direct-securities upper bound places the banking system near the activation threshold, while a broader repo-inclusive proxy moves it into the constrained region. The high-exposure calibration used in the detailed experiments is a laboratory case for the interior of the constrained region, rather than the empirically anchored Brazilian baseline.

The results also clarify the role of macroprudential policy. Smooth capital targets that react to aggregate public debt or to bank sovereign exposure have similar welfare implications and only limited effects on the binding regime. The quantitatively important margin is the regulatory treatment of sovereign debt in risk-weighted assets. When the relevant nonlinearity is a hard capital floor, zero or low sovereign risk weights can make duration losses on domestic public debt translate into a sharp contraction of private credit.

The broader implication is twofold. First, domestic-currency sovereign debt need not be innocuous for the banking system even when default and exchange-rate valuation channels are absent: duration risk can activate the sovereign–bank nexus when regulation treats sovereign assets favorably and banks operate with thin effective buffers. Second, the interaction of financial constraints depends on their balance-sheet incidence. A new constraint can intensify regime activation while attenuating peak losses if the adjustment it induces relaxes the denominator or boundary governing another constraint. Monetary policy, debt management, prudential regulation, and private deleveraging must therefore be evaluated as parts of the same nonlinear balance-sheet system.

A Welfare and smooth macroprudential rules

The welfare results in this appendix compare the debt-aware quantitative baseline with the exposure-aware counterfactual. The exercise is narrower than the rule grid in Section 4.11: it asks whether replacing aggregate public-debt information with bank-specific sovereign-duration information produces a meaningful welfare difference. Accordingly, the welfare exercise compares only the two sovereign-informed specifications. The analysis is secondary to the central mechanism, which operates through the regulatory weight of sovereign debt in RWA_t and the hard capital floor. In this appendix only, private credit b^I is read explicitly as a loan to the impatient household, so that the distributional comparison between saver and borrower is meaningful.

Welfare is computed using an offline engine validated against the Dynare baseline paths. Household welfare differences are reported as consumption-equivalent changes in basis points. Let θ denote the planner's weight on the patient household; the threshold θ^* is the weight at which the planner is indifferent between the two rules.

Unlike the impulse-response figures, which are generated directly from the model, Figure 17 is a derived object: it combines the simulated paths with each household type's

welfare metric. Because both rules are evaluated within the same engine, level differences across implementations do not affect the welfare comparison.

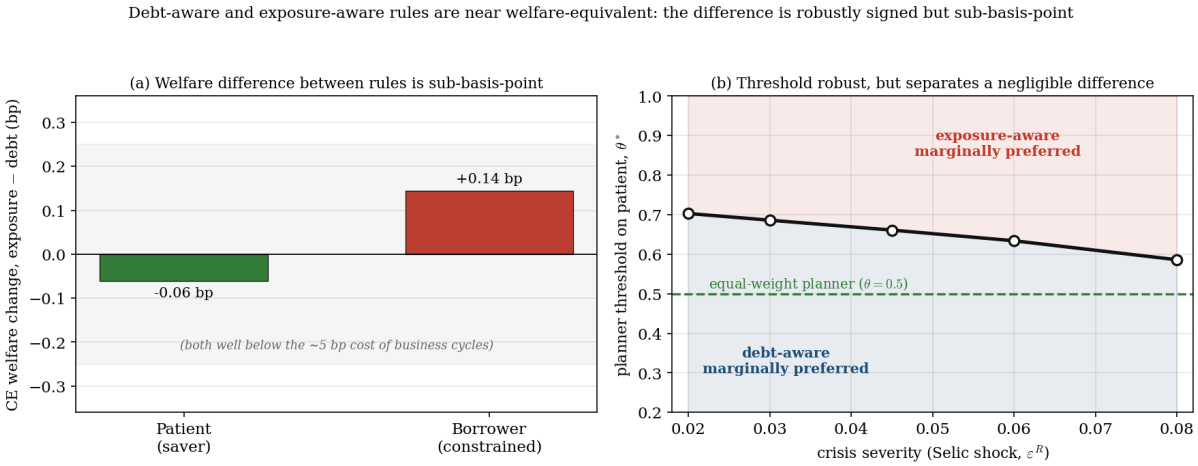


Figure 17: Near-equivalence of welfare between the debt-aware and exposure-aware rules.

Figure 17 shows that the welfare difference between the exposure-aware and debt-aware rules is of sub-basis-point magnitude. The left panel reports this welfare difference, while the right panel reports the planner threshold. The threshold is well defined but separates economically small differences. The figure therefore documents near-equivalence between the two sovereign-informed rules. The first-order regulatory margin lies in the treatment of sovereign debt in risk-weighted assets and its interaction with the hard capital floor.

B Physical-capital robustness

This appendix asks whether the regulatory-duration activation mechanism survives once the real side of the economy includes physical capital and investment. In the extension, the patient household owns physical capital K_t^p, rents it to firms at rate r_t^k, and chooses investment I_t subject to a standard adjustment cost; production becomes Cobb–Douglas, $y_t = A_t(K_{t-1}^p)^{\alpha_K}(l_t^P + l_t^I)^{1-\alpha_K}$. The banking block, the risk-weighted-asset definition, the sovereign-exposure measure, and the occasionally binding capital floor are left unchanged. The exercise therefore enriches the propagation environment without altering the mechanism being tested. Calibration: $\alpha_K = 0.33$, $\delta_k = 0.025$, investment adjustment cost $\phi_I = 4$, which imply an investment–output ratio of 19.6%.

B.1 Steady-state comparability

The extension is constructed to hold $\bar{y} = 1$ fixed, so the bank balance sheet and the sovereign-exposure ratios are numerically identical to the benchmark; only the real block is recalibrated (TFP A and the wage w absorb the capital share, and consumption adjusts to

the new investment use of resources). Table 9 verifies this: the capital ratio, private credit, RWA, bank capital, and the long-bond price coincide to all reported digits, confirming that exposure and the floor are not reparameterized by the extension.

Table 9: Steady-state comparability: benchmark vs. physical-capital model.

	Benchmark	Physical capital
Bank block (unchanged)		
Capital ratio (SS)	0.0900	0.0900
Private credit b^I	0.3017	0.3017
Risk-weighted assets	0.3017	0.3017
Bank capital K^b	0.0272	0.0272
Long-bond price p^B	16.639	16.639
Real block (changed)		
TFP A	1.000	0.507
Wage w	0.833	0.558
Patient consumption c^P	0.415	0.357
Impatient consumption c^I	0.380	0.243
Capital K^p	—	7.835
Investment I	—	0.196
Rental rate r^k	—	0.0351
Tobin's q	—	1.000

The sovereign positions $B^{b,S}$ and B^b are mechanically identical across models for a given value of `Bb_share`; they are therefore omitted from the table.

B.2 Activation frontier

Table 10 reports the sovereign-exposure threshold on the model-consistent credit-plus-securities basis at which the capital floor first activates, by capital buffer, in the two models. The frontier survives and stays monotone; it shifts modestly outward for thin buffers, indicating that the benchmark without physical capital is not mechanically forcing the floor to bind. For wider buffers the threshold is unchanged at the resolution of the exposure grid.

Table 10: Activation frontier: exposure threshold (% of credit plus securities) by capital buffer.

Capital buffer	Benchmark	Physical capital
0.5 pp	37.4%	44.3%
1.0 pp	49.9%	54.4%
1.5 pp	61.4%	61.4%
2.0 pp	66.5%	66.5%

B.3 Exposure-by-shock grid: peak-tightening experiments

Table 11 reports the trough of private credit (% deviation) and whether the floor binds, across sovereign-exposure rows and peak-tightening columns. The shock is scaled within each column to match the reported peak Selic tightening in the slack reference economy. In this peak-tightening grid, the pivotal Direct-TVM × 1,175 bp cell continues to bind under physical capital, and the credit contraction is, if anything, slightly larger: −2.1% in the benchmark versus −2.5% with capital. A sufficiently large tightening crosses the frontier even in the capital extension.

Table 11: Exposure-by-shock grid: credit trough (%) and floor binding (Y/N).

Exposure	250 bp	500 bp	1,175 bp	1,500 bp
Benchmark				
Public-only lower bound	−0.2/N	−0.3/N	−0.8/N	−1.1/Y
Direct TVM upper bound	−0.2/N	−0.4/N	−2.1/Y	−3.7/Y
Repo-inclusive proxy	−0.3/N	−0.6/N	−5.5/Y	−8.1/Y
High-exposure laboratory	−2.3/Y	−8.0/Y	−22.1/Y	−29.1/Y
Physical capital				
Public-only lower bound	−0.3/N	−0.7/N	−1.7/N	−2.1/N
Direct TVM upper bound	−0.4/N	−0.8/N	−2.5/Y	−4.1/Y
Repo-inclusive proxy	−0.5/N	−1.0/N	−6.2/Y	−8.5/Y
High-exposure laboratory	−2.6/Y	−8.4/Y	−23.0/Y	−30.1/Y

B.4 Mechanism diagnostics: common baseline Selic shock

Table 12 compares impulse responses to the same Selic shock sequence embedded in the model file (both models are hit with the identical shock; the realized peak differs slightly through general equilibrium). The sovereign-duration input of the mechanism is essentially unchanged: the long-bond price response (p^B) and the bank-capital loss (K^b) coincide across the two models—in the high-exposure case K^b falls by −21.3% in both. What differs is the activation margin. In the Direct-TVM case the benchmark binds only marginally (one quarter, $\max \mu_b = 3.4 \times 10^{-4}$), while the capital model stays slack ($\mu_b \approx 0$, a positive gap of 0.093 pp). In the high-exposure case both models bind for five quarters with multipliers of order 10^{-2}, and b^I and RWA fall almost identically.

The capital-specific responses are modest and do not materially alter the sovereign–bank channel: under the baseline shock, investment falls by 0.5–0.6%, Tobin's q by about 2%, the rental rate by 5–5.6%, and the capital stock is nearly unchanged over the short horizon.

Table 12: Mechanism diagnostics under the common baseline Selic shock.

Panel A. Sovereign-duration and credit responses

Model	Exposure	Peak Selic (bp)	$\min p^B$ (%)	$\min K^b$ (%)	$\min \mathrm{RWA}$ (%)	$\min b^I$ (%)
Benchmark	Direct TVM	871.2	−2.054	−5.915	−0.754	−0.754
Capital	Direct TVM	839.0	−2.004	−5.735	−1.375	−1.375
Benchmark	High-exp.	854.2	−1.949	−21.252	−15.697	−15.697
Capital	High-exp.	820.6	−1.917	−21.271	−15.716	−15.716

Panel B. Real response and binding diagnostics

Model	Exposure	$\min y$ (%)	Min gap (pp)	$\max \mu_b$	Binding quarters μ_b/gap
Benchmark	Direct TVM	−1.305	0.0000	3.4×10^{-4}	1/1
Capital	Direct TVM	−1.020	0.0926	0	0/0
Benchmark	High-exp.	−1.406	0.0000	2.8×10^{-2}	5/5
Capital	High-exp.	−1.091	0.0000	2.6×10^{-2}	5/5

Notes: Percentage entries are trough deviations from steady state over the reported horizon. "Min gap" is $100(\mathrm{capratio}_t - \nu_{\min})$ at its minimum. The final column reports the number of binding quarters according to the multiplier criterion $\mu_b > 10^{-6}$ and the gap criterion $\mathrm{capratio}_t \le \nu_{\min} + 10^{-8}$.

Summary

The physical-capital extension confirms that the regulatory-duration mechanism is not an artifact of abstracting from capital accumulation. The long-bond price response and the associated bank-capital losses are virtually unchanged across the benchmark and the capital extension. Physical capital mainly affects the activation margin, not the sovereign-duration input of the mechanism: under the baseline Selic shock, the Direct-TVM case becomes slack, while the high-exposure case remains clearly constrained. Under a peak tightening of about 1,175 basis points, the Direct-TVM cell binds again in the capital model. Thus, the benchmark without physical capital is somewhat more sensitive at the extensive activation margin near the frontier, but it does not overstate the core regulatory-duration mechanism once the economy enters the constrained region.

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