When Risk-Off Hits: Foreign-Currency Bank Funding and Amplification in a Small Open Economy

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Abstract

This paper develops a small open New Keynesian DSGE model with a financial accelerator and a banking sector that borrows abroad in foreign currency and faces a leverage constraint. A "risk shock" is modeled as an increase in the cross-sectional dispersion of entrepreneurial idiosyncratic risk, which raises default probability and monitoring losses and thereby widens the external finance premium. The banking block links this domestic tightening to global risk conditions and external leverage through an endogenous foreign funding premium, while currency mismatch erodes bank net worth when the exchange rate depreciates. Calibrated impulse responses show that a one-standard-deviation risk shock generates a sharp and persistent contraction in investment and output, and that amplification is substantially stronger when leverage is higher, monitoring frictions are more severe, or capital flows are more procyclical. The framework provides a transparent laboratory for evaluating macroprudential and capital-flow management policies.

Keywords: Financial accelerator; Bank leverage constraints; Foreign-currency funding; Capital-flow procyclicality; Small open economy DSGE

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1 Introduction

When global markets are calm, a small open economy can look deceptively insulated. Banks roll over foreign-currency funding at thin spreads, firms refinance routinely, and the exchange rate moves like background noise. Then sentiment turns. The same investors who were willing to hold risky assets suddenly demand safety, credit premia jump, and the exchange rate starts to move in the "wrong" direction—depreciating exactly when balance sheets are least able to absorb it. In that moment, the macro story is not mainly about a fall in productivity or a change in tastes. It is about how risk is priced, how quickly funding conditions tighten, and how leverage turns a financial tremor into a real contraction.

This paper studies that moment. We ask a simple question with large implications: how do financial risk shocks propagate in a small open economy when credit is intermediated by a banking sector that can borrow abroad in foreign currency and is subject to balance-sheet constraints? The focus is on risk shocks that raise default risk in the corporate sector—captured as an increase in the dispersion of idiosyncratic capital-quality shocks—and on how these shocks are amplified by: i) leverage, ii) the severity of credit-market frictions, and iii) the procyclicality of cross-border funding conditions.

The mechanism combines two strands of thinking that have developed largely in parallel. The first strand emphasizes the financial accelerator: when borrowers' net worth falls, external finance becomes more expensive, and the resulting contraction in investment further erodes balance sheets (Bernanke *et al.*, 1999, Carlstrom and Fuerst, 1997, Kiyotaki and Moore 1997). The second strand stresses that, in open economies, capital flows and global financial conditions can overwhelm domestic fundamentals and compress monetary autonomy (Rey, 2015, Bruno and Shin, 2015). A key lesson from both strands is that amplification is not a black box. It depends on measurable features of the economy: leverage, currency mismatch, and the sensitivity of funding premia to risk.

To quantify these forces in a coherent way, we build a small open New Keynesian DSGE model with monopolistic competition and nominal rigidities (Calvo, 1983, Clarida *et al.*, 1999, Galí and Monacelli, 2005), and embed a costly-state-verification financial accelerator (Bernanke *et al.*, 1999, Carlstrom and Fuerst, 1997). Entrepreneurs finance capital with internal net worth and bank loans. The banking sector funds those loans with domestic deposits and, in the open-economy extension, foreign-currency wholesale funding. A regulatory or incentive-based leverage constraint limits bank balance-sheet expansion, so bank net worth becomes a state variable for credit supply (Gertler and Kiyotaki, 2010, Gertler and Karadi, 2011). Finally, external funding costs are allowed to move with global risk and with the economy's external leverage, capturing that cross-border credit is abundant in booms and scarce in downturns (Rey, 2015, Bruno and Shin, 2015, Mendoza, 2010).

The shock we highlight is a "risk shock" in the spirit of Christiano *et al.*, (2014): the dispersion of idiosyncratic uncertainty rises, increasing the probability of default for a given leverage profile. This shock is attractive for two reasons. First, it speaks to a common empirical pattern: spreads often widen sharply even when current productivity indicators look stable. Second, it targets a margin that is naturally amplified by balance sheets. When dispersion rises, lenders require a higher external finance premium; investment declines; Tobin's q falls; and net worth is squeezed further. In models with financial frictions, these feedback loops are central to the macro response (Gilchrist and Zakrajšek, 2012, Jermann and Quadrini, 2012, Brunnermeier and Sannikov, 2014).

The open-economy dimension makes the same shock more consequential. In a closed economy, a risk shock is "only" a wedge between the borrower's return and the lender's required return. In a small open economy, the same risk shock can also trigger a repricing of external funding, a compression in bank net worth through currency mismatch, and a sharper fall in credit supply. This is the channel that links domestic financial distress to the exchange rate and to global risk conditions, consistent with the idea of a global financial cycle (Rey, 2015) and with the evidence that cross-border banking and leverage are pivotal for capital-flow dynamics (Bruno and Shin, 2015). It also connects naturally to the sudden-stop logic: when financing becomes scarce, the economy must adjust through expenditure compression and asset-price declines (Mendoza, 2010).

Our analysis sits at the intersection of macro-finance, open-economy monetary economics, and macroprudential policy. On the macro-finance side, we build on the financial accelerator tradition in which agency frictions make credit conditions endogenous and amplify real shocks (Bernanke *et al.*, 1999, Carlstrom and Fuerst, 1997). The broader balance-sheet perspective emphasizes that collateral constraints and borrowing limits can generate persistent dynamics even from small disturbances (Kiyotaki and Moore 1997). Modern macro-finance models push the same idea further by allowing nonlinear amplification, endogenous risk, and crisis-like episodes (Brunnermeier and Sannikov, 2014). Empirically, the central role of credit spreads in forecasting and propagating business cycles is well documented (Gilchrist and Zakrajšek, 2012), and models with explicit financial shocks show that disturbances originating in finance can account for a substantial share of macro fluctuations (Jermann and Quadrini, 2012).

On the "risk shock" dimension, the key insight is that time-varying uncertainty about idiosyncratic outcomes can matter as much as changes in average outcomes. Christiano *et al.*, (2014) formalize this by allowing the volatility of cross-sectional uncertainty to move over time and showing that such movements can have large real effects. Our paper adopts that discipline in an open-economy setting where risk is priced in both domestic and external funding markets.

On the monetary/open-economy side, we rely on the small open New Keynesian framework with nominal rigidities (Calvo, 1983, Galí and Monacelli, 2005), enriched by realistic open-economy features such as incomplete pass-through and imported goods (Adolfson *et al.*, 2007, Justiniano and Preston, 2010). We also use standard devices to ensure stationarity of net foreign asset positions in small open economy models (Schmitt-Grohé and Uribe, 2003). Importantly, the open-economy financial accelerator is not new: Gertler et al., (2007) show how exchange-rate regimes can interact with financial distress when borrowing constraints matter. Our contribution is to bring that logic into a framework that includes a banking sector with foreign-currency funding exposure and an explicit bank leverage constraint.

Finally, on macroprudential policy, a growing literature argues that when financial frictions interact with nominal rigidities, policy tools aimed at leverage and credit conditions can improve welfare by leaning against externalities in demand and balance sheets (Farhi and Werning, 2016). While the core of this paper is positive—documenting propagation and amplification—the model is designed as a laboratory for disciplined policy experiments, including countercyclical leverage regulation and capital-flow management tools.

The paper's main contributions are threefold. First, we develop a small open New Keynesian DSGE model that nests a costly-state-verification financial accelerator and adds a banking sector with balance-sheet constraints and foreign-currency wholesale funding. This integration allows risk shocks to move both the corporate external finance premium and the cost of foreign funding, creating a coherent channel from global risk to domestic credit and real activity.

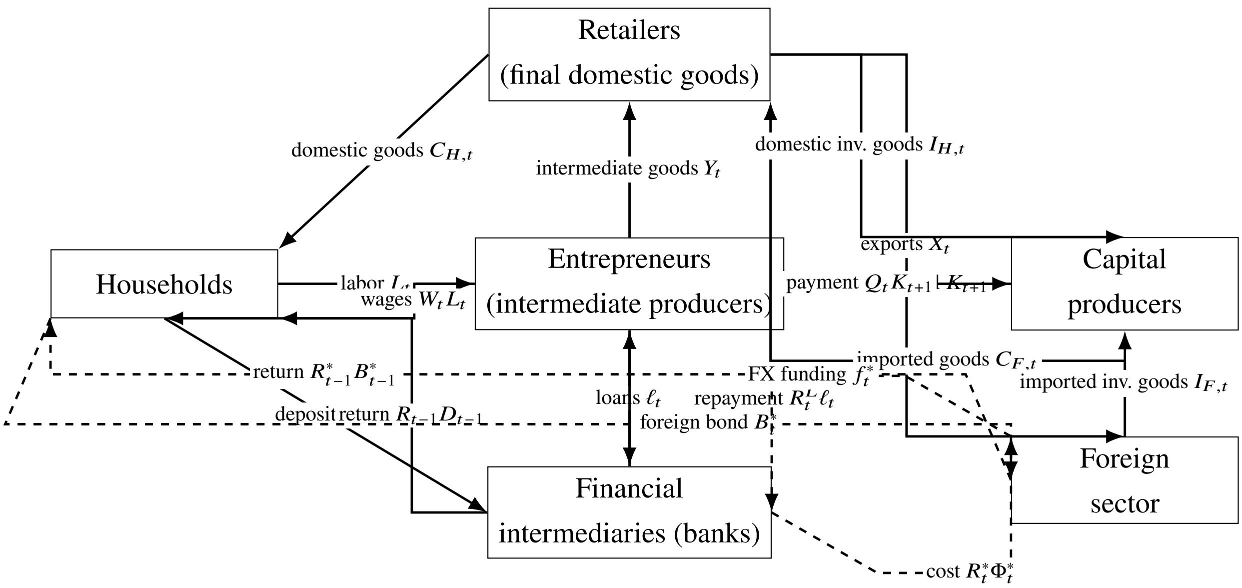
Second, the model isolates three practical sources of amplification: i) higher steady-state leverage (e.g., a higher K/N), ii) tighter financial frictions (e.g., higher monitoring costs), and iii) stronger procyclicality of external funding conditions. This taxonomy helps connect the theory to observable country characteristics and to the way macro-financial vulnerability is discussed by policymakers.

Third, using impulse-response analysis, we show that a one-standard-deviation risk shock can generate a sizable and persistent contraction in investment and output, and that the downturn is markedly larger when leverage is high, monitoring frictions are severe, or foreign funding premia are more state-dependent. The results line up with the empirical emphasis on spreads and leverage in macro downturns (Gilchrist and Zakrajšek, 2012, Schularick and Taylor, 2012) and with the view that global financial conditions matter even for countries with flexible exchange rates (Rey, 2015).

The model delivers a simple narrative with sharp quantitative content. A rise in risk dispersion raises the external finance premium on impact, compressing borrowing and investment. As investment falls, the price of installed capital declines, which further depresses capital accumulation. Net worth falls quickly, and the credit spread remains elevated for several years. In the open economy, the same risk shock also worsens foreign funding terms for banks, tightening lending conditions beyond what would occur in a closed economy. Comparative experiments show that amplification is substantially stronger in economies that enter the shock with higher leverage, tighter credit-market frictions, or more procyclical capital flows.

Section 2 lays out the model environment and defines equilibrium. Section 3 describes the baseline calibration. Section 4 presents impulse responses and the comparative-static exercises across leverage, financial frictions, and capital-flow procyclicality. Section 5 concludes and discusses implications and directions for policy analysis.

Figure 1: Main agents and flow of goods and funds in the model



Note: Solid arrows denote real-side transactions (goods, labor, and payments). Dashed arrows denote cross-border financial links (foreign bonds and foreign-currency bank funding).

2 Model

Figure 1 summarizes the architecture of the model we set up. Households supply labor to entrepreneurs and receive wage income; they also allocate savings between domestic bank deposits and foreign bonds. Entrepreneurs (intermediate-good producers) combine labor and installed capital to produce intermediate output, which is sold to retailers. Retailers differentiate and price final domestic goods under nominal rigidities, selling them to households and to the foreign sector (exports). Capital producers transform domestic and imported investment goods into installed capital and sell it to entrepreneurs. Financial intermediaries (banks) fund entrepreneurial loans using household deposits and, in the open-economy extension, foreign-currency wholesale funding. The foreign sector supplies imported consumption and investment goods and prices foreign bonds; through these channels, exchange-rate movements and global risk conditions affect domestic credit spreads and real activity.

2.1 Set up

Time is discrete, indexed by $t = 0, 1, 2, \ldots$. The economy is a small open New Keynesian DSGE model with: i) monopolistically competitive price setters and nominal rigidities, ii) an open-economy expenditure structure with imported consumption and investment goods, and iii) a financial accelerator in the spirit of costly state verification, enriched by bank balance-sheet frictions and foreign-currency funding exposure. The key amplification channel runs from macro shocks to: a) entrepreneurial default risk and external finance premia and b) bank net worth, which jointly feed back into investment, output, and the exchange rate.

There are seven blocks: households, entrepreneurs (intermediate-good producers), banks, capital producers, retailers (domestic final-good producers), import distributors (pricing imported goods with local-currency stickiness), the monetary authority, and the rest of the world.

The representative household consumes a CES composite of a domestically produced final good $C_{H,t}$ and an imported final good $C_{F,t}$:

$$C_t = \left[\gamma_c^{\frac{1}{\eta_c}} C_{H,t}^{\frac{\eta_c-1}{\eta_c}} + (1-\gamma_c)^{\frac{1}{\eta_c}} C_{F,t}^{\frac{\eta_c-1}{\eta_c}}\right]^{\frac{\eta_c}{\eta_c-1}}, \tag{1}$$

where $\eta_c > 0$ is the elasticity of substitution between home and foreign consumption goods and $\gamma_c \in (0, 1)$ captures home bias.

The associated CPI is:

$$P_t = \left[\gamma_c P_{H,t}^{1-\eta_c} + (1-\gamma_c) P_{F,t}^{1-\eta_c}\right]^{\frac{1}{1-\eta_c}}, \qquad \Pi_t \equiv \frac{P_t}{P_{t-1}}. \tag{2}$$

Gross investment I_t is a CES composite of a domestically produced investment good $I_{H,t}$ and an imported investment good $I_{F,t}$:

$$I_t = \left[\gamma_i^{\frac{1}{\eta_i}} I_{H,t}^{\frac{\eta_i-1}{\eta_i}} + (1-\gamma_i)^{\frac{1}{\eta_i}} I_{F,t}^{\frac{\eta_i-1}{\eta_i}}\right]^{\frac{\eta_i}{\eta_i-1}}, \tag{3}$$

with elasticity $\eta_i > 0$ and home bias $\gamma_i \in (0, 1)$. The corresponding investment price index is:

$$P_{I,t} = \left[\gamma_i P_{H,t}^{1-\eta_i} + (1-\gamma_i) P_{F,t}^{1-\eta_i}\right]^{\frac{1}{1-\eta_i}}. \tag{4}$$

2.2 Households

The representative household has external habit in consumption and supplies labor L_t:

$$\max_{\{C_t, L_t, D_t, B_t^*\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \frac{\psi L_t^{1+\varphi}}{1+\varphi} \right], \tag{5}$$

where $\beta \in (0,1)$ is the discount factor, $\sigma > 0$ is relative risk aversion, $h \in [0,1)$ governs habit strength, $\psi > 0$ scales labor disutility, and $\varphi > 0$ is the inverse Frisch elasticity.

Households hold one-period nominal deposits D_t at domestic banks (gross nominal return R_{t-1}), and a one-period foreign bond B_t^* denominated in foreign currency (gross foreign return R_{t-1}^*). Let S_t be the nominal exchange rate (domestic currency per unit of foreign currency). The household faces a quadratic portfolio adjustment cost on deviations of foreign bond holdings from a steady-state position $\bar{B}^*$, and a time-varying capital-flow wedge τ_t:

$$P_t C_t + D_t + S_t B_t^* (1 - \tau_t) + \frac{\xi_b}{2} \left(B_t^* - \bar{B}^* \right)^2 S_t = W_t L_t + R_{t-1} D_{t-1} + S_t R_{t-1}^* B_{t-1}^* + \Omega_t, \tag{6}$$

where W_t is the nominal wage and Ω_t denotes lump-sum profits rebated from firms, banks, and distributors (net of any lump-sum taxes).

Let Λ_t be the marginal utility of nominal income:

$$\Lambda_t \equiv \frac{\partial U_t}{\partial (P_t C_t)} = (C_t - hC_{t-1})^{-\sigma} - \beta h \, \mathbb{E}_t \left[(C_{t+1} - hC_t)^{-\sigma} \right]. \tag{7}$$

The intratemporal labor condition is:

$$\psi L_t^{\varphi} = \frac{W_t}{P_t} \Lambda_t^{-1}. \tag{8}$$

The Euler equation for domestic deposits is:

$$1 = \beta \, \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \frac{R_t}{\Pi_{t+1}} \right]. \tag{9}$$

The foreign bond condition yields a modified uncovered interest parity (UIP) with endogenous risk premium:

$$1 = \beta \, \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \frac{R_t^*}{\Pi_{t+1}} \frac{S_{t+1}}{S_t} \right] \cdot \exp\Big(- \tau_t - \xi_b (B_t^* - \bar{B}^*) \Big). \tag{10}$$

2.3 Entrepreneurs and intermediate-good production

A continuum of entrepreneurs produce homogeneous intermediate goods Y_t using capital services and labor:

$$Y_t = A_t(u_t K_t)^{\alpha} L_t^{1-\alpha}, \tag{11}$$

where A_t is total factor of productivity (TFP), $\alpha \in (0,1)$ is the capital share, K_t is the physical capital stock, and u_t is the utilization rate. Utilization entails a real resource cost $a(u_t)K_t$ with

$$a(1) = 0, \quad a'(1) = 0, \quad a''(u) > 0. \tag{12}$$

Entrepreneurs sell intermediate goods to domestic retailers at nominal price $P_{m,t}$. Let real marginal cost be $mc_t \equiv \frac{P_{m,t}}{P_{H,t}}$ (retailers' real input cost in units of the domestic final-good price). Cost minimization implies the usual factor demands:

$$\frac{W_t}{P_{H,t}} = (1-\alpha)\, mc_t \frac{Y_t}{L_t}, \tag{13}$$

$$z_t \equiv \frac{Z_t}{P_{H,t}} = \alpha\, mc_t \frac{Y_t}{u_t K_t}, \tag{14}$$

where Z_t is the nominal rental payment for one unit of utilized capital and z_t its real counterpart.

Capital is produced by capital producers and purchased by entrepreneurs at real price $q_t \equiv Q_t/P_{H,t}$. Installed capital evolves as:

$$K_{t+1} = (1-\delta)K_t + I_t - \frac{\phi_I}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t, \tag{15}$$

where $\delta \in (0,1)$ is depreciation and $\phi_I > 0$ governs convex adjustment costs.

At $t+1$, the effective value of installed capital is hit by an idiosyncratic shock ω_{t+1}:

$$\omega_{t+1} \sim \log \mathcal{N}\left(-\frac{\sigma^2_{\omega,t+1}}{2}, \sigma^2_{\omega,t+1}\right), \qquad \mathbb{E}[\omega_{t+1}] = 1,$$

where the cross-sectional dispersion $\sigma_{\omega,t}$ is time-varying (risk shock), specified below. Higher $\sigma_{\omega,t}$ means thicker tails and greater default risk.

The gross real return on a unit of installed capital (before ω) is:

$$R^k_{t+1} = \frac{(1-\delta)q_{t+1} + z_{t+1}u_{t+1} - a(u_{t+1})}{q_t}. \tag{16}$$

Entrepreneurs finance capital purchases with net worth n_t and one-period real loans ℓ_t from banks:

$$q_t K_{t+1} = n_{t+1} + \ell_{t+1}. \tag{17}$$

Loans are subject to costly state verification. If the realized ω_{t+1} falls below a cutoff $\bar{\omega}_{t+1}$, the entrepreneur defaults; the bank audits and recovers a fraction $(1-\mu)$ of the project payoff, where $\mu \in (0,1)$ is the monitoring cost.

The standard contract implies a promised repayment that pins down the cutoff:

$$\ell_{t+1} R^L_{t+1} = \bar{\omega}_{t+1} R^k_{t+1}\, q_t K_{t+1}, \tag{18}$$

where R^L_{t+1} is the gross real loan rate charged to entrepreneurs.

Define the distribution functions under dispersion $\sigma_{\omega,t+1}$:

$$F(\bar{\omega}_{t+1}; \sigma_{\omega,t+1}) \equiv \Pr(\omega_{t+1} \le \bar{\omega}_{t+1}), \tag{19}$$

$$G(\bar{\omega}_{t+1}; \sigma_{\omega,t+1}) \equiv \int_0^{\bar{\omega}_{t+1}} \omega\, dF(\omega; \sigma_{\omega,t+1}). \tag{20}$$

Let

$$\Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t+1}) \equiv \bar{\omega}_{t+1}\left[1 - F(\bar{\omega}_{t+1}; \sigma_{\omega,t+1})\right] + G(\bar{\omega}_{t+1}; \sigma_{\omega,t+1}), \tag{21}$$

which is the expected fraction of gross project returns transferred to the bank (promised repayment in non-default states plus recovered proceeds in default states, net of the cutoff structure).

Thus, the bank's expected gross real receipts from one unit of capital investment satisfy:

$$\mathbb{E}_t\,[\text{bank payoff}] = \mathbb{E}_t\left[\Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t+1})\, R^k_{t+1}\, q_t K_{t+1}\right] - \mu\, \mathbb{E}_t\left[G(\bar{\omega}_{t+1}; \sigma_{\omega,t+1})\, R^k_{t+1}\, q_t K_{t+1}\right]. \tag{22}$$

A fraction $\nu_e \in (0,1)$ of entrepreneurs survives into $t+1$; the remainder exits and is replaced by entrants receiving a transfer χ_e (in real units). Net worth therefore evolves as:

$$n_{t+1} = \nu_e\left(1 - \Gamma(\bar{\omega}_t; \sigma_{\omega,t})\right) R^k_t\, q_{t-1} K_t + \chi_e, \tag{23}$$

so that higher default premia (a higher Γ for given leverage) slow down internal funding and amplify downturns.

2.4 Banks: balance sheets, foreign funding, and capital regulation

Banks intermediate between households and entrepreneurs, and may also borrow abroad in foreign currency.[1]

Let $d_t \equiv D_t/P_t$ denote real deposits, and let f_t^* denote foreign-currency wholesale funding (in foreign units). Its domestic real value is $\frac{S_t}{P_t} f_t^*$. Let n_t^b be bank real net worth. Banks' real lending to entrepreneurs equals ℓ_{t+1}, so the balance sheet is:

$$\ell_{t+1} = d_t + \frac{S_t}{P_t} f_t^* + n_t^b. \tag{24}$$

Deposits pay the domestic gross nominal rate R_t (gross real R_t/Π_{t+1}). Foreign funding pays the gross foreign nominal rate R_t^* plus a bank/sovereign spread Φ_t^*, both in foreign currency. In domestic real terms, the expected gross cost of one unit of foreign funding is:

$$\mathbb{E}_t \left[\frac{S_{t+1}}{S_t} \frac{R_t^* \Phi_t^*}{\Pi_{t+1}} \right]. \tag{25}$$

The spread Φ_t^* is increasing in external leverage and global risk, capturing that foreign lenders charge more when the country or the banking system looks fragile:

$$\ln \Phi_t^* = \phi_f \left(\frac{S_t f_t^*}{P_t Y_t} - \overline{f} \right) + \phi_{\sigma^*} \sigma_t^*, \tag{26}$$

where $\overline{f}$ is a steady-state foreign funding ratio, $\phi_f > 0$, and σ_t^* is a global risk shock.

Banks face a time-varying regulatory leverage constraint:

$$\ell_{t+1} \leq \lambda_t n_t^b, \tag{27}$$

where $\lambda_t > 1$ is the maximum leverage multiple. Macroprudential policy and risk conditions move λ_t:

$$\ln \lambda_t = (1 - \rho_\lambda) \ln \bar{\lambda} + \rho_\lambda \ln \lambda_{t-1} - \phi_\ell \ln \left(\frac{\ell_t}{\bar{\ell}} \right) - \phi_y \ln \left(\frac{Y_t}{\bar{Y}} \right) + \varepsilon_{\lambda,t}, \tag{28}$$

where $\phi_\ell, \phi_y \geq 0$ capture countercyclicality (tightening when credit expands or output booms), $\rho_\lambda \in (0,1)$ is persistence, and $\varepsilon_{\lambda,t}$ is a regulatory shock.

When (27) is slack, competition drives the expected loan return to match marginal funding costs. When it binds, the shadow value of bank capital creates an endogenous lending spread.

[1] This block makes the model materially more sensitive to exchange-rate movements, a feature that matters in many small open economies during risk-off episodes.

A tractable representation is:

$$R_{t+1}^{L} = \left(\frac{R_t}{\mathbb{E}_t \Pi_{t+1}}\right) \cdot \Phi_t^b, \qquad \ln \Phi_t^b = \chi_b \left(\frac{\ell_{t+1}}{\lambda_t n_t^b} - 1\right), \tag{29}$$

where $\Phi_t^b \geq 1$ is the bank-capital-induced wedge and $\chi_b > 0$ measures how aggressively loan spreads react when leverage approaches the regulatory ceiling.

Banks earn on entrepreneurial loans but pay depositors and foreign creditors. Let Π_{t+1}^b be real bank profits:

$$\Pi_{t+1}^b = \underbrace{\Big(\Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t+1}) - \mu\, G(\bar{\omega}_{t+1}; \sigma_{\omega,t+1})\Big) R_{t+1}^k\, q_t K_{t+1}}_{\text{loan receipts net of monitoring}} - \underbrace{\frac{R_t}{\Pi_{t+1}} d_t}_{\text{deposit cost}} - \underbrace{\frac{S_{t+1}}{S_t} \frac{R_t^* \Phi_t^*}{\Pi_{t+1}} \frac{S_t}{P_t} f_t^*}_{\text{foreign funding cost}}. \tag{30}$$

A fraction $\nu_b \in (0, 1)$ of bankers survives; entrants receive transfer χ_b^0. Net worth evolves as:

$$n_{t+1}^b = \nu_b \left(n_t^b + \Pi_{t+1}^b\right) + \chi_b^0. \tag{31}$$

Because foreign liabilities are revalued by $\frac{S_{t+1}}{S_t}$, a depreciation raises funding costs and can erode bank net worth quickly, tightening (27) and pushing up Φ_t^b.

2.5 Capital producers

Capital producers transform investment goods into installed capital and sell it to entrepreneurs at price Q_t. Their problem in real terms (units of the domestic final-good price) is:

$$\max_{\{I_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[q_t I_t - \frac{P_{I,t}}{P_{H,t}} I_t - \frac{\phi_I}{2} \left(\frac{I_t}{K_t} - \delta\right)^2 K_t \right], \tag{32}$$

subject to the accumulation equation (15). The optimality condition yields Tobin's q relation:

$$q_t = \frac{P_{I,t}}{P_{H,t}} + \phi_I \left(\frac{I_t}{K_t} - \delta\right) + \beta\, \mathbb{E}_t \left[q_{t+1} \frac{\phi_I}{2} \left(\frac{I_{t+1}}{K_{t+1}} - \delta\right)^2 \right] \quad \text{(up to standard second-order terms).} \tag{33}$$

2.6 Retailers: domestic price stickiness

A continuum of retailers buys intermediate goods at price $P_{m,t}$, differentiates, and sells domestic final goods under monopolistic competition. Retail prices are subject to Calvo stickiness: in each period, a fraction $1 - \phi_H$ can reset prices; the rest keep last period's price indexed to past inflation at rate $\iota_H \in [0, 1]$.

Log-linearizing around a zero-inflation steady state produces a hybrid New Keynesian Phillips curve for domestic inflation $\pi_{H,t} \equiv P_{H,t}/P_{H,t-1}$:

$$\hat{\pi}_{H,t} = \beta \mathbb{E}_t \hat{\pi}_{H,t+1} + \iota_H \hat{\pi}_{H,t-1} + \kappa_H \hat{mc}_t, \qquad \kappa_H \equiv \frac{(1-\phi_H)(1-\beta\phi_H)}{\phi_H} \cdot \frac{1}{1+\beta\iota_H}, \tag{34}$$

where hats denote log-deviations from steady state and $\hat{mc}_t$ is real marginal cost in domestic-final-good units.

2.7 Import distributors: incomplete pass-through and import inflation

Imported final goods are distributed domestically by monopolistically competitive importers who purchase the foreign good at world price P_t^* (in foreign currency) and set a domestic-currency price $P_{F,t}$. Calvo stickiness applies with parameter ϕ_F and indexation ι_F.

Let the (log) real marginal cost of import distribution be:

$$\widehat{mc}_{F,t} = \widehat{s}_t + \widehat{p}_t^* - \widehat{p}_{F,t}, \tag{35}$$

where $\widehat{s}_t$ is the log exchange rate and $\widehat{p}_t^*$ the log foreign price level. The hybrid NKPC for import-price inflation $\pi_{F,t} \equiv P_{F,t}/P_{F,t-1}$ is:

$$\hat{\pi}_{F,t} = \beta \mathbb{E}_t \hat{\pi}_{F,t+1} + \iota_F \hat{\pi}_{F,t-1} + \kappa_F \widehat{mc}_{F,t}, \qquad \kappa_F \equiv \frac{(1-\phi_F)(1-\beta\phi_F)}{\phi_F} \cdot \frac{1}{1+\beta\iota_F}. \tag{36}$$

This block makes pass-through state-dependent: a depreciation raises $\widehat{mc}_{F,t}$, but prices respond gradually when ϕ_F is high.

2.8 External sector, exports, and international asset market clearing

Foreign demand for the home good depends on the relative price (terms of trade) and foreign activity:

$$X_t = X_t^* \left(\frac{P_{H,t}}{S_t P_t^*} \right)^{-\eta_x}, \qquad \eta_x > 0, \tag{37}$$

where X_t^* is an exogenous foreign-demand shifter and η_x is the export price elasticity.

Imports are the sum of imported consumption and imported investment goods:

$$M_t = C_{F,t} + I_{F,t}. \tag{38}$$

Domestic output of intermediate goods equals domestic absorption of home goods plus exports, net of utilization costs and adjustment costs:[2]

$$Y_t = C_{H,t} + I_{H,t} + X_t + a(u_t)K_t + \frac{\phi_I}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t. \tag{39}$$

The evolution of net foreign assets follows from the household foreign bond position and bank foreign funding. In domestic currency,

$$S_t B_t^* - S_t R_{t-1}^* B_{t-1}^* = P_{H,t}X_t - P_{F,t}M_t - \left(S_t f_t^* - S_t R_{t-1}^* \Phi_{t-1}^* f_{t-1}^*\right), \tag{40}$$

so that the trade balance finances changes in the household's foreign asset position net of banks' foreign wholesale funding dynamics.

2.9 Monetary policy

The monetary authority sets the gross nominal policy rate R_t via a Taylor-type rule with interest-rate smoothing and an exchange-rate term:

$$\ln\frac{R_t}{\bar{R}} = \rho_R \ln\frac{R_{t-1}}{\bar{R}} + (1-\rho_R)\left[\phi_\pi \ln\frac{\Pi_t}{\bar{\Pi}} + \phi_y \ln\frac{Y_t}{\bar{Y}} + \phi_s \ln\frac{S_t}{\bar{S}}\right] + \varepsilon_{R,t}, \tag{41}$$

where $\rho_R \in (0,1)$, $\phi_\pi, \phi_y, \phi_s \geq 0$, and $\varepsilon_{R,t}$ is a monetary policy shock.

2.10 Shock processes

All exogenous shocks follow AR(1) processes:

$$\ln A_t = (1-\rho_A)\ln\bar{A} + \rho_A \ln A_{t-1} + \sigma_A \varepsilon_{A,t}, \tag{42}$$
$$\ln R_t^* = (1-\rho_{R^*})\ln\bar{R}^* + \rho_{R^*}\ln R_{t-1}^* + \sigma_{R^*}\varepsilon_{R^*,t}, \tag{43}$$
$$\ln P_t^* = (1-\rho_{P^*})\ln\bar{P}^* + \rho_{P^*}\ln P_{t-1}^* + \sigma_{P^*}\varepsilon_{P^*,t}, \tag{44}$$
$$\ln X_t^* = (1-\rho_X)\ln\bar{X}^* + \rho_X \ln X_{t-1}^* + \sigma_X \varepsilon_{X,t}, \tag{45}$$
$$\tau_t = (1-\rho_\tau)\bar{\tau} + \rho_\tau \tau_{t-1} + \sigma_\tau \varepsilon_{\tau,t}, \tag{46}$$
$$\ln\sigma_{\omega,t} = (1-\rho_\sigma)\ln\bar{\sigma}_\omega + \rho_\sigma \ln\sigma_{\omega,t-1} + \sigma_\sigma \varepsilon_{\sigma,t}, \tag{47}$$
$$\sigma_t^* = \rho_{\sigma^*}\sigma_{t-1}^* + \sigma_{\sigma^*}\varepsilon_{\sigma^*,t}, \tag{48}$$
$$\varepsilon_{\lambda,t} = \rho_{\varepsilon_\lambda}\varepsilon_{\lambda,t-1} + \sigma_{\varepsilon_\lambda}\epsilon_{\lambda,t}. \tag{49}$$

[2] Written here in domestic-final-good units for compactness.

Innovations $\varepsilon_{\cdot,t}$ are i.i.d. standard normal and mutually independent.

2.11 Competitive equilibrium

Given initial states $(C_{-1}, K_0, D_{-1}, B^*_{-1}, n_0, n^b_0, f^*_{-1})$ and exogenous processes $\{A_t, R^*_t, P^*_t, X^*_t, \tau_t, \sigma_{\omega,t}, \sigma^*_t, \varepsilon_{R,t}, \varepsilon_{\lambda,t}\}_{t\geq 0}$, a competitive equilibrium is a set of quantities and prices such that: i) households maximize Equation (5) subject to Equation (6), implying Equation (8)–(10); ii) entrepreneurs choose inputs and utilization consistent with Equation (11)–(16) and participate in a loan contract satisfying Equation (17)–(21); iii) banks satisfy Equation (24)–(31) and price loans according to Equation (29); (iv) capital producers solve Equation (32) and capital evolves by Equation (15); (v) retailers and import distributors set prices consistent with Equations (34) and (36); (vi) external demand and market clearing hold: Equation (37)–(40); (vii) monetary policy satisfies Equation (41).

3 Calibration

This section describes the baseline calibration of the model in Section 2. The model is quarterly. We normalize steady-state CPI inflation to zero, $\bar{\Pi} = 1$, and set the steady-state policy rate consistent with the household Euler equation, $\bar{R} \approx 1/\beta$. Parameter values are chosen following two principles. First, we adopt standard values widely used in small open economy New Keynesian DSGE models with financial frictions to ensure comparability with the literature. Second, for the additional banking block (foreign-currency wholesale funding and a leverage constraint), we pick values that deliver plausible steady-state leverage, spreads, and external funding shares.

3.1 Preferences and real-side parameters

The household discount factor is set to $\beta = 0.99$, implying an annualized steady-state risk-free real rate close to 4% under quarterly frequency, a common benchmark in DSGE work (Smets and Wouters, 2007, Galí, 2015). The coefficient of relative risk aversion is set to $\sigma = 2$. External habit in consumption is calibrated to $h = 0.7$ so that consumption responds gradually to shocks, consistent with the inertia typically required to match macro time series (Christiano *et al.*, 2005, Smets and Wouters, 2007). The inverse Frisch elasticity is set to $\varphi = 1$; the labor disutility scale parameter ψ is chosen to pin down a reasonable steady-state hours level (e.g., $\bar{L} = 1/3$) via the intratemporal optimality condition.

On the production side, the capital share is $\alpha = 0.33$ and the quarterly depreciation rate is $\delta = 0.025$, consistent with standard calibrations (Smets and Wouters, 2007, Galí, 2015). Investment adjustment costs are governed by $\phi_I = 8$, which dampens excessive investment volatility and yields realistic Tobin's q dynamics (Christiano *et al.*, 2005). Capital utilization costs follow $a(u) = \frac{\phi_u}{2}(u-1)^2$ with $\phi_u = 2$, allowing utilization to adjust over the cycle while preventing implausibly large short-run swings (Christiano *et al.*, 2005).

3.2 Nominal rigidities and price setting

Domestic retailers face Calvo price stickiness. We set the probability of not re-optimizing to $\phi_H = 0.75$, implying an average price duration of roughly one year under quarterly frequency (Calvo, 1983, Galí, 2015). Inflation indexation is set to $\iota_H = 0.2$ to allow for moderate inflation persistence without making inflation dynamics overly backward-looking (Smets and Wouters, 2007).

Imported final goods are priced in domestic currency by local distributors (local-currency pricing) subject to Calvo stickiness. We set $\phi_F = 0.80$ and $\iota_F = 0.2$, which delivers incomplete and gradual exchange-rate pass-through consistent with the open-economy NK literature (Galí and Monacelli, 2005, Justiniano and Preston, 2010, Devereux and Yetman, 2002). For steady-state markups, we use a standard demand elasticity (e.g., $\epsilon = 6$) which implies a gross markup around 1.2 (Galí, 2015).

3.3 Open-economy parameters

Home bias in consumption and investment are calibrated to $\gamma_c = 0.75$ and $\gamma_i = 0.60$, capturing that imported goods represent a sizable share of expenditure in small open economies while domestic goods remain dominant (Galí and Monacelli, 2005, Adolfson *et al.*, 2007). The elasticities of substitution between home and foreign varieties are set to $\eta_c = \eta_i = 1.5$, within the range commonly used in quantitative open-economy DSGE studies (Justiniano and Preston, 2010, Adolfson *et al.*, 2007). Export demand is given an elasticity $\eta_x = 1$ and is shifted by the foreign-demand process X_t^* (Kollmann, 2001).

To ensure stationarity of net foreign assets and to generate a realistic risk-premium elasticity, the foreign bond position adjustment cost is set to $\xi_b = 0.0025$, following the standard device in small open economy models (Schmitt-Grohé and Uribe, 2003). The steady-state foreign bond position $\bar{B}^*$ is normalized to zero. The capital-flow wedge τ_t has steady state $\bar{\tau} = 0$ and captures time variation in cross-border financial conditions.

3.4 Financial accelerator, banks, and foreign-currency funding

Entrepreneurial finance follows the costly state verification (CSV) mechanism. The monitoring cost is set to $\mu = 0.12$, and the entrepreneur survival probability is $\nu_e = 0.972$ (an average horizon of about nine years). These values generate plausible steady-state default frequencies and external finance premia as in the classic financial accelerator literature (Bernanke *et al.*, 1999, Carlstrom and Fuerst, 1997). The dispersion of the idiosyncratic capital-quality shock has steady-state $\bar{\sigma}_\omega = 0.28$ and persistence $\rho_\sigma = 0.90$, capturing the slow-moving nature of financial risk (Christiano *et al.*, 2014, Quint and Rabanal, 2013).

Banks are subject to a leverage constraint $\ell_{t+1} \leq \lambda_t n_t^b$. The steady-state leverage ceiling is set to $\bar{\lambda} = 8$ (assets around eight times equity). Banker survival is $\nu_b = 0.965$, and the entry transfer χ_b^0 pins down positive steady-state net worth, consistent with banking-sector DSGE frameworks (Gertler and Karadi, 2011, Gertler and Kiyotaki, 2010). The lending wedge sensitivity is calibrated to $\chi_b = 20$, implying that approaching the leverage ceiling raises loan spreads noticeably, strengthening the macro-financial feedback loop (Gertler and Karadi, 2011).

Foreign-currency wholesale funding is calibrated to represent 10% of steady-state output in domestic-value terms, $\overline{f} = 0.10$. The foreign funding spread depends on external leverage and global risk: we set $\phi_f = 0.5$ and $\phi_{\sigma^*} = 0.2$ in Equation (26). This makes depreciations and global risk-off shocks increase the domestic cost of foreign funding, erode bank net worth through currency mismatch, and tighten credit supply (Gertler and Kiyotaki, 2010, Quint and Rabanal, 2013).

3.5 Policy rules and shock processes

Monetary policy follows the Taylor-type rule (41). Interest-rate smoothing is $\rho_R = 0.80$. The inflation coefficient is $\phi_\pi = 1.50$, the output coefficient is $\phi_y = 0.125$, and the exchange-rate coefficient is $\phi_s = 0.05$, capturing limited but non-zero concern about exchange-rate fluctuations in small open economies (Galí, 2015).

The macroprudential leverage rule is persistent, with $\rho_\lambda = 0.90$, and responds countercyclically to credit and output (baseline values $\phi_\ell = 0.10$ and $\phi_y^\lambda = 0.05$). All exogenous shocks are AR(1). Typical baseline persistences are $\rho_A = 0.95$ for TFP, $\rho_X = 0.90$ for foreign demand, and $\rho_{R^*} = \rho_{P^*} = 0.85$ for the world interest rate and foreign prices. The shock standard deviations are selected to deliver empirically plausible volatilities for output, inflation, spreads, and the exchange rate in baseline impulse-response exercises, and can be disciplined further by moment matching or Bayesian estimation in applications (Smets and Wouters, 2007, Christiano *et al.*, 2014).

Table 1: Baseline calibration (quarterly)

Parameter	Value	Description
β	0.99	Discount factor
σ	2	Relative risk aversion
h	0.7	External habit
φ	1	Inverse Frisch elasticity
α	0.33	Capital share
δ	0.025	Depreciation rate
ϕ_I	8	Investment adjustment cost
ϕ_u	2	Utilization cost curvature
$\phi_H,\ \iota_H$	$0.75,\ 0.2$	Domestic Calvo stickiness and indexation
$\phi_F,\ \iota_F$	$0.80,\ 0.2$	Import-price Calvo stickiness and indexation
$\gamma_c,\ \eta_c$	$0.75,\ 1.5$	Home bias and substitution elasticity (consumption)
$\gamma_i,\ \eta_i$	$0.60,\ 1.5$	Home bias and substitution elasticity (investment)
η_x	1	Export demand elasticity
ξ_b	0.0025	Foreign bond position adjustment cost
μ	0.12	Monitoring (verification) cost
ν_e	0.972	Entrepreneur survival probability
$\bar{\sigma}_\omega,\ \rho_\sigma$	$0.28,\ 0.90$	Risk dispersion (steady state) and persistence
$\bar{\lambda},\ \rho_\lambda$	$8,\ 0.90$	Bank leverage ceiling (steady state) and persistence
χ_b	20	Sensitivity of the lending wedge to leverage tightness
$\overline{f}$	0.10	Bank foreign-currency funding share (relative to Y)
$\phi_f,\ \phi_{\sigma^*}$	$0.5,\ 0.2$	Foreign funding spread sensitivities
$\rho_R,\ \phi_\pi,\ \phi_y,\ \phi_s$	$0.80,\ 1.50,\ 0.125,\ 0.05$	Taylor-rule parameters
$\rho_A, \rho_X, \rho_{R^*}, \rho_{P^*}$	$0.95, 0.90, 0.85, 0.85$	Shock persistences (TFP, exports, world rate, foreign prices)

Table 1 reports the baseline parameterization used in the quantitative experiments. The parameters most tightly linked to the strength of macro-financial amplification are $(\mu, \bar{\sigma}_\omega, \bar{\lambda}, \chi_b, \overline{f})$. In particular, higher $\bar{\sigma}_\omega$ or tighter $\bar{\lambda}$ raises equilibrium credit spreads and magnifies the impact of adverse shocks, while a larger $\overline{f}$ strengthens the exchange-rate channel through banks' currency mismatch.

4 Simulations

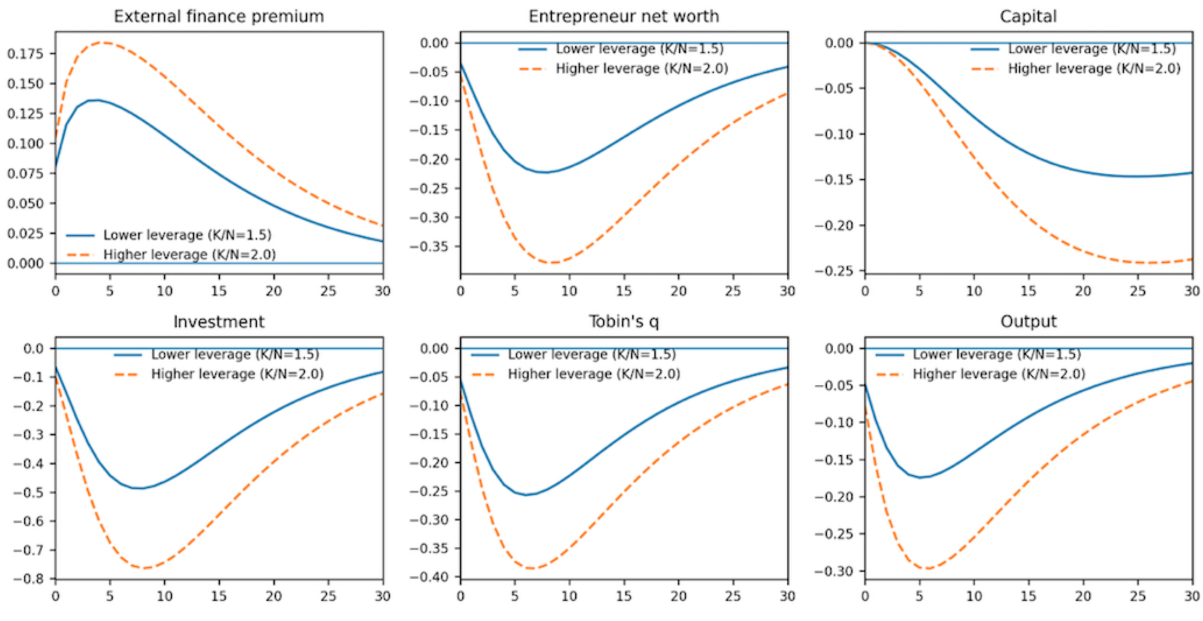
This section presents impulse-response functions (IRFs) that quantify the model's transmission mechanism. The simulations are conducted at quarterly frequency around the deterministic steady state. All reported variables are expressed as percentage deviations from steady state (for inflation and interest rates, the responses are interpreted in percentage-point terms in the usual log-linear approximation). The horizon is 30 quarters.

4.1 Experiment design: a financial risk shock

The key experiment is a positive one-standard-deviation risk shock that raises the cross-sectional dispersion of the idiosyncratic capital-quality disturbance, $\sigma_{\omega,t}$, in the entrepreneurial sector. Economically, this shock increases default probability and expected monitoring losses under costly state verification, thereby elevating the external finance premium and tightening borrowing conditions. The shock follows an AR(1) process as in Equation (47), so its effects are persistent but mean-reverting.

To highlight the amplification channels emphasized by the model, we report three comparative-static exercises: i) different steady-state leverage (a higher capital-to-net-worth ratio, K/N); ii) different degrees of financial friction (a higher monitoring cost, μ); iii) different procyclicality of capital flows (a stronger sensitivity of the foreign funding premium to risk conditions, κ in Equation (26)).

Figure 2: IRFs to a one-s.d. risk shock under different leverage (K/N)



Note: Solid line: lower leverage ($K/N = 1.5$). Dashed line: higher leverage ($K/N = 2.0$).

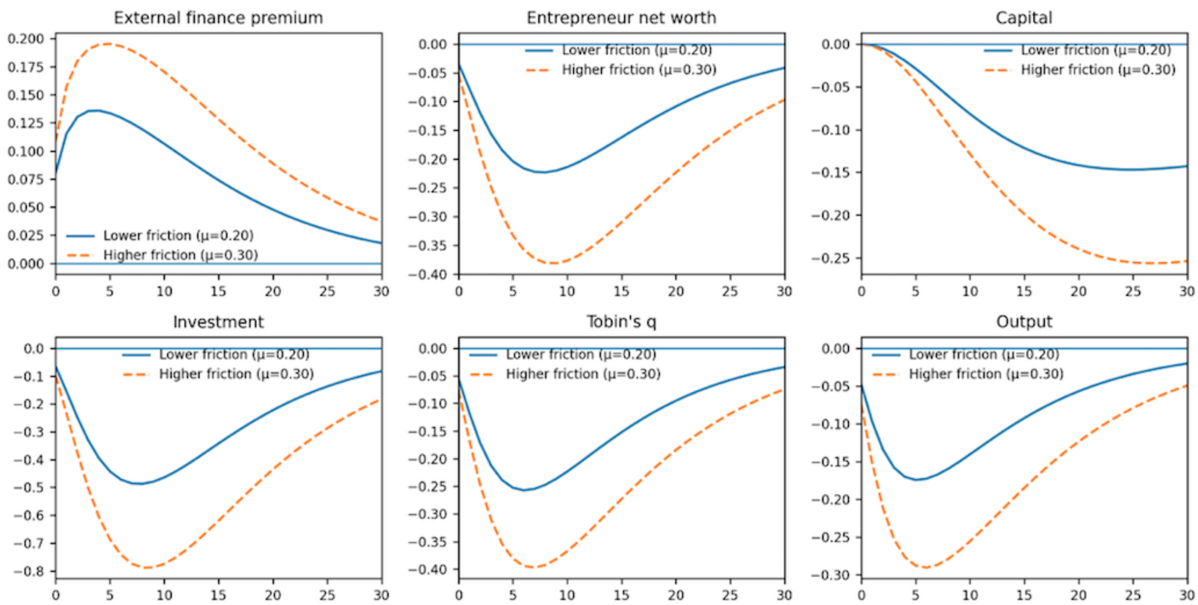
Figure 2 summarizes the baseline dynamics in response to the risk shock. The shock immediately raises the external finance premium: with more dispersion in project returns, lenders anticipate higher expected losses and require a larger premium to supply credit. The higher premium depresses entrepreneurial borrowing capacity and reduces effective investment demand.

As investment falls, the price of installed capital (Tobin's q) declines, which further discourages capital accumulation through the investment-adjustment-cost channel. The contraction in investment translates into a gradual decline in the capital stock, and output falls on impact and remains below trend for an extended period.

Net worth declines sharply because the rise in spreads and the fall in activity reduce retained earnings. This deterioration in borrower balance sheets feeds back into credit conditions, reinforcing the initial tightening. Overall, the impulse responses feature the standard "financial accelerator" pattern: a modest disturbance to risk conditions produces a disproportionately large and persistent decline in real activity through endogenous movements in financing premia and net worth.

The financial accelerator is stronger when steady-state leverage is higher. In Figure 2, the dashed line corresponds to a higher K/N economy. With a larger fraction of capital financed externally, a given increase in risk dispersion translates into a larger increase in the external finance premium. Consequently, investment and Tobin's q fall by more, capital accumulation slows more markedly, and output contracts more deeply and for longer. The net-worth response is also more negative, consistent with the idea that highly levered balance sheets are more sensitive to adverse credit conditions.

Figure 3: IRFs to a one-s.d. risk shock under different financial friction (monitoring cost)

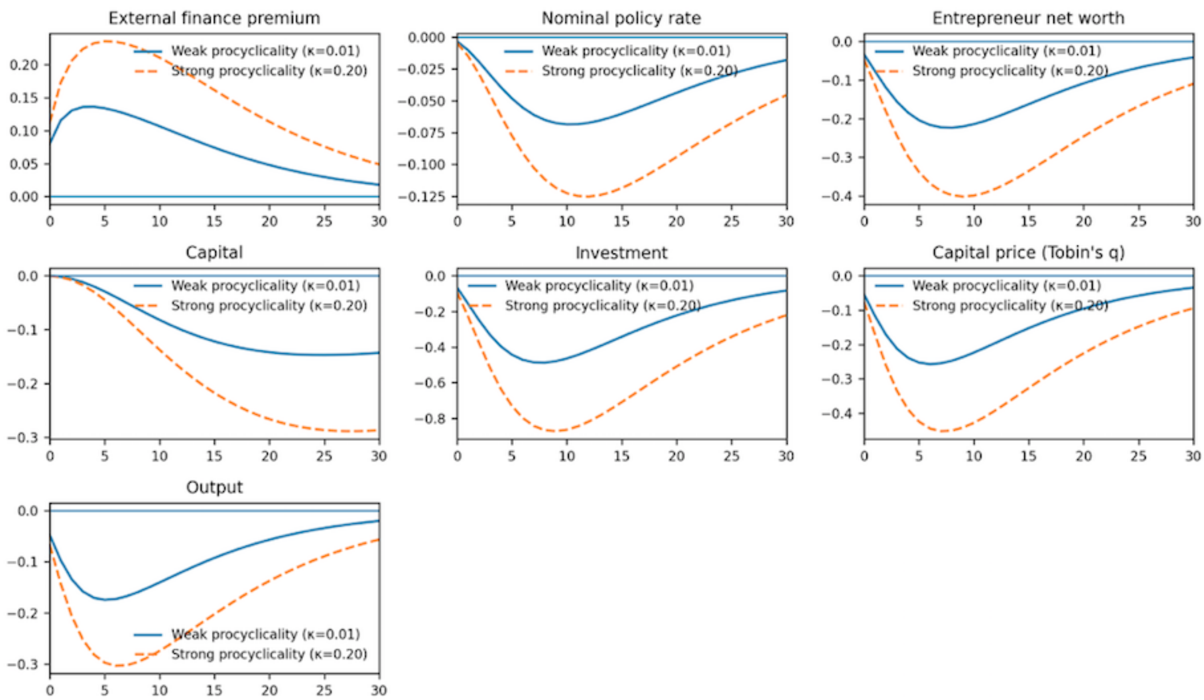


Note: Solid line: lower friction ($\mu = 0.20$). Dashed line: higher friction ($\mu = 0.30$).

Figure 3 contrasts economies with lower versus higher monitoring costs (a higher μ). A higher monitoring cost raises the effective deadweight loss associated with default and increases the sensitivity of lending terms to changes in risk dispersion. As a result, the risk shock produces a larger and more persistent increase in the external finance premium. The stronger rise in spreads translates into a deeper contraction in investment, a larger decline in Tobin's q, and a larger fall in output and capital. This experiment underscores that the same risk shock can have materially different macro consequences depending on the severity of agency frictions in the credit market.

Figure 4 shows how the open-economy financial channel interacts with domestic credit frictions. When capital flows are more procyclical (a larger κ in the foreign funding premium specification), the risk shock triggers a larger increase in the foreign funding premium and hence a stronger tightening of external funding conditions for the banking sector. Through banks' balance sheets and the lending wedge, domestic credit spreads rise by more, amplifying the investment and output contraction. Moreover, tighter external conditions translate into more pronounced movements in domestic financial variables (including the policy rate response through the policy rule), strengthening the propagation of the shock.

Figure 4: IRFs to a one-s.d. risk shock under different capital-flow procyclicality



Note: Solid line: weak procyclicality ($\kappa = 0.01$). Dashed line: strong procyclicality ($\kappa = 0.20$).

Taken together, Figures 2–4 demonstrate that risk shocks can generate sizable downturns, and that amplification is strongest when: i) leverage is high, ii) monitoring frictions are severe, and iii) external funding conditions are highly state-dependent. These comparative dynamics are consistent with the model's central mechanism: risk re-prices both domestic and external finance, compresses net worth, and depresses investment and output through mutually reinforcing balance-sheet effects.

5 Conclusion

This paper studies how a financial risk shock propagates in a small open economy when credit is intermediated by banks that: i) face balance-sheet constraints and ii) rely partly on foreign-currency wholesale funding. The model's central disturbance is an increase in the cross-sectional dispersion of entrepreneurial idiosyncratic risk, which raises default likelihood and expected verification losses, thereby lifting the external finance premium and tightening borrowing conditions. The banking block then connects this domestic credit tightening to external funding conditions: foreign wholesale funding is priced with an endogenous premium that increases with external leverage and global risk, while a leverage constraint ties lending capacity to bank net worth. Together, these features generate a disciplined open-economy amplification mechanism.

The quantitative experiments deliver three core findings. First, a one-standard-deviation risk shock produces an immediate increase in the external finance premium, a sharp decline in investment and Tobin's q, a gradual fall in the capital stock, and a persistent contraction in output. Second, amplification is substantially stronger when the economy is more leveraged (higher K/N) or when credit-market frictions are more severe (higher monitoring cost): both cases translate the same increase in risk dispersion into a larger and more persistent rise in spreads and a deeper real downturn. Third, the open-economy channel matters in a state-dependent way. When capital flows (or external funding premia) are more procyclical, the risk shock triggers a larger increase in the foreign funding premium, tightens bank funding conditions, and raises domestic spreads by more, magnifying the investment and output.

The model is built as a laboratory for policy analysis, and its mechanisms map naturally into a small set of actionable recommendations. First, lean against leverage in good times. Because the downturn is larger when leverage is high, a first-order implication is to build resilience ex ante. Countercyclical capital buffers, leverage caps, and stress tests that explicitly condition on credit spreads can reduce the sensitivity of lending to risk shocks. In the model, tighter effective leverage limits (a lower λ_t in the bank constraint) damp the feedback from falling net worth to tighter credit supply. Practically, this points to a simple rule of thumb: if private credit and leverage expand rapidly during tranquil periods, macroprudential policy should tighten even if inflation is contained.

Second, reduce currency mismatch and strengthen FX liquidity buffers. Foreign-currency wholesale funding exposes bank balance sheets to exchange-rate movements and global risk repricing, because the cost of foreign funding scales with both the exchange rate and the external funding premium. Policies that limit unhedged FX exposures or require stronger FX liquidity coverage can therefore reduce crisis amplification. Examples include net open position limits, higher liquidity requirements for short-term FX liabilities, differentiated reserve requirements on FX funding, and incentives for longer maturity or hedged FX borrowing. The model's logic is straightforward: when FX liabilities are smaller or better hedged, a risk-off episode is less likely to erode bank net worth and force a sharp retrenchment in lending.

Third, address procyclical external funding conditions with targeted tools. When the foreign funding premium becomes strongly state-dependent, the economy is more exposed to global risk swings. In such environments, carefully designed capital flow management measures can complement prudential regulation. The aim is not to suppress all capital movements, but to reduce destabilizing short-term funding cycles. In practice this can include time-varying levies on short-maturity external borrowing, margin requirements on FX derivatives, or macroprudential limits that tighten specifically on foreign-currency wholesale funding during booms and relax during stress. The model suggests that these tools are most valuable when external finance premia react sharply to risk (i.e., when procyclicality is high).

Fourth, monetary policy should avoid doing all the work. The policy rate influences activity, but the model highlights that the main wedge during a risk shock is a spread between borrowing costs and risk-free rates. In that situation, raising interest rates to stabilize exchange rates can worsen domestic balance sheets and intensify the downturn. A more robust approach is coordination: monetary policy focuses on inflation stabilization and output smoothing, while macroprudential policy targets leverage and funding fragility directly. In the model, this division of labor is natural because the drivers of amplification sit in balance sheets and funding premia, not only in price-setting frictions.

Last, crisis management: backstops for liquidity, not blanket bailouts. When risk shocks trigger abrupt funding stress, liquidity support can prevent inefficient fire sales and a collapse in credit supply. The model's banking channel motivates facilities that backstop short-term liquidity (including FX liquidity) while preserving discipline through eligibility rules, pricing, and collateral requirements. The key is to separate solvency from liquidity: liquidity backstops can reduce unnecessary amplification, whereas unconditional support can create moral hazard and raise steady-state leverage.

The present analysis is intentionally focused on transmission and amplification. Several extensions would strengthen the paper for policy evaluation. First, estimating key parameters (especially those governing risk dispersion persistence, the sensitivity of foreign funding premia to global risk, and the tightness of bank leverage constraints) would allow the IRFs to be disciplined by data. Second, incorporating nonlinear dynamics and occasionally binding constraints would help capture crisis asymmetries, which are likely important when spreads spike. Third, adding an explicit welfare criterion and solving for optimal (or jointly optimal) monetary and macroprudential policy would convert the model's policy lessons into formal prescriptions. These extensions are natural next steps given the model structure and the mechanisms highlighted in the simulation results.

In sum, the paper's message is simple: risk shocks are macroeconomically costly not only because risk rises, but because balance sheets and external funding conditions translate higher risk into tighter credit. Policies that curb leverage, limit currency mismatch, and reduce the procyclicality of external funding can materially dampen the real effects of global risk-off episodes.

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Appendix

A Parameter interpretation

Table A1 summarises the parameters and their economic roles. The mapping is explicit so that calibration and comparative statics are transparent.

Table A1: Parameters and interpretation

Parameter	Interpretation
β	Household discount factor (patience; pins down steady-state real interest rate).
σ	Relative risk aversion / inverse intertemporal elasticity of substitution.
h	External habit strength; higher h makes consumption smoother and raises marginal-utility persistence.
ψ	Scale parameter in disutility of labor; pins down steady-state hours given wages and preferences.
φ	Inverse Frisch elasticity; higher φ makes labor supply less responsive to wages.
γ_c	Home bias in consumption; share weight on domestic goods inside the CES aggregator.
η_c	Elasticity of substitution between domestic and imported consumption goods.
γ_i	Home bias in investment; share weight on domestic investment goods.
η_i	Elasticity of substitution between domestic and imported investment goods.
$P_t, P_{H,t}, P_{F,t}$	CPI, domestic final-good price, imported-good price (levels).
Π_t	Gross CPI inflation P_t/P_{t-1}.
S_t	Nominal exchange rate (domestic currency per unit foreign).
$\bar{B}^*$	Steady-state foreign bond position (net foreign assets benchmark).
ξ_b	Portfolio adjustment cost on foreign bond holdings; stabilizes net foreign assets and risk premia.
τ_t	Capital-flow wedge (tax/subsidy on foreign bond position); captures capital controls or policy frictions.
R_t	Gross nominal policy rate paid on deposits; household risk-free asset return.
R_t^*	Gross foreign nominal interest rate (exogenous world rate).
ϕ_f	Sensitivity of foreign funding spread Φ_t^* to external leverage (foreign funding intensity).
ϕ_{σ^*}	Sensitivity of foreign funding spread to global risk shock σ_t^*.
α	Capital share in production of intermediate goods.
A_t	TFP (technology) level; shifts marginal products of capital and labor.
u_t	Capital utilization rate; chosen margin that affects effective capital services.

Table A1: Parameters and interpretation (contiuned)

Parameter	Interpretation
$a(u)$	Utilization cost function; convexity governs how costly it is to raise utilization in the short run.
δ	Physical depreciation rate of capital.
ϕ_I	Investment adjustment cost parameter; higher values damp investment and make q_t more volatile.
q_t	Tobin's q (real price of installed capital in domestic-good units).
R_t^k	Gross real return on installed capital (before idiosyncratic shock).
ω_t	Idiosyncratic capital-quality shock; drives default events under debt contracts.
$\sigma_{\omega,t}$	Time-varying dispersion of ω_t (risk shock); higher dispersion means greater default probability.
μ	Monitoring (verification) cost in default; resource loss when entrepreneurs default.
$\bar{\omega}_t$	Default cutoff; entrepreneurs default if $\omega_t < \bar{\omega}_t$.
$F(\cdot), G(\cdot)$	CDF and truncated first-moment objects for ω; summarize default probabilities and recoveries.
$\Gamma(\cdot)$	Expected share of gross project returns transferred to lenders under the optimal contract.
ν_e	Entrepreneur survival probability; governs persistence of entrepreneurial net worth.
χ_e	Real transfer to entering entrepreneurs; keeps entrepreneurial sector from collapsing in deep downturns.
ℓ_t	Real bank lending to entrepreneurs (external funds).
d_t	Real household deposits at banks.
f_t^*	Foreign-currency wholesale funding of banks (foreign units).
n_t^b	Bank real net worth (equity); key state variable for bank lending capacity.
ν_b	Banker survival probability; controls persistence of bank net worth.
χ_b^0	Real transfer to entering bankers; steady-state anchor for bank equity.
λ_t	Maximum leverage multiple (regulatory or incentive-based); higher λ_t permits more lending per unit equity.
$\bar{\lambda}$	Steady-state bank leverage ceiling.
ρ_λ	Persistence of the leverage rule; how slowly/tightly regulation adjusts over time.

Table A1: Parameters and interpretation (contiuned)

Parameter	Interpretation
ϕ_ℓ	Countercyclical macroprudential response to credit (tightens when lending rises).
ϕ_y	Countercyclical macroprudential response to output (tightens in booms, loosens in recessions).
χ_b	Sensitivity of the lending wedge Φ_t^b to proximity to the leverage constraint.
ϕ_H	Calvo stickiness for domestic prices; higher ϕ_H means more rigid domestic inflation.
ι_H	Indexation to lagged inflation in domestic pricing; adds inflation inertia.
κ_H	Slope of domestic NKPC; increasing in price flexibility and decreasing in effective rigidity.
ϕ_F	Calvo stickiness for import prices (local currency pricing); governs exchange-rate pass-through speed.
ι_F	Indexation in import pricing; adds persistence to import inflation.
κ_F	Slope of import-price NKPC; controls pass-through intensity conditional on marginal cost.
η_x	Export price elasticity; sensitivity of exports to the relative price of home goods abroad.
X_t^*	Foreign demand shifter for exports; captures foreign activity or taste shocks.
ρ_R	Interest-rate smoothing in the Taylor rule; higher values make policy more inertial.
ϕ_π	Policy response to CPI inflation; anchors inflation dynamics.
ϕ_y	Policy response to output; captures stabilization motive.
ϕ_s	Policy response to the exchange rate; captures managed float / fear of floating.
$\varepsilon_{(\cdot),t}$	i.i.d. innovations to exogenous processes; $\sigma_{(\cdot)}$ scale their volatility.
$\rho_A, \rho_{R^*}, \rho_{P^*}, \rho_X, \rho_\tau, \rho_\sigma, \rho_{\sigma^*}$	Persistence parameters for TFP, world rate, foreign prices, export demand, capital-flow wedge, risk dispersion, and global risk.