The Foreign Liability Channel of Bank Capital Requirements*

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Abstract

We examine the effects of tighter capital requirements in a quantitative model of risky financial intermediaries partially funded with defaultable and flighty foreign currency debt. Higher capital requirements enhance banks' resilience against sudden losses and insolvency risk. However, by reducing bank default risk, they also lower uninsured foreign funding costs, increasing banks' reliance on foreign liabilities. This reveals a novel tradeoff: higher capital requirements strengthen banks' resilience against domestic shocks, but increase their exposure to foreign funding disruptions. Foreign prudential tools complement capital requirements in mitigating financial vulnerabilities. Empirical evidence from Peru's capital requirement reform supports model predictions.

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Following the 2008 global financial crisis, major advanced and emerging market economies implemented tighter bank capital regulation to enhance the banking sector's resilience to shocks and promote macroeconomic and financial stability.[1] Due to their significant exposure to foreign currency uninsured liabilities (e.g. Gopinath and Stein, 2021), emerging market economies are vulnerable to the global financial cycle (e.g. Rey, 2015). As a result, they often adopt an eclectic approach to financial stability, combining both domestic macroprudential measures and foreign prudential policy. This raises important questions: What are the costs and benefits of bank capital requirements in the presence of foreign liabilities? Are bank capital requirements and foreign prudential interventions substitutes? Or do they have complementary effects that depend on the sources of financial stability risk?

This paper addresses these questions by developing a quantitative dynamic general equilibrium model that embeds a risky financial intermediation sector relying on two types of defaultable liabilities: insured domestic deposits and uninsured foreign debt. We then empirically test the model's predictions by examining the impact of bank capital requirements in Peru. Our analysis yields three key results, highlighting the crucial role of the foreign liabilities in the effectiveness of bank capital requirements.

Firstly, tighter bank capital regulation increases banks' reliance on foreign liabilities. By limiting banks' leverage, higher capital requirements better protect them from sudden losses and decrease the risk of insolvencies. As bank default decreases, their cost of foreign funding declines, leading to a greater reliance on foreign liabilities - a mechanism we refer to as the *foreign liability channel* of bank capital requirements.[2][3] Secondly, in setting bank

[1] Leading emerging market economies - like Argentina, Brazil, China, India, Mexico, Poland, South Africa and Turkey - that are are members of the international financial standard-setting bodies (the Basel Committee on Banking Supervision and the Financial Stability Board) have committed to implement the minimum regulatory requirements under Basel III. Other emerging market and developing economies - like Colombia, Malaysia, Peru and Thailand - have adopted them on a voluntary basis and many others are considering whether to do so. See Hohl et al. (2018) on the adoption of Basel III standards around the world.

[2] We also establish this result theoretically in a simplified two-period version of our quantitative model. In Appendix A we analytically demonstrate that higher capital requirements reduce bank default probability, lower the cost of foreign funding, and consequently increase banks' reliance on foreign liabilities. This analytical framework provides the theoretical foundation for the quantitative results discussed in Section 3.

[3] In a closed economy setup, Quadrini (2017) emphasizes the role of the bank liabilities channel in providing insurance to the real sector of the economy. In line with e.g. Bocola and Lorenzoni (2020), this paper instead

capital requirements macroprudential authorities face a trade-off between solvency risk and exposure to disruptions in foreign funding. While higher capital requirements are effective in limiting bank insolvencies, they also increase banks' reliance on foreign liabilities, making the economy more vulnerable to shocks to the availability of foreign funds related to exogenous global factors, such as the US monetary policy, the global financial cycle or sudden stops (e.g. Rey, 2015). Finally, foreign prudential interventions, such as capital flow taxes or foreign exchange interventions, play a complementary role to bank capital requirements in addressing financial vulnerabilities.

Crucially, the first two results are also relevant for advanced economies such as the euro area countries, where banks rely heavily on foreign debt.[4] The last result instead provides new insights into the use of capital flow management tools within an integrated policy framework, aimed at advancing our understanding of trade-offs between domestic and external stabilization objectives in emerging market economies (see Das et al., 2023; IMF, 2020, 2023). In particular, it highlights the complementarity between bank capital requirements and foreign prudential interventions in managing financial stability risks associated with the exposure to foreign liabilities in the presence of bank solvency risk.

In the model, banks invest in productive capital using a combination of domestic and foreign debt, equity issuance, and their own net worth. Raising equity capital is costly, and banks are subject to an occasionally binding regulatory constraint. Banks operate under limited liability and have the option of defaulting on their debt obligations. They operate in the presence of safety net guarantees (e.g. Kareken and Wallace, 1978), in the form of insured domestic deposits. They issue insured deposits to domestic households and uninsured debt to foreign investors. While the interest rate on insured deposits is equivalent to the domestic risk-free rate, the foreign debt is uninsured and its price reflects the bank fundamentals. The cost of foreign bank debt adjusts endogenously with the degree of riskiness of the banking

focuses on the role of bank foreign liabilities as a source of financial instability.

[4]The share of bank foreign liabilities exceed 20% in Germany, France, Italy and Spain. Source: ECB Supervisory Banking Statistics.

sector.

The model embeds both idiosyncratic and aggregate sources of financial stability risks. As standard in quantitative models of bank default risk (e.g. Mendicino et al., 2020; Elenev, Landvoigt and Van Nieuwerburgh, 2021; Jermann, 2019), banks face idiosyncratic shocks which are meant to capture heterogeneity in (unmodeled) sources of banks' costs or revenues, e.g. bank asset quality or returns. Crucially, their idiosyncratic nature allows the model to produce ex-post heterogeneity in default outcomes across banks in a tractable way. A lower realization of this shock reduces bank profits, diminishing their ability to generate enough funds to repay their debt and, consequently, increasing the likelihood of bank insolvency. Bankruptcy results in deadweight losses (see e.g. Bernanke, Gertler and Gilchrist, 1999). Additionally, bank default impacts the aggregate dynamics of bank equity, which affect the intermediation capacity of the entire banking sector with real effects.

Furthermore, banks are also subject to two sources of aggregate uncertainty. The first arises from increased volatility in bank profits, modeled as a mean-preserving shock to the standard deviation of the bank idiosyncratic shock, akin to risk or uncertainty shocks commonly used in the literature (see Bloom, 2009; Christiano, Motto and Rostagno, 2014). The second source instead stems from a sudden disruption in foreign funding for banks. While the former generates financial outflows which endogenously emerge in response to the increased riskiness in the domestic banking sector, the latter resembles exogenous global factors, such as the US monetary policy, the global financial cycle or sudden stops (e.g. Mendoza, 2010; Coimbra and Rey, 2018; Miranda-Agrippino and Rey, 2020; Akinci and Queralto, 2024) commonly analyzed in the emerging economy literature.

The model is calibrated to match macro, financial, and banking data targets for an emerging economy of Peru. We focus on Peru for two main reasons. First, it is a small open economy with strong external linkages and significant dependence on foreign funding by banks.[5] Second, Peru has implemented the Basel III regulatory framework, exposing

[5]Peruvian banks hold on average about 10% of foreign liabilities, excluding inter-bank deposits.

the banking sector to changes in capital requirements (see Fang et al., 2022). These factors provide an ideal setting to empirically study the impact of bank capital regulation on banks' foreign liabilities.

In our model, as in the real world, bank capital requirements serve as a key tool for addressing bank solvency risk. Banks operating under limited-liability do not internalize the social costs of their individual decisions.The presence of safety net guarantees for banks, combined with the aggregate externalities arising from the deadweight losses associated with bank defaults, provides a rationale for the implementation of bank capital regulation in our framework.

We begin our analysis by using the calibrated model to examine how changes in bank capital requirements influence the model-implied (stochastic) long-run allocations and social welfare. Our findings reveal a trade-off between the size and stability of the banking sector: while higher capital requirements reduce bank leverage and mitigate insolvency risk, they may also constrain the overall scale of banking activities. By limiting leverage, stricter capital requirements shield banks from sudden losses, ensuring they can meet their debt obligations even when asset values decline. At the aggregate level, this strengthens the banking sector's intermediation capacity and reduces the deadweight losses associated with bank failures. These benefits, however, come at a cost. Higher capital requirements force banks to rely more on equity funding, which is more expensive than debt. This, in turn, curtails banks' intermediation capacity and constrains overall economic activity.

The foreign liability channel contributes to both aspects of this trade-off. On the one hand, the decrease in the likelihood of bank default reduces the cost of foreign funding, leading banks to increase their reliance on foreign liabilities. This benefits banks as it partially offsets the higher funding costs associated with greater reliance on equity funding. On the other hand, the increased dependence on foreign liabilities makes banks, and hence the entire economy, more vulnerable to disruptions in foreign funding. Banks with limited liability, however, do not internalize this latter effect.

Ultimately, the trade-off between the scale and fragility of the banking sector is reflected in the welfare effects of capital requirements. Starting from the pre-Global Financial Crisis baseline level of 8%, tighter capital requirements result in an initial welfare enhancement, peaking at 13%, where they substantially reduce bank default. However, further increases in capital requirements beyond this point have a negative impact on welfare, due to the negative effects of the reduced intermediation capacity of banks.

Our results highlight the crucial role of bank default in uncovering the *foreign liability channel* of bank capital requirements. Absent limited liability and bank solvency risk considerations, bank capital requirements have no direct impact on the cost and availability of foreign funds for banks. In such a case, higher capital requirements would only reduce the size of the banking sector without affecting banks' exposure to foreign liabilities.

Next, we assess how abrupt shifts in bank foreign funding impact the efficacy of tighter bank capital requirements in ensuring macroeconomic and financial stability. To this end, we examine the response of the economy to financial outflows from the banking sector driven by heightened riskiness in the domestic banking sector or exogenous global factors. We then assess the effectiveness of tighter bank capital requirements in protecting the economy against fluctuations in bank foreign liabilities.

We start by exploring the transmission of a bank risk shock. Higher volatility in idiosyncratic bank profits increases the likelihood of bank failure and reduces bank net worth. This, in turn, leads to a decline in the price of capital and aggregate investment, as banks reduce their investment in productive assets. Additionally, higher bank default rates result in larger bankruptcy costs, which depress domestic consumption. The increased probability of bank default also raises the cost of foreign funding, which endogenously reduces foreign funding of banks, further curtailing their investment. The overall disruption in the financial intermediation capacity of banks feeds back into the real economy, resulting in substantial and persistent declines in economic activity.

Higher levels of bank capital requirements enable banks to absorb the adverse effects of bank risk shocks. As a result, higher capital requirements help reducing both the likelihood of insolvency in response to bank risk shocks and the broader impact on funding outflows in the banking sector and on the real economy.

Next, we examine the transmission of exogenous shocks to banks' foreign liabilities. A sudden reduction in the availability of foreign funds dampens banks' ability to invest in productive assets. This, in turn, leads to a decline in aggregate investment and output. The depreciation of the real exchange rate further intensifies the decline in economic activity.

Unlike in the case of bank risk shocks, higher capital requirements do not provide better insulation against exogenous shocks to banks' foreign liabilities. On the one hand, higher capital requirements strengthen banks' ability to repay their debt, making them less prone to default. On the other hand, they increase reliance on foreign funding, heightening the vulnerability of both banks and the broader economy to shocks that directly disrupt this funding source. Consequently, under tighter bank capital requirements, an exogenous sudden-stop type of event results in a stronger exchange rate depreciation, a more pronounced drop in bank investment in productive assets, and, in turn, a greater contraction in overall production. Importantly, these results are mainly driven by the quantity impact rather than foreign exchange rate effects. Specifically, our findings remain robust also in the absence of the exchange rate channel in the bank balance sheet, suggesting that even under hedging (see e.g. Gonzalez et al., 2021) or restrictions on holdings of mismatched currency positions (see e.g. Gutierrez, Ivashina and Salomao, 2023), the shock would still affect the economy through the direct quantity effect on the availability of foreign liabilities.

When setting bank capital requirements, the macroprudential authority must account for the fact that this tool affects the transmission of different sources of financial stability risks in distinct ways. Consequently, the regulator sets capital requirements at a higher level when the probability of a bank risk-driven financial recession increases. However, the regulator also internalizes the presence of the foreign liability channel and the impact of higher capital requirements on banks' reliance on foreign funding. As a result, if the likelihood of foreign funding disruptions rises, the regulator optimally chooses a lower rather than a higher level of capital requirements. Bank default risk is a key determinant of the trade-off.

Foreign prudential interventions are helpful to mitigate this trade-off. Measures such as capital flow management taxes, which directly limit exposure to foreign liabilities, or sterilized FX interventions, which reduce real exchange rate volatility, effectively mitigate the economy's response to sudden reductions in the availability of foreign funding.

Overall, our findings indicate that bank capital requirements and foreign prudential interventions are complementary policy tools. This result crucially hinges on incorporating bank default risk into the policy assessment. Ignoring bank default risk would imply that capital requirements have no impact on the share of foreign liabilities and, consequently, on the exposure to foreign financial shocks.

Finally, our empirical results based on Peru's transition to higher capital requirements provide support for the *foreign liability channel* of bank capital requirements. Our analysis exploits the July 2011 reform in Peru, which introduced bank-specific compulsory capital buffers in addition to the uniform 10 % minimum capital requirement. Using monthly bank-level data and a difference-in-differences empirical strategy, we find that higher capital requirements are associated with a greater reliance of banks on foreign liabilities in the aftermath of the reform. This empirical finding is consistent with the predictions of our model. In line with the implications of our model and other empirical studies on the impact of bank capital requirements on lending (see e.g. Gropp et al., 2018; Fraisse and Thesmar, 2019; Fang et al., 2022), we also find that higher capital requirements are associated with a reduction in bank credit supply to the corporate sector.

Related Literature. Our paper contributes to a number of recent strands of the literature. Firstly, it belongs to the growing body of work that assesses the role of bank capital requirements in quantitative macro-banking models (see e.g. Van Den Heuvel, 2008; Begenau, 2020; Begenau and Landvoigt, 2022; Elenev, Landvoigt and Van Nieuwerburgh, 2021; Mendicino et al., 2018, 2020, 2024; Corbae and D'Erasmo, 2021; Jermann, 2019; Abad, Martinez-Miera and Suarez, 2024; Mendicino et al., 2024). While previous studies enhance our understanding of bank capital regulation in the face of trade-offs in closed economies, we examine the role of banks' foreign liabilities in assessing the effectiveness of bank capital requirements in an open economy setting. Our results uncover a novel trade-off between bank solvency risk and exposure to disruptions in foreign funding.

Secondly, this paper contributes to the recent literature on the effectiveness of macroprudential policies in emerging markets (see e.g. Aoki, Benigno and Kiyotaki, 2016; Korinek and Sandri, 2016; Gopinath and Stein, 2021; Ahnert et al., 2021; Benigno et al., 2016; Fornaro and Romei, 2019; Bianchi and Lorenzoni, 2022). We complement previous studies by explicitly considering the role of bank default risk as a key determinant of the complementarity between bank capital requirements and foreign prudential interventions. Differently from the existing work, we focus on the distortions that create externalities associated with bank risk-taking incentives, rather than on pecuniary or aggregate demand externalities as the primary rationale for macroprudential policy interventions.

More broadly, this paper connects with the literature that examines the cross-border effects of bank capital requirements in a two-country setting (see e.g. Acharya, 2003; Dell'Ariccia and Marquez, 2006; Bahaj and Malherbe, 2024). We examine the implications of bank capital requirements for allocation and welfare in small open economies with financial intermediation frictions and bank foreign liabilities.

Finally, our paper contributes to the empirical literature on the impact of changes in bank capital requirements (see e.g. Aiyar, Calomiris and Wieladek, 2016; Peek and Rosengren, 1995; Gropp et al., 2018; Fraisse and Thesmar, 2019; Degryse, Karapetyan and Karmakar, 2021). This literature primarily focuses on the effect of capital requirements on lending in advanced economies. More closely related to our paper is the work by Fang et al. (2022) which offers evidence on bank lending in Peru. Our findings reveal a new empirical result on the impact of capital requirements on the liability side of banks' balance sheet: as capital requirements increase, banks tend to rely more on foreign liabilities. This finding lends empirical support to *the foreign liability channel* of bank capital requirements highlighted by our model.

The paper is organized as follows. Section 1. and 2. present the model economy and the calibration. Section 3. documents the long-run effects of higher bank capital requirements and highlights *the foreign liability channel*. Section 4. explores the implications of abrupt shifts in bank foreign funding for the effectiveness of bank capital requirements. Section 5. examines the role of foreign prudential interventions. Section 6. provides and empirical validation of the *foreign liability channel* of bank capital requirements. Section 7. concludes.

1. Model

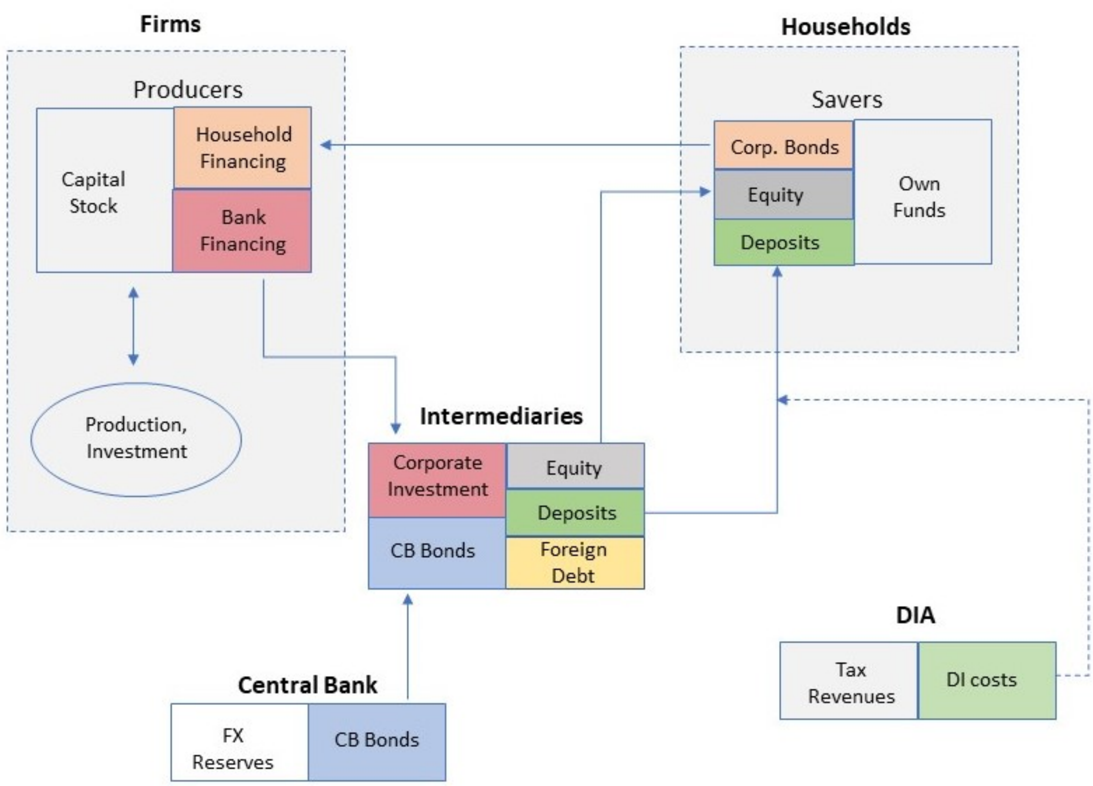
Time is discrete and indexed by $t = \{1, 2, 3, ...\}$. The economy is populated by a continuum of infinitely-lived identical households (H) of measure one. Households work, consume and save either by depositing funds in a bank or by holding productive capital directly. They also own the equity capital of intermediaries. Productive capital is held by both banks and households and rented to final good-producing firms, which use labor, capital and imported goods as production inputs.

Infinitely lived financial intermediaries (I) invest in a domestic capital using both domestic and foreign funds subject to an occasionally binding regulatory constraint. Banks face idiosyncratic profit shocks, operate with limited liability and have the option of default. Bankruptcy is costly and imposes deadweight losses on the society.

The deposit insurance agency (DI) fully insures domestic bank deposits funded with lump-sum taxes levied on households. The central bank (CB) is responsible for setting the level of capital requirements, manages foreign currency reserves and may also engage in foreign prudential interventions.

Finally, the economy is exposed to two distinct sources of aggregate uncertainty that directly impact the banking sector and are subsequently transmitted to the household and production sector. The first source of aggregate uncertainty originates from increased riskiness in the banking sector. The second instead stems from sudden disruptions in the availability of foreign funding for banks.

Figure 1: Model Sketch



In each time period, the sequence of events in the economy unfolds as follows: (i) Aggregate shocks are realized; (ii) Production inputs are rented, production occurs, and factors are compensated; (iii) Idiosyncratic shocks to banks are realized, and individual banks decide whether to declare bankruptcy. In the event of default, the foreign sector and the deposit insurance (DI) agency take ownership of the assets of defaulting banks, with the DI agency covering the costs of insured deposits; (iv) All agents solve their respective optimization problems, consumption occurs, and markets clear.

Figure 1 provides a visual representation of the model. A detailed description of the economic environment follows below.

1.1 Representative Household

Households choose consumption C_t, deposits D^H_{t+1} and capital K^H_{t+1}, to maximize their discounted future stream of utility

$$\max_{\{C_{t+\tau}, K^H_{t+1+\tau}, D^H_{t+1+\tau}\}_{\tau=0,1,2,\ldots}} \mathbb{E}\left[\sum_{\tau=0}^{\infty} \beta^{t+\tau}\left[\frac{C_t^{1-\gamma}}{1-\gamma}\right]\right] \tag{1}$$

with risk aversion coefficient γ and discount rate β, subject to the budget constraint

$$W_t + w_t + \Pi_t \geq C_t + q_{d,t}D^H_{t+1} + q_{k,t}K^H_{t+1} + \Psi^H(K^H_{t+1}) + T^{CB}_t + T^{DI}_t - T^{CC}_t, \tag{2}$$

where household's wealth is defined as the portfolio payoff

$$W_t = q_{k,t}(1-\delta)K^H_t + r_{k,t}K^H_t + D^H_t. \tag{3}$$

Households are endowed with one unit of labour, which they supply inelastically to final good producers at the wage w_t. Households own the equity capital of financial intermediaries and receive aggregate dividend payments Π_t, defined below in (18). Households can save in fully insured deposits, D^H_t, which trade at the price $q_{d,t}$. Additionally, households can invest directly in productive capital, K^H_t, which trades at the price $q_{k,t}$ and generates a return of $r_{k,t}$ per period. However, unlike intermediaries, households are inefficient at monitoring capital investments and incur capital management costs, $\Psi^H(K^H_{t+1})$, when they purchase capital:

$$\Psi^H(K^H_{t+1}) = \frac{\Psi_0}{2}\Big(\frac{K^H_{t+1}}{\Psi_0} - \Psi_1\Big)^2. \tag{4}$$

This inefficiency creates a role for financial intermediaries (see, e.g., Gertler and Kiyotaki, 2015). Furthermore, households pay lump-sum taxes, T_t^{DI} and T_t^{CB}, to the deposit insurance agency and the central bank, respectively, and receive lump-sum transfers from the capital management flow tax, T_t^{CC}.

1.2 Production

1.2.1 Final good producers

The representative firm produces output, Y_t, by employing labor L_t, capital K_t, and imported goods M_t as inputs in a Cobb-Douglas production function:

$$Y_t = Z K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m} \tag{5}$$

where Z is total factor productivity, normalized to 1; $\alpha_k > 0$, $\alpha_l > 0$, and $\alpha_m > 0$ represent the shares of capital, labor, and imports in production, respectively, with $\alpha_k + \alpha_l + \alpha_m = 1$.

The final good producer hires labor L_t at the wage rate w_t, rents capital K_t at the rental price $r_{k,t}$, and purchases imported goods M_t from the foreign sector at the exchange rate f_t.[6] The optimality condition for final good producers require that prices of inputs equal their marginal products:

$$w_t = \alpha_l Z_t K_t^{\alpha_k} L_t^{\alpha_l - 1} M_t^{\alpha_m}, \tag{6}$$

$$r_{k,t} = \alpha_k Z_t K_t^{\alpha_k - 1} L_t^{\alpha_l} M_t^{\alpha_m}, \tag{7}$$

$$f_t = \alpha_m Z_t K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m - 1}. \tag{8}$$

Finally, productive capital owned by households and financial intermediaries and rented to final good producing firms.

[6] We follow the convention that an increase in f_t indicates a depreciation of the domestic currency relative to foreign currency.

1.2.2 Capital goods producers

For a given level of capital stock K_t, the capital producer needs $X_t + \Psi(X_t, K_t)K_t$ units of the final good to produce X_t units of capital, which is then sold at price $q_{k,t}$. New capital creation is subject to adjustment costs $\psi(X_t, K_t)$. We assume $\Psi(X_t, K_t)$ to follow

$$\Psi(X_t, K_t) = \Psi_k \Big(\frac{X_t}{K_t} - \delta \Big)^2, \tag{9}$$

where δ is the depreciation rate of capital. The optimality condition with respect to X_t is given by

$$q_{k,t} = 1 + \Psi_X(X_t, K_t), \tag{10}$$

where $\Psi_X(X_t, K_t)$ represents the derivative of the cost function with respect to X_t.

1.3 Financial Intermediaries

1.3.1 Individual Intermediaries

Financial intermediaries maximize the present discounted value of net dividend payments to their shareholders. They invest in productive capital, k^I_{t+1}, and central bank reserves, b^I_{t+1}, using their own net-worth, n_t, outside equity, e_t, domestic deposits, d^I_{t+1}, and foreign currency denominated debt, $d^{I,*}_{t+1}$. Domestic deposits and foreign debt are issued at prices $q_{d,t}$ and $q^*_{d,t}$, respectively. We define the share of foreign liabilities as $\Theta_{t+1} = \frac{f_t d^{I,*}_t}{f_t d^{I,*}_t + d^I_t}$. Domestic deposits are fully insured and are therefore perceived by households as a risk-free investment. In contrast, foreign debt is uninsured, and its price reflects foreign investors' expectations of the bank's probability of default.

Intermediaries pay a fixed fraction of their net-worth, ϕ^0, as dividends to their owners but they can deviate from this target by issuing equity, e_t. The issuance of equity and foreign deposits are subject to costs $\Psi^{I,e}(e_t)$ and $\Psi^{I,\Theta}(d^I_t, d^{I,*}_t)$, respectively. Issuing equity is subject to a quadratic cost, $\Psi^{I,e}(e_t) = \phi_1 e^2_t$, while the cost of issuing foreign debt are convex in the foreign liability share Θ_{t+1}.

$$\Psi^{I,\Theta}(d^{I,*}_{t+1}, d^I_{t+1}) = \frac{\Psi^*_d f_t d^{I,*}_{t+1}}{2}\Theta_{t+1}. \tag{11}$$

The profit of an individual intermediary is given by:

$$\pi_t = \phi_0 n_t - e_t + \epsilon_t. \tag{12}$$

where ϵ_t represents an idiosyncratic shock to their profit, realized at the time of dividend payouts, as in Elenev, Landvoigt and Van Nieuwerburgh (2021). The shocks are i.i.d. across banks and time with $E(\epsilon_t) = 0$ and c.d.f. F_ϵ. [7]

The intermediary's net worth is determined by their gross return from investments in capital and reserves, minus the amount repaid to creditors:

$$n^I_t = k^I_t[r_{k,t} + (1-\delta)q_{k,t}] + b^I_t - d^I_t - f_t d^{I,*}_t. \tag{13}$$

where $r_{k,t} + (1-\delta)q_{k,t}$ represents the gross return on capital, and f_t denotes the real exchange rate.

Each intermediary optimally decides to default conditional on n_t and the idiosyncratic profit shock realization ϵ_t. Ceteris paribus, lower realization of ϵ_t increase the likelihood of bank failure.

Let $V^I_t(n^I_t, \epsilon_t, \mathcal{S}_t)$ be the value function of a bank with net-worth n_t and idiosyncratic shock ϵ_t in aggregate state $\mathcal{S}_t$. Given an initial state, intermediaries choose capital structure

[7] The idiosyncratic shocks to bank profitability account for unmodeled heterogeneity in bank portfolios, due to for instance differences in bank asset quality. The idiosyncratic nature of these shocks ensures ex-post heterogeneity in bank default outcomes as in Mendicino et al. (2020) and Elenev, Landvoigt and Van Nieuwerburgh (2021). These shocks only influence the dividend payments and do not impact the future net worth of the bank.

and asset allocation, $\mathcal{C}_t \equiv \{k^I_{t+1}, b^I_{t+1}, d^I_{t+1}, d^{I,*}_{t+1}, e_t\}_{t=0}^{\infty}$, to solve

$$V^I_t(n_t, \epsilon_t, \mathcal{S}_t) = \max_{\mathcal{C}_t}\{\pi_t + \mathbb{E}_t[\mathcal{M}_{t+1} \max\{V^I_{t+1}(n_{t+1}, \epsilon_{t+1}, \mathcal{S}_{t+1}), 0\}]\}$$

subject to (12), (13), the budget constraint

$$\underbrace{(1-\phi^0)n_t}_{\text{retained earnings}} + \underbrace{e_t - \Psi^{I,e}(e_t)}_{\text{equity issuance}} - \underbrace{\Psi^{I,\Theta}(d^I_{t+1}, d^{I,*}_{t+1})}_{\text{foreign debt cost}} \geq \underbrace{q_{k,t}k^I_{t+1} + q_{b,t}b^I_{t+1} - q_{d,t}d^I_{t+1} - q^*_{d,t}(\mathcal{C}_t)f_{t+1}d^{I,*}_{t+1}(1-\tau)}_{\text{net investment}}, \tag{14}$$

the regulatory capital constraint

$$q_{b,t}b^I_{t+1} + \theta q_{k,t}k^I_{t+1} \geq q_{d,t}d^I_{t+1} + q^*_{d,t}(\mathcal{C}_t)f_t d^{I,*}_{t+1}, \tag{15}$$

and the external borrowing constraint

$$\bar{d}^*_{t+1} \geq d^{I,*}_{t+1}. \tag{16}$$

where $\mathcal{M}_{t+1}$ is the stochastic discount factor of the households which are bank owners. Equation (14) states that retained earnings and issuance of equity, net of the foreign debt costs, must be enough to finance the net investment in capital.

Financial intermediaries operate under two occasionally binding constraints. The first is a regulatory constraint (Equation (15)), which limits their liabilities to finance with debt at most a fraction, θ, of the market value of their risky assets. The parameter θ serves as the key macro-prudential policy parameter in this model.

The second constraint is an external borrowing limit (Equation (16)), which caps the dollar amount that intermediaries can borrow from abroad at $\bar{d}_{t+1}$. Following Bianchi and Mendoza (2020), we interpret variations in $\bar{d}^*_{t+1}$ as capturing shocks to the supply of foreign debt due to for instance US monetary policy or the global financial cycle (Miranda-Agrippino and Rey, 2020; Coimbra and Rey, 2023). Finally, in case of a capital flow management tax, intermediaries are required to pay a tax rate τ on their foreign debt holdings as in (e.g Bianchi and Mendoza, 2018; Chi, Schmitt-Grohe and Uribe, 2024).

1.3.2 Aggregation and Bankruptcy

The problem of an individual intermediary is not scale-invariant with respect to net worth, but it is possible to aggregate the individual intermediary's problem into that of an aggregate bank. For a detailed proof, see Appendix B.

As shown in equation (12), the bank's objective is linear with respect to the idiosyncratic shock. This means that the shock does not impact bank's net worth in future periods. The linearity assumption allows us to define the value function $\tilde{V}^I(N_t, \mathcal{S}_t)$ as $\tilde{V}^I(N_t, \mathcal{S}_t) = V^I(N_t, \epsilon_t, \mathcal{S}_t) - \epsilon_t$. The bank default rate can then be defined as:

$$F_{\epsilon,t} \equiv F_\epsilon\left(-\tilde{V}^I\left(N_t^I, \mathcal{S}_t\right)\right).$$

When an individual intermediary defaults, it is liquidated. While creditors fully recover the profits and safe assets of the defaulting bank, a fraction μ of its risky assets is lost during the repossession process. The recovery value of the defaulting intermediaries, RV_t, is given by

$$RV_t = (1-\mu)[r_{k,t} + q_{k,t}(1-\delta)]K_t^I + B_t^I + \epsilon_t^-, \tag{17}$$

where $\epsilon_{t+1}^- = E_\epsilon[\epsilon | \epsilon \leq \tilde{V}(N_{t+1}, S_{t+1})]$ is the expected idiosyncratic profit conditional on defaulting.

We assume that new banks replacing defaulted intermediaries are endowed with the average equity of non-defaulting banks. As a result, the aggregate profits distributed to households are given by

$$\Pi_t = \phi^0 N_t + e_t - F_{\epsilon,t}N_t + (1-F_{\epsilon,t})\epsilon_t^{I,+}, \tag{18}$$

where $\epsilon^+_{t+1} = E_\epsilon[\epsilon|\epsilon > \tilde{V}(N_{t+1}, S_{t+1})]$ is the expected idiosyncratic profit conditional on non-defaulting.

Unlike domestic deposits, the price of foreign currency-denominated debt reflects the intermediary's fundamentals. The price of foreign debt, $q^*_{d,t}(\mathcal{C}t)$, depends on the intermediary's endogenous choices, which we discuss in detail in Section 1.5.1. Crucially, the representative intermediary recognizes that foreign debt is a risky asset and internalizes the impact of bank default risk on the price they receive. As a result, the price schedule of foreign debt is treated as a constraint in intermediaries' optimization problem.

1.4 Deposit Insurance Agency

When an intermediary defaults, the Deposit Insurance Agency (DI) takes over $(1-\Theta_t)$ of the recoverable assets from the defaulting intermediaries and redeems deposits at their full par value, paying back depositors in full. To cover the shortfall, the DI finances the difference by imposing lump-sum taxes levied on households, T^{DI}_t, which are given by:

$$T^{DI}_t = \left[D^I_t - (1-\Theta_t)RV_t\right]F_{\epsilon,t}. \tag{19}$$

1.5 Foreign sector

1.5.1 Foreign Investors

Foreign investors are risk-neutral and have deep pockets, discounting the future at an exogenous rate R^*. They provide banks with uninsured debt, D^*_{t+1}. When a bank defaults, foreign investors recover a fraction Θ_t of the bank's assets and profits. As a result, the price of risky foreign debt, $q^*_{d,t}$, must satisfy their zero-profit condition:

$$q^*_{d,t} = \frac{1}{R^*}\mathbb{E}_t\Big\{F_{\epsilon,t+1}\frac{\Theta_{t+1}RV_{t+1}}{f_{t+1}D^*_{t+1}} + (1-F_{\epsilon,t+1})\Big\}. \tag{20}$$

Crucially, the price of foreign debt is sensitive to the risk of bank default. A higher default risk implies a lower price (or higher rate) charged to intermediaries, as foreign investors require compensation for the additional risk they are taking.

1.5.2 Foreign goods market

The foreign sector supplies intermediate import goods, M_t, denominated in foreign currency, and purchases EX_t of the final good, denominated in the home currency. We assume that the demand for exports follows:

$$EX_t = (f_t)^{\chi} Y^*, \tag{21}$$

where χ is the constant price elasticity of demand, and Y^* represents an exogenous level of foreign output. Specifically, we assume that foreign demand for final goods is a decreasing function of the relative price of exports, f_t, and foreign income, Y^*.

1.5.3 Balance of Payments

Equilibrium requires that financial flows from the home economy to the rest of the world equal the current account. This condition expressed in foreign currency is given by:

$$\underbrace{q^*_{d,t} D^*_{t+1} - D^*_t (1 - F_{\epsilon,t}) - \Theta_t R V_t F_{\epsilon,t}}_{\text{Financial flows from banking sector}} - \underbrace{q^*_s \mathcal{R}_{t+1} + \mathcal{R}_t}_{\text{Financial flows from CB}} = \underbrace{M_t - \frac{EX_t}{f_t}}_{\text{Current Account}} . \tag{22}$$

1.6 Central Bank

The central bank in this economy sets the level of bank capital requirements θ and manages foreign currency reserves. In addition, it can also engage in foreign prudential interventions.

1.6.1 Foreign Reserves Holding

The balance sheet of the central bank is given by

$$B_{t+1}^{CB} = f_t \mathcal{R}_{t+1}, \tag{23}$$

where B^{CB} denotes central bank bonds and $\mathcal{R}_{t+1}$ represents foreign exchange (FX) reserves. When the central bank buys (sells) foreign currency, its official FX reserves increase (decrease), and the central bank offsets the effect on domestic liquidity by issuing (retiring) central bank bonds to (from) the banking system.

We assume the central bank purchases reserves at the foreign currency price $q^* = 1/R^*$, while the price of domestic sterilization bonds is $q_{b,t}$. As long as $q_{b,t} < q^*$, the central bank incurs operational losses from the sterilization process, which are covered by imposing lump-sum taxes on households. The central bank's quasi-fiscal deficit, T_t^{CB}, is thus given by

$$T_t^{CB} = \left(q_s^* - q_{b,t}\right) B_{t+1}^{CB} + \left(1 - \frac{f_t}{f_{t-1}}\right) B_t^{CB}. \tag{24}$$

1.6.2 Foreign Prudential Interventions

In a variation of our baseline model, discussed in Section 5., we examine two types of foreign prudential interventions: a capital flow management tax and FX interventions.[8]

Capital flow management tax. The central bank can impose a capital flow management tax, τ, on banks' foreign debt. The total revenue from this tax on foreign debt is given by

$$T_t^{CC} = \tau q_{d,t}^* f_t D_{t+1}^*, \tag{25}$$

which is rebated back to households.

[8] In the baseline version of the model, the parameters governing capital flow management tools and FX interventions are set to zero.

FX interventions. We also consider a scenario where the central bank buys or sells official FX reserves according to the following FX intervention rule

$$\log(B^{CB}_{t+1}) = \log(\bar{B}^{CB}) - \phi_{FX} log\Big(\frac{f_t}{\bar{f}}\Big) \tag{26}$$

where $\bar{B}$ and $\bar{f}$ represent the steady-state values of sterilization bonds and exchange rates, respectively, and $\phi_{FX} > 0$ is a parameter that governs how strongly the central bank sells (buys) foreign reserves when the home currency depreciates (appreciates) (see e.g. Carrasco and Florián Hoyle, 2021).

1.7 Aggregate Shocks

The model features two sources of aggregate uncertainty: a bank risk shock and an a shock to the availability of foreign funds for banks. Regarding the bank risk shock, we assume the following $AR(1)$ law of motion for the standard deviation of the distribution of idiosyncratic profit shocks

$$\sigma_{\epsilon,t+1} = (1 - \rho_{\sigma_\epsilon})\sigma_\epsilon + \rho_{\sigma_\epsilon} + \rho_\epsilon \sigma_{\epsilon,t} + \sigma_{\sigma_\epsilon} \varepsilon_{\epsilon,t+1}$$

where $\varepsilon_{\epsilon,t+1}$ is normally distributed with mean zero and variance one.

The foreign borrowing limit shocks follow a two state markov chain d^*_1, d^*_2 with the following transition matrix

$$P_{d^*} = \begin{pmatrix} P_{1,1} & 1 - P_{1,1} \\ 1 - P_{2,2} & P_{2,2} \end{pmatrix}.$$

1.8 Market Clearing

Model aggregation and equilibrium conditions, market clearing conditions, as well as a definition of the competitive equilibrium in the context of our model, see Appendix B.

2. Calibration

We solve the model using the projection algorithm developed by Elenev, Landvoigt and Van Nieuwerburgh (2021). This method is suitable for capturing the non-linearities embedded in the model arising from the precautionary behavior of agents due to aggregate risk, as well as the two occasionally binding constraints.

The model is calibrated using quarterly macroeconomic, banking and financial data for Peru over the period 2002Q2 - 2019Q4.[9] We start by setting some model parameters in accordance with the existing literature (see Table 1). We then simultaneously calibrate the remaining parameters to match key data targets. See Table 2.

[TABLES 1 and 2 HERE]

Pre-set parameters. The capital requirement level is set to be 0.08 according to the regulatory minimum in the Basel II regime. We set $\mu = 0.3$ in line with Elenev, Landvoigt and Van Nieuwerburgh (2021) and Mendicino et al. (2018).[10] Due to the lack of suitable data for Peru, we set the parameters governing the flow of profits from banks, ϕ_0 and ϕ_1, using the values from Elenev, Landvoigt and Van Nieuwerburgh (2021).[11] Finally, the capital depreciation rate $\delta\%$ is set to 2.5, as in Carrasco and Florián Hoyle (2021). In the baseline version of the model, the parameters governing the capital flow management tools, ϕ_{FX} and τ, respectively, are set to zero.

Moment Matching. The remaining parameters are calibrated simultaneously to match key data targets.

Production: We use data from *Banco Central de Reserva del Perú* (BCRP) for nominal GDP, investment and imports series deflated using the GDP deflator. In calibrating the

[9] See Appendix D for details on the data series used in the calibration.

[10] See also Bennett and Unal (2015) for evidence on the US. Djankov et al. (2008) report that emerging market economies typically have larger resolution costs relative to the US. However, in line with the literature we choose a more conservative value.

[11] Neither the flow-of-funds from BCRP nor the micro-data from SBS allow us to observe dividends and equity pay-outs separately. We therefore opt to use the parameters reported by Elenev, Landvoigt and Van Nieuwerburgh (2021), adjusted to quarterly frequency.

import share in production α_m, we follow Mendoza (2010). We compute the imports to gross output ratio to be on average 16.3%, which directly pins down $\alpha_m = 0.163$. We calibrate α_k to match the average investment to GDP ratio of 22.5% observed in the data. We then compute the labour input share in production using $\alpha_l = 1 - \alpha_k - \alpha_m$. Regarding the capital production cost, we follow Elenev, Landvoigt and Van Nieuwerburgh (2021) and calibrate Ψ_k to match the HP de-trended volatility of investment relative to GDP of 4.19.

Exports: We use BCRP data to compute the exports to GDP ratio of about 21.1%, which we use as a target to calibrate Y^*.

Household Capital Share: We compute total corporate debt as the sum of the stock of corporate loans by depository institutions and the stock of outstanding corporate bonds by Peruvian firms. Accordingly, we interpret the household capital share as the fraction of non-bank corporate credit relative to the total stock of corporate debt. his yields an average of 11.4% and a volatility of 0.36%, which aligns with the U.S. figures reported in Elenev, Landvoigt and Van Nieuwerburgh (2021). We match these values by calibrating Ψ_0 and Ψ_1 accordingly.

Interest Rates: We target a domestic real interest rate of 3.5%, computed using the BCRP target rate over the GDP deflator. We match this target by calibrating β such that $400(1/\beta - 1) = 3.5$. For what concerns the foreign interest rate, we target 2.7%, which correspond to the U.S. real rate over the same sample period, computed as the (annualized) nominal 3-month rate on US treasuries adjusted by the GDP deflator.

Bank Foreign Liability Share: We use data from *Superintendencia de Banca, Seguros y Administradoras Privadas de Fondos de Pensiones* (SBS) to compute total liabilities as the sum of banks' deposits held by households (we exclude inter-bank deposits) and foreign liabilities. The average foreign liability share stands at 10.1%, which we target by calibrating Ψ_{d^*}. Its volatility is computed after de-trending the series using the HP filter.

Bank Default: We use Moody's Expected Default Frequency to calculate the average default rate of depository institutions in Peru of 1.04%. We then calibrate σ_ϵ to match this value.

FX Reserves: We compute the average FX reserves as a fraction of annual GDP, obtaining a value of 22%, which we match by calibrating $\bar{B}^{CB}$. In the baseline calibration, we set $\phi_{FX} = 0$.

Aggregate Risk. We calibrate the persistence parameter, ρ_{σ_ϵ}, and the standard deviation of bank risk shock innovations, σ_{σ_ϵ}, to match the standard deviation and first-order autocorrelation (AC(1)) coefficient of Moody's EDF for depository institutions in Peru. The corresponding standard deviation and AC(1) coefficient in the data are 1% and 0.89, respectively. To match the volatility of the foreign volatility share, we calibrate a two-state Markov chain over realizations of $\bar{d}^*_{t+1}$. The realized values of the shock are $[\bar{d}^*_1, \bar{d}^*_2]D^*_{ss}$, where D^*_{ss} is a steady-state value of foreign borrowing D^*. We follow Bianchi and Mendoza (2020) by pre-setting the transition matrix to match the (quarterly) probability of tight and loose financial regimes.

Table 2 shows that our model matches the macro- and bank-level data targets reasonably well along a number of important dimensions. First, the average shares of investment, export and reserves to GDP as well as the volatility of investment are close to their empirical counterparts. Second, the model can match very well the average, volatility and autocorrelation of bank default. Third, the model also does a good job in matching the average, volatility and persistence of foreign liability shares.

3. Bank Capital Requirements: Long-Run Effects

The level of capital requirements is a tool in the hands of the macro-prudential authority to address banks' solvency issues. Banks with limited liability do not internalize the social costs of their individual choices. The existence of safety net guarantees in the form of insured deposits, together with the aggregate externalities derived from the deadweight losses caused by bank failures, provides a rationale for the implementation of bank capital regulation in our framework.

In what follows, we use our calibrated model to examine the impact of bank capital requirement choices on key model variables. In the benchmark model, banks are constrained by a regulatory equity-to-asset ratio requirement of 8%. We explore the effects of more stringent requirements. First, we examine the long-run implications of changing capital requirements on the model allocation and welfare. Next, we highlight the role of bank default risk in understanding how changes in capital requirements influence banks, particularly with regard to their foreign liabilities.

3.1 Macroeconomic and Welfare implications

We first explore the effect of bank capital requirement choices θ on the mean of the ergodic distribution of selected macro and financial model variables. Then, we study the (stochastic) welfare implications.

[FIGURE 2 and 3 HERE]

Macro and Financial Variables. The implementation of more stringent bank capital requirements results in a safer, but smaller, banking sector (see Figure 2). Tighter bank capital requirements lead to a reduction in bank leverage which allows banks to more effectively cover their debt even in the event of a substntial decline in the value of their investments, thereby protecting them from insolvency. Consequently, the average probability of bank default declines as the level of the requirement rises. Under limited liabilities banks do not internalize the social costs of their leverage decisions. Overall, the economy benefits from a reduction in the deadweight losses for the society associated with bankruptcy costs. The cost of the deposit insurance to taxpayers also decreases, which in turn leads to an initial increase in consumption.

These benefits, however, come with trade-offs. Higher capital requirements, indeed, force banks to finance their investments with a larger share of equity, which is relatively more expensive than both domestic deposits and foreign funding. The relative scarcity of equity resulting from higher capital requirements leads to an overall increase in the cost of bank funding, which ultimately reduces banks' intermediation capacity and hence productive investment.

Higher bank capital requirements also result in an increased reliance on banks' foreign liabilities. As the probability of bank default decreases, the cost of foreign funding declines, encouraging banks to increase their use of foreign liabilities. We refer to this as the *foreign liability channel* of bank capital requirements.[12]

We formally establish the analytical foundation for this mechanism in Appendix A, which presents a simplified two-period version of our quantitative model in which banks finance their capital purchases using a mix of domestic deposits, foreign debt, and equity. The appendix analytically derives the key equilibrium conditions, demonstrating that an increase in capital requirements reduces the probability of bank default, which in turn lowers the cost of foreign funding. As foreign debt becomes more attractive relative to domestic deposits, banks optimally increase their reliance on foreign liabilities. This theoretical result underpins the findings from the quantitative model presented in this section and highlights the foreign liability channel as a key transmission mechanism of bank capital regulation.

Overall, the decline in foreign funding costs benefits banks as it partially offsets the higher funding costs associated with greater reliance on equity funding. At the same time, the larger reliance on foreign liabilities makes the economy more vulnerable to disruptions in the availability of foreign funding for banks, resulting in bank defaults and associated costs for the society. The latter effect is, however, not internalized by banks with limited-liability.

Welfare. The welfare effects of capital requirements summarize the trade-off between the size and fragility of the banking sector implied by higher bank capital requirements (see

[12] For tractability we assume that all domestic deposits are in local currency. Households in emerging economy might have incentives to hold foreign currency deposits (see e.g. Bocola and Lorenzoni, 2020; Gutierrez, Ivashina and Salomao, 2023). The foreign liability channel would hold even with the addition of domestic deposits in foreign currency, as higher capital requirements would still lead to a reduction in the cost of funding by foreign investors.

Figure 3). Tighter capital requirements initially increase social welfare in the model, starting from the baseline level of 8%. This reflects the net benefits of reducing bank failures and the costs associated with them. Once bank default is substantially reduced, further increases in bank capital requirements become instead detrimental due to the negative effects of the reduction in banks intermediation capacity. Welfare displays an optimum corresponding to a capital requirement level about 13%. This yields welfare gains of about 0.35% in consumption equivalent terms relative to the baseline level of 8%.

3.2 The Role of Bank Default Risk

[FIGURE 4 and 5 HERE]

What is the role of bank default in the model? How does it affect the impact of bank capital requirements? To answer these questions we first explore the effects of bank default risk on the long-run properties of the model. Then we examine the impact of changes in capital requirements in the absence of bank default risk.

Financial intermediaries optimally decide on their default outcome contingent on their net worth and the realization of the idiosyncratic profit shock, denoted by ϵ_t. Changes in the standard deviation of the bank idiosyncratic shock, σ_{ϵ_t}, are directly related to the average probability of bank failure. Figure 4 shows how σ_{ϵ_t} affects selected model variables. A higher standard deviation increases the probability of a low realization of ϵ_t which ceteris paribus increases the probability of bank default. Starting from the baseline calibrated level, an increase in the average bank default directly translates into higher foreign funding costs. Unlike domestic deposits, the price of foreign liabilities is sensitive to bank default risk. Hence, higher bank funding costs are associated with a lower reliance of the banking sector on foreign liabilities.

Next, Figure 5 compares the long-run effects of capital requirements in our baseline model (blue line) with those in a version of the model without bank default risk (red line). Higher capital requirements, by limiting the intermediation capacity of banks, reduce economic activity. However, if bank default risk is neglected, higher bank capital requirements have no beneficial effect on the soundness of the banking sector and hence on the overall economy. In the absence of considerations related to limited liability and bank solvency risk, the cost and availability of foreign funds for banks are not directly impacted by bank capital requirements. Higher capital requirements would only reduce the size of the banking sector. The cost and availability of foreign funding costs would also not be affected by changes in bank capital requirements.[13] Overall, our results show that bank default risk is key to uncover the foreign liabilities channel of bank capital requirements.

4. Banks' Financial Outflows and Capital Requirements

[FIGURE 6 and 7 HERE]

How do abrupt shifts in bank foreign funding affects the efficacy of tighter bank capital requirements in mitigating financial stability risks? To address this question, we examine how bank capital requirements affect the response of the economy to two sources of aggregate uncertainty that directly impact the banking sector: heightened riskiness (bank-risk shock) and disruptions in the availability of foreign funding (sudden stop). We show that tighter capital requirements may prove inadequate in safeguarding the banking sector and, consequently, the domestic economy from both sources of volatility in banks' foreign liabilities.

4.1 Bank-risk shock

Figure 6 reports the response of the economy to a domestic bank risk shock, i.e. a mean-preserving shock to the standard deviation of the idiosyncratic shock to bank profits, under two different levels of capital requirements. The black solid line refers to the baseline level of capital requirements of 8 percent. An increase in the volatility of bank profits leads to a

[13]The economy subject to costly bankruptcy reports levels of GDP, consumption and investment below those of the no-default economy. These differences are larger the higher the average bank default.

depletion of bank net worth and to an increase in the probability of bank failure. As a result, banks reduce their investment in productive assets, which depresses the price of capital and aggregate investment. An increase in bank default rates endogenously leads to higher foreign funding costs and, hence, to a decrease in the reliance on foreign debt, which further reduces the intermediation capacity of banks. The rise in bank default rates is associated to larger bankruptcy costs which in turn further depress consumption and investment. Overall, the economy experiences a persistent decline in economic activity.

Under a higher capital requirement of 10% (blue line), the impact of the bank risk shock is substantially mitigated. Better capitalized banks can better absorb the negative effects of the shock, leading to a less significant impact on bank net worth and, therefore, on bank solvency. As a result, tighter bank capital requirements play a mitigation effect in the transmission of increased riskiness in the banking sector to the real economy.

4.2 Bank foreign liabilities disruptions

Next, we consider an exogenous shock to the availability of foreign funding, $\bar{d}^*_{t+1}$. The black solid line in Figure 7 displays the response of the economy under the baseline level of capital requirements of 8%.

A sudden outflow of foreign funding results in a persistent decline in economic activity and an outflow of capital from the banking sector. The substitution of foreign debt for more expensive domestic deposit funding reduces banks' net worth and increases the likelihood of bank failure. A sudden reduction in foreign funding feeds back into banks' ability to finance productive capital, ultimately reducing investment and economic activity.

At the same time, the shock implies a depreciation of the real exchange rate, with further adverse effects on the cost of foreign funds and on banks' intermediation capacity. Since firms price final goods in foreign currency, a real depreciation boosts exports only modestly relative to the fall in imports, leading to a decline in net exports. This, in turn, further dampens the response of economic activity and consumption.

Overall, the financial recession induced by a shock to banks' foreign liabilities has a much stronger impact on the exchange rate than a bank risk shock, but it results in a milder response of the bank failure rate.

Interestingly, an economy with tighter bank capital requirements (see Figure 7 (blue line)) suffers a deeper recession, as summarized by the larger decline in GDP on impact. In contrast to the capacity of bank risk shocks to be buffered by higher capital requirements, the same cannot be expected for foreign financial shocks. On the one hand, higher capital requirements enable banks to be in a more favorable position to repay their debt, thereby reducing the likelihood of default. Conversely, they lead to a larger reliance of banks on external funding, making them more vulnerable to disturbances that directly impact this source of funding. An exogenous sudden stop event, therefore, gives rise to a more pronounced depreciation of the currency and a larger decline in bank investment in productive assets and, consequently, in production.

Importantly, the exchange rate depreciation doesn't play a key role via its impact on banks balance sheet. As illustrated in Appendix Figure D.1, our results remain robust even when the exchange rate depreciation is assumed to have no effect on the bank balance sheet. This result suggests that even if banks were to hedge against exchange rate risk, or banks are restricted from holding mismatched currency positions, the shock would still affect the economy through the direct quantity effect on bank foreign liabilities.

4.3 Capital Requirement and Aggregate Risk Trade-Off

[FIGURE 8 HERE]

The results discussed in the previous section suggest that higher bank capital requirements are effective in mitigating the impact of domestic bank risk shocks. They are, however, not able to insulate the economy from exogenous sudden reductions in foreign bank funding. On the contrary, higher bank capital requirements tend to exacerbate the adverse effects of such shocks, leading to a novel trade-off of bank capital regulation in open economies.

Figure 8 summarizes this trade-off. Specifically, we analyze the optimal level of capital requirements in economies facing different probabilities of crisis driven by heightened or by a sudden stop in foreign funding. The optimal level of capital requirements increases with the probability of a crisis driven by bank risk. On the contrary it decreases with the probability of a sudden drop in the availability of foreign funds. Hence, when establishing the optimal level of bank capital requirements, the macroprudential authority must achieve a balance between the macroeconomic and financial stability implications of domestic and foreign financial shocks.

Crucially, bank default risk is a key determinant of this trade-off. In the absence of bank default risk, a higher capital requirement would not amplify the impact of disruptions in the availability of foreign funding for banks (see Appendix Figure D.2). This is because bank foreign liabilities would not be affected by the capital requirement level, as illustrated in Figure 5.

5. Foreign Prudential Interventions

In what follows we show that policies that directly restrict the access to foreign funding or address fluctuations in the real exchange rate can be useful to counterbalance the negative effects of capital requirement increases in response to global sources of financial outflows in the banking sector. Crucially, this can be achieved without compromising the effectiveness of tighter capital requirements in response to bank risk-shocks. Foreign prudential interventions can, therefore, reduce the policy trade-off between achieving domestic and external stabilization objectives. In sum, our results indicate that in the presence of bank default risk, bank capital requirements and foreign prudential interventions operate in a complementary manner.[14]

[14]This result hinges on the consideration of bank default risk in the policy assessment. In the absence of bank default risk capital requirements have no effect on the share of foreign liabilities and hence on the exposure to exogenous global shocks. Consequently, foreign prudential interventions would not be beneficial and complementary to bank capital regulation.

5.1 Capital flow management tax

[FIGURES 9 - 10 HERE]

We begin by showing that capital flow management taxes are an effective tool to reduce the share of banks' foreign liabilities, even when capital requirements are more stringent. Figure 10 displays the long run implications of varying the capital flow management tax under the baseline 8% level of capital requirements and under a higher level of 10%. It demonstrates that there exists a capital flow management tax, τ^*, which reduces the share of banks' foreign liabilities associated with a capital requirement of 10% to the level corresponding to a capital requirement of 8% (without capital flow management tax).

The red line in Figure 10 displays the economy's response to a disruption in foreign funding under a capital requirements of 10% coupled with a capital flow management tax τ^*. A comparison of the economic response with (red line) and without (blue line) the implementation of a capital flow management tax allows us to conclude that the latter is an effective measure for reducing banks' exposure to external shocks. The impact of an increase in bank defaults and a decline in economic activity is less severe when higher bank capital requirements are coupled with a capital flow management tax.

The impact of a sudden reduction in bank foreign liabilities is also substantially less remarkable than under the baseline capital requirements of 8% (black line). This is because for the same level of bank foreign liabilities, the economy benefits from lower bank defaults and associated bankruptcy costs induced by the higher level of capital requirements.

The introduction of a capital flow management tax has instead no significant effects on the transmission of a bank-risk induced financial outflow as documented in Appendix Figure D.3.

5.2 FX Interventions

[FIGURE 11 HERE]

In what follows we assess the role of foreign prudential policies in the form of FX interventions. FX interventions are calibrated such that on impact, the real exchange rate depreciates by the same amount as in the case of a capital flow management tax τ^*.

Figure 11 (dashed black line) displays the impact of a sudden drop in banks' foreign liabilities when the central bank also engages in FX interventions in addition to imposing a tighter bank capital requirement of 10%. The results show that FX interventions are beneficial in mitigating the effects of such shocks. Under FX interventions, the central bank responds to exchange rate depreciations by selling official foreign exchange reserves. Compared to the baseline case, the exchange rate depreciates by less, mitigating the fall in economic activity. Under the FX intervention regime, banks' default rate also increases by less on impact, further resulting in a reduced drop in GDP compared to an economy with only tighter bank capital requirements.

Similarly to capital flow management tax, adopting FX interventions alongside higher capital requirements does not have a significant effect on the transmission of domestic financial shocks, as shown in Appendix Figure D.3.

6. The Foreign Liability Channel of Capital Requirements in the Data

The findings discussed in previous sections indicate that banks with more stringent capital requirements tend to rely more heavily on foreign funding and reduce their lending. In this section, we proceed to empirically test this channel. In order to investigate this hypothesis, we focus on the transition to higher bank capital requirements in Peru. While Fang et al. (2022) examines the impact of this reform on domestic bank lending, we extend their analysis by investigating how the reform affected banks' foreign liabilities. For completeness, we also analyze the effects on lending to firms, providing a broader understanding of the consequences of higher capital requirements.

In the aftermath of the Global Financial Crisis, Peru's banking regulator, the *Superintendencia de Banca, Seguros y AFP del Perú* (SBS), initiated a two-phase enhancement of capital requirements. In the initial phase, which spanned from 2009 to 2011, the SBS increased the baseline minimum capital requirements from 9.1% to 10% of risk-weighted assets (RWA). In the second phase, which spanned from 2012 to 2016, the SBS established bank-specific capital buffers in addition to the 10% standard minimum. These additional buffers could potentially reach up to 5.6 percentage points.

The initial reform, which was declared in July 2008, specified incremental increases in the uniform minimum capital requirements on July 1 of 2009, 2010, and 2011 from 9.1% to 9.5%, then to 9.8% of RWA, respectively. The subsequent reform, which was announced in July 2011, deviated from the previous approach of specifying fixed increases. Instead, it introduced a formula for calculating the additional capital buffer that each bank was required to maintain above the 10% minimum. In accordance with this formula, banks were obliged to adhere to a phased implementation schedule from 2012 to 2016. This entailed a gradual increase in the proportion of the prescribed buffer held, reaching 40%, 55%, 70%, 85%, and ultimately 100% of the prescribed buffer. Accordingly, the buffer was recalculated on a monthly basis.

Figure 12 presents the evolution of capital requirements across 16 commercial banks in Peru from 2008 until 2016.[15] Prior to the second quarter of 2012, there was no distinction in capital requirements among the banks, as they were uniformly applied. From the third quarter of 2012 onwards, the boxplot illustrates the distribution of capital requirements among the banks.

[15] We are indebted to Andrea Presbitero and Lev Ratnovsky for sharing with us the data on bank-level capital requirements for Peruvian banks.

Empirical Specification. To investigate the impact of higher bank capital requirements on banks' foreign liabilities and corporate lending, we use bank-level quarterly balance sheet and capital requirement data for all 16 Peruvian commercial banks, for the period 2011–2013. In our empirical analysis, we focus on the capital requirement reform that came into force in July 2011. This regulatory change provides an ideal setting to test the predictions of our model, as it applied bank-specific capital requirements, thereby generating substantial cross-sectional variation in bank capital requirements (see Figure 12). Consequently, we are able to employ a difference-in-difference methodology to evaluate the impact of banks subject to different capital requirement. Importantly, this setting allows us to saturate the regressions with time fixed effects which account for any time-varying factors that are common across banks, such as economic conditions and the average level of capital requirements. This approach would not be feasible if capital requirements were identical across banks.

Furthermore, the inclusion of bank fixed effects enables us to control any time-invariant observable and unobservable bank-level heterogeneity. It is crucial to note that the use of bank fixed effects serves to control for factors that may be correlated with the level of bank-specific capital requirements. These factors include the riskiness of the bank loan portfolio, leverage, and the bank's appetite for risk, which could bias our estimates.

The analysis focuses on the initial phase of the implementation of the bank-specific capital requirement, which began in July 2012 and ended in June 2013. This period encompasses both the pre-reform period (July 2011 to June 2012) and the post-reform period (July 2012 to June 2013). The initial phase of bank-specific requirements began in July 2012, as illustrated in Figure 12.[16] The rationale for focusing on this period is that the subsequent phases (2 to 5) of the reform were likely anticipated by the banks, enabling them to adjust their balance sheets ahead of time.

[16]The results remain robust when the sample is extended to encompass the period preceding the reform announcement (July 2010 to June 2011).

Our empirical specification takes the following form:

$$y_{b,t} = \alpha_b + \alpha_t + \beta CapReq_{b,t-1} + \gamma X_{b,t-1} + \epsilon_{b,t} \tag{27}$$

where the outcome variable $y_{b,t}$ represents either the bank-level log amount of foreign debt or the ratio of foreign debt to total liabilities. For completeness, we also consider the impact on bank-level credit measured by the log amount of loans to firms. $CapReq_{b,t-1}$ denotes the level of capital requirement and $X_{b,t-1}$ are bank-level time-varying controls such as bank size, EBITA, liquidity position and risk-weighted assets. We saturate the model with bank fixed effects, α_b, and time fixed effects, α_t.[17]

The key identifying assumption of our empirical strategy is parallel trends. That is, the strategy assumes that in the absence of capital requirement changes the reliance on foreign liabilities of banks with ex-post relatively higher and lower capital requirement would have trended similarly. To establish pre-trends and visualize the effects over time, we estimate a dynamic difference-in-difference specification using the equation:

$$y_{b,t} = \alpha_b + \alpha_t + \sum_{k \neq 2012q3} \beta_k HighCapReq_b \times 1_{k=t} + \gamma X_{b,t-1} + \epsilon_{b,t} \tag{28}$$

where $HighCapReq_b$ is a dummy variable that takes the value of 1 for banks that were subject to a capital requirement in the top 25th percentile of the distribution after the reform, and 0 otherwise. We normalize the 2012q3 coefficient to zero.

Results. Table 3 presents the results. Columns (1) - (3) report the estimates for the log amount of foreign debt, while columns (4) - (6) use the ratio of foreign debt to total liabilities as the dependent variable. Columns (7) - (9) display the estimates for the log amount of loans to firms.[18] Importantly, our results are stable when including bank and time fixed

[17]See Data Appendix for details on the data series used in the estimation.

[18]The reduced number of observations for the specification utilizing the logarithm of the foreign debt as the outcome variable is due to the presence of banks without foreign debt. These cases are accounted for in the analyses using the ratio of external debt to total liabilities as the outcome variable.

effects.

Consistent with the model predictions, we find that higher capital requirements are associated with significantly higher bank reliance on foreign debt. In terms of economic magnitudes, a 1 percentage point increase in capital requirements is associated with a 6.7% increase in the absolute amount of foreign debt and an increase in share of foreign liabilities of 0.8pp. The latter result is in line with our model's predictions of approximately 1 pp increase in the banks' share of foreign liabilities when capital requirements increase by 1pp, i.e. from 10% (the pre-reform level of 2011) to 11% (the median post-reform level after the initial phase in 2012). We also find that banks reduce their supply of corporate loans in response to higher capital requirements, in line with our model predictions and other empirical studies on the impact of bank capital requirements on lending (see e.g. Gropp et al., 2018; Fraisse and Thesmar, 2019; Fang et al., 2022).

Figure 13 plots the results of a dynamic difference-in-difference estimator. Comparing foreign debt at banks with capital requirements increse in the top 25th percentile to those in the bottom 75th percentile, we see parallel trends prior and significant divergence following the change in capital requirements starting in 2012q3. Consistent with the results in Table 3, we find that banks in top quintile of capital requirement increased their foreign liabilities by more after the reform was implemented.

7. Conclusion

This paper examines the effects of tighter capital requirements through a quantitative model of risky financial intermediaries, which are partially funded by foreign currency debt. A key trade-off emerges: while higher bank capital requirements effectively reduce default risks, they simultaneously increase exposure to foreign funding risks.

Higher capital requirements reduce banks' leverage and protect them from insolvency and enable them to secure cheaper foreign funding. However, this heightened dependence on foreign liabilities makes both banks and the broader economy more vulnerable to disruptions in foreign funding — risks that banks do not internalize. Macroprudential authorities, hence, need to carefully balance these opposing risks when determining the level of bank capital requirements.

Our findings suggest that foreign prudential interventions, such as capital flow management taxes or foreign exchange interventions, can complement capital requirements in mitigating the vulnerabilities associated with foreign liabilities. Together, these policies can better manage the trade-offs between domestic financial stability and external shocks.

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Tables and Figures

Table 1: Model Parameters

Description	Parameter	Value	Description	Parameter	Value
Import Share in Production	α_m	0.163	Elasticity of Foreign Demand	χ	5.2
Domestic Discount Factor	β	0.991	Capital Share in Production	α_k	0.25
Dividend Pay-out Ratio	ϕ_0	0.017	Capital Adjustment Costs	Ψ_k	0.625
Equity Issuance Costs	ϕ_1	28	HH Capital Holding Costs	Ψ_1	0.013677
Bank Resolution Costs	μ	0.3	Foreign Debt Issuance Costs	Ψ_{d^*}	0.011
US Risk-free Rate	R_s^*	1.006	Bank Risk	σ_ϵ	0.453
Capital Depreciation	δ	0.025	Foreign Demand Exports	Y^*	3
Sudden Stop Transition Prob.	$[P_{1,1}, P_{2,2}]$	[0.942,0.984]	Central Bank FX Reserves	$\bar{B}$	1.35
Bank Regulatory Leverage	θ	0.92	Variance Bank Risk Innovations	σ_{σ_ϵ}	0.43
FX Intervention Rule	ϕ_{FX}	0	Persistence Bank Risk	ρ_{σ_ϵ}	0.7
Capital Control Tax	τ	0	Borrowing Limit Shocks	$[d_1^*, d_2^*]$	[0.675 ,1.425]

Notes: This table presents the parameters of the model. The first section corresponds to parameters set in accordance with the existing literature. The second part includes parameters calibrated to match the moments presented in Table 2.

Table 2: Calibration Targets

Moment	Data	Model	Formula	Moment	Data	Model	Formula
Av. Investment / GDP	22.56	22.20	$\frac{X}{GDP}$	Av. HH Capital Share	11.38	14.64	$\frac{K^H}{K}$
Av. For. Liability Share	10.12	9.22	$\frac{fD^*}{D+fD^*}$	Av. Bank Default	1.05	1.02	$4F_\epsilon$
Av. Export / GDP	21.84	19.45	$\frac{EX}{GDP}$	Av. Reserves / GDP	24.39	24.72	$\frac{\bar{B}}{GDP}$
Vol. Bank Default	0.98	1.07	$std(4 \cdot F_\epsilon)100$	AC(1) Bank Default	0.89	0.74	$AC(4 \cdot F_\epsilon)$
Vol. For. Liability Share	1.04	0.75	$std(\Theta)100$	AC(1) For. Liability Share	0.79	0.97	$AC(\Theta)$
Vol. HH Capital Share	0.36	1.22	$std(\frac{K^H}{K})100$	Vol. Investment / Vol. GDP	4.19	3.46	$\frac{std(I)}{std(GDP)}100$
Vol. Export/ Vol. FX	5.22	3.26	$\frac{std(EX)}{std(f)}100$				

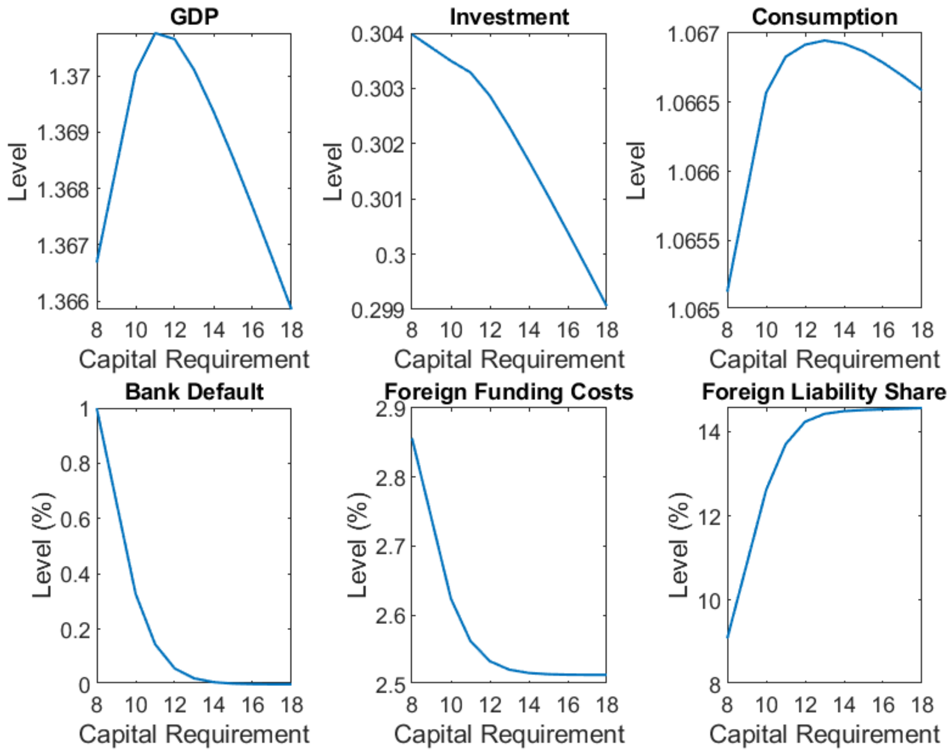
Notes: This table presents a set of moments calculated from the data and implied by the model. The model-based moments are computed using simulated data over 100,000 periods. All values in the table are expressed as percentages.

Table 3: Capital Requirements, foreign liabilities and corporate loans: empirical analysis

	$log(ForeignDebt_{b,t})$			$\frac{ForeignDebt_{b,t}}{TotalLiabilities_{b,t}}$			log(Loans to Firms$_{b,t}$)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$CapReq_{b,t-1}$	6.29***	6.88***	6.72***	0.697***	0.520***	0.756***	-0.0125***	-0.0597***	-0.0103**
	(1.82)	(1.93)	(1.92)	(0.179)	(0.176)	(0.177)	(0.00398)	(0.00844)	(0.00473)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
N	185	185	185	245	245	245	234	234	234
R^2	0.975	0.877	0.977	0.822	0.569	0.838	0.997	0.765	0.997

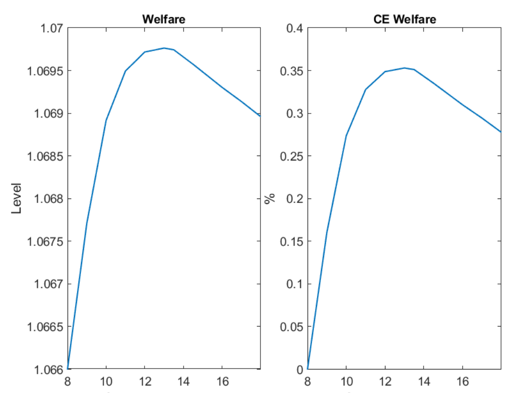
Notes: This table presents the empirical results based on Peru's transition to higher capital requirement. Using bank-level quarterly balance sheet data and capital requirement data for 16 Peruvian banks, we examine the impact of capital requirements for the period 2011-2013 following difference-in-difference specification **??**. The explanatory variable is a lagged level of capital requirement at the bank-quarter level. The outcome variables are the log amount of foreign debt (Columns (1) - (3)), the ratio of foreign debt to total liabilities (Columns (4) - (6)), and the log amount of loans to firms (Columns (7) - (9)). Controls include bank-level time-varying bank size, EBITA, liquidity position and risk-weighted assets. We saturate the model with bank fixed effects, and time fixed effects. Robust standard errors shown in parentheses. Statistical significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Figure 2: Comparative Statics wrt Capital Requirement Level



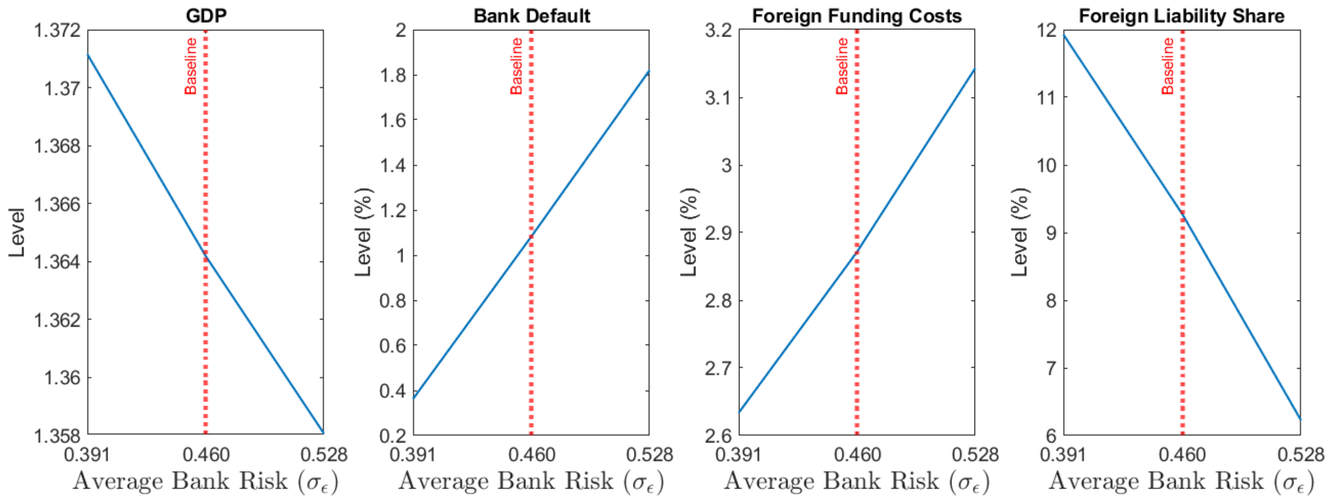
Notes: This figure illustrates the effects of different values of the bank capital requirement level, θ, on the mean of the ergodic distribution for selected variables in the baseline model. The plotted variables represent long-run averages derived from a simulated series of 100,000 periods.

Figure 3: Welfare wrt Capital Requirement Level



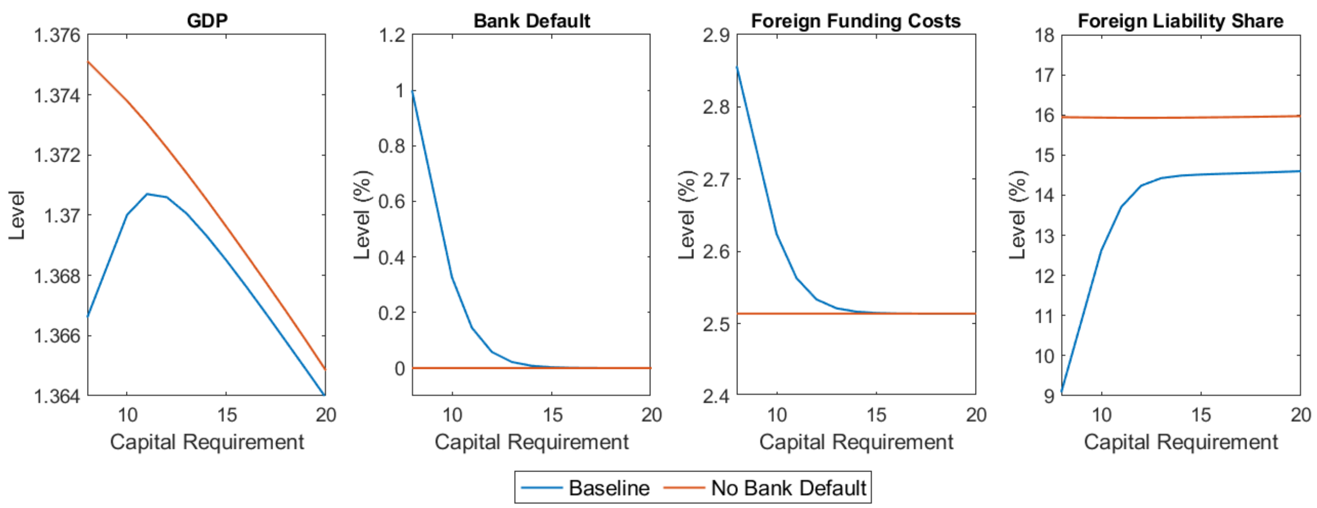
Notes: The left-hand side panel reports the ergodic mean of household welfare as a function of different values of the bank capital requirement level, θ. The right-hand side panel shows the welfare effects in consumption-equivalent terms relative to the baseline capital requirement of 8 %. The plotted variables represent long-run averages based on a simulated series of 100,000 periods.

Figure 4: Comparative Statics wrt Average Default



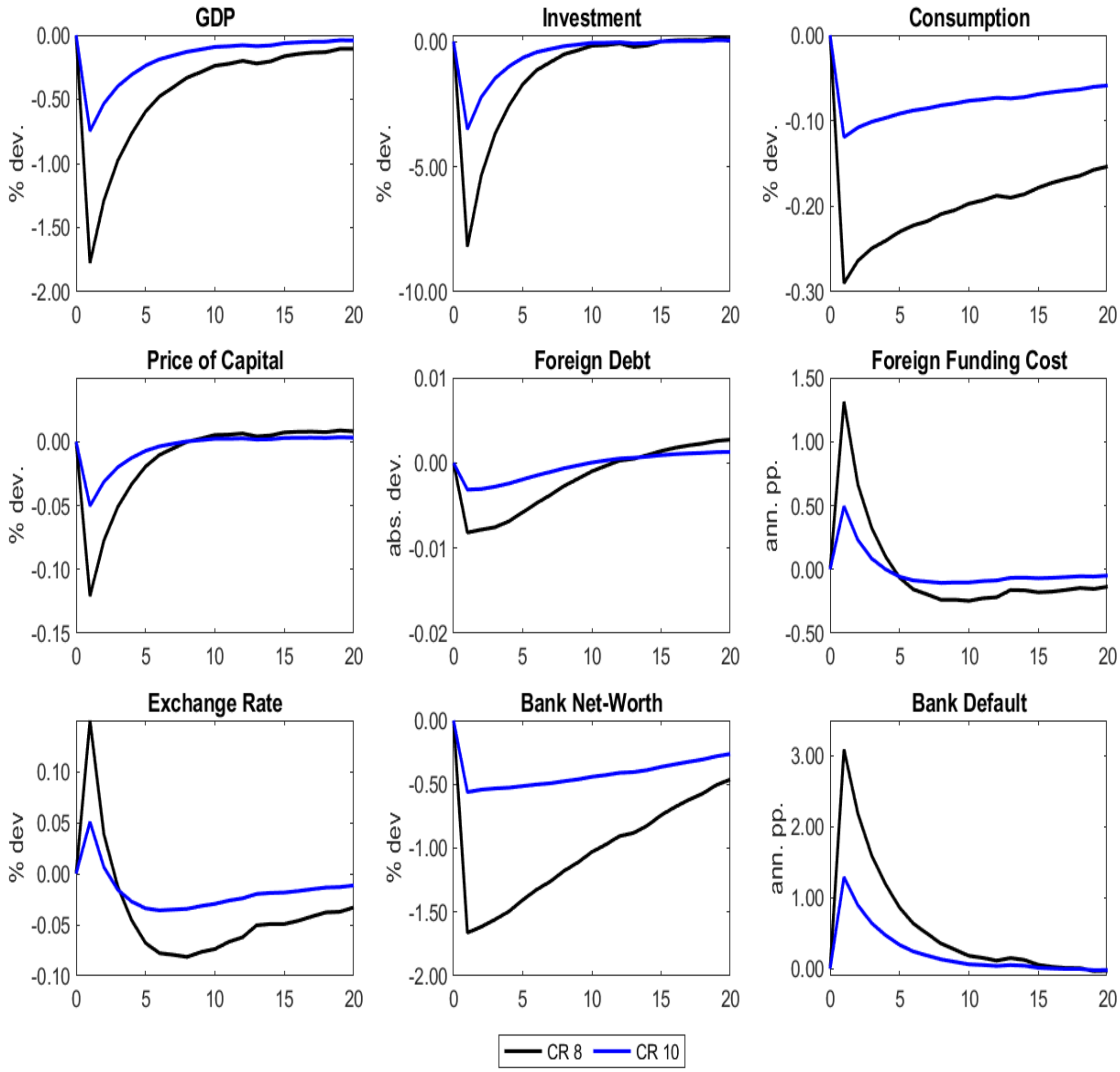
Notes: This figure illustrates the effects of different values of the mean of the idiosyncratic bank risk process, $\bar{\sigma}_\epsilon$, on the mean of the ergodic distribution for selected variables. The plotted variables represent long-run averages derived from a simulated series of 100,000 periods.

Figure 5: Comparative Statics wrt Capital Requirement



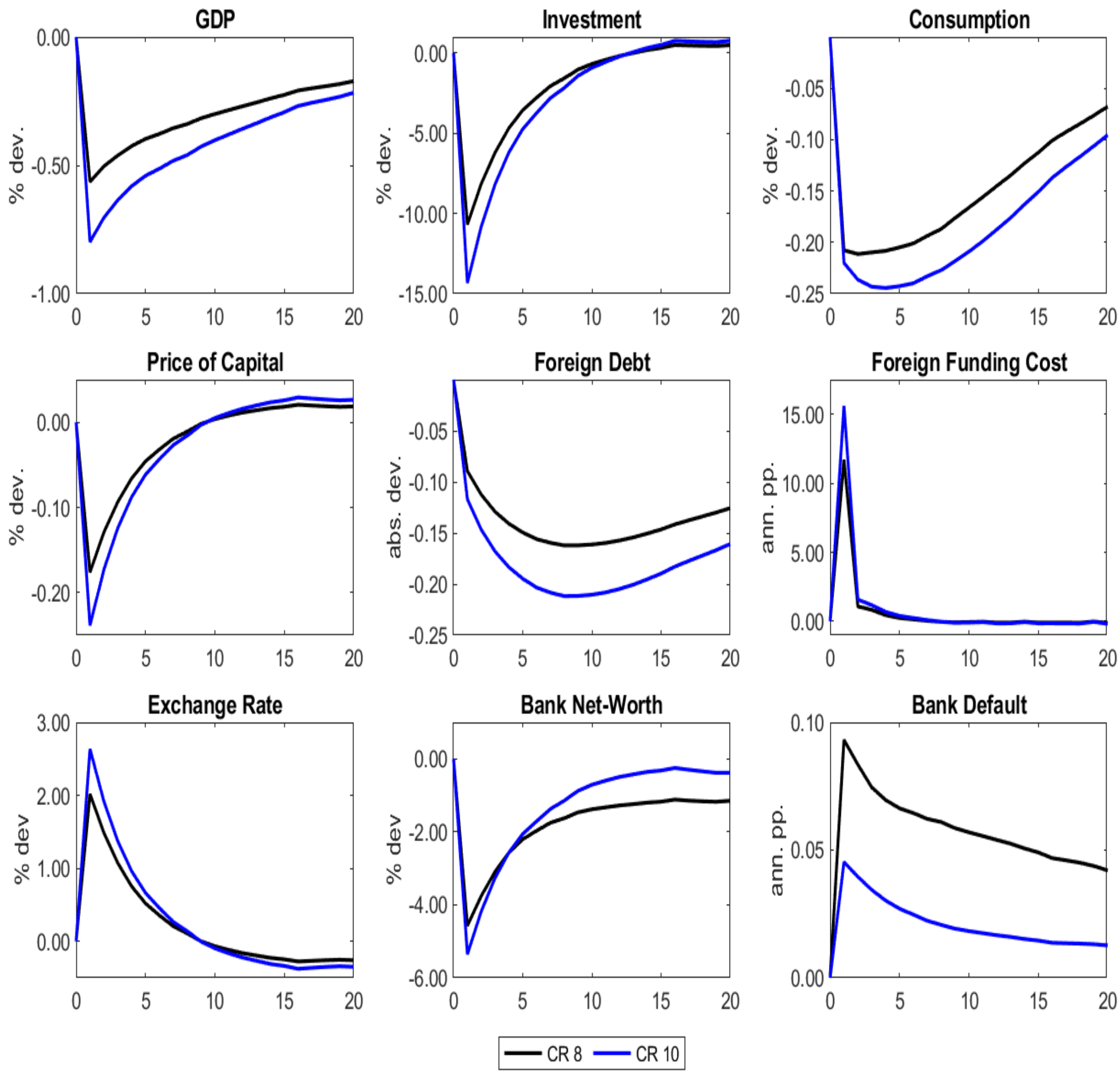
Notes: This figure highlights the role of default in the effects of different values of the bank capital requirement level on the mean of the ergodic distribution for selected variables. The blue line represents the baseline model, while the red line represents a version of the model without bank default (i.e., $\sigma_{\epsilon,t} = 0$ for all t). The plotted variables are long-run averages derived from a simulated series of 100,000 periods.

Figure 6: Bank Risk Shock



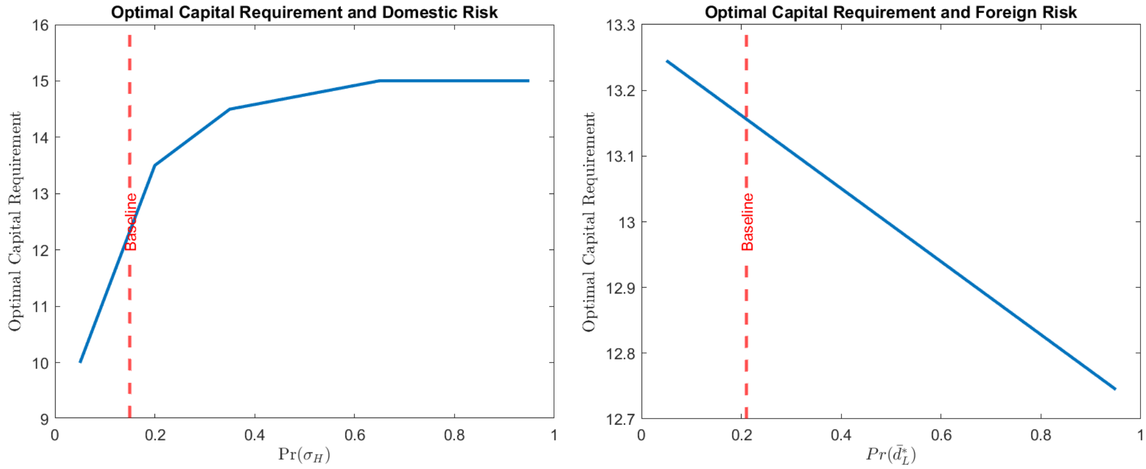
Notes: This figure presents the impulse response functions (IRFs) of model variables to a bank risk shock, defined as a mean-preserving shock to the standard deviation of the idiosyncratic shock to bank profits. The black solid line shows the economy's response to the shock under the baseline capital requirement level of 8 %, while the blue line represents the response with a capital requirement level of 10 %, for the same shock size. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except for bank default, foreign debt, and foreign funding costs, responses are shown in percentage deviations. Bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are expressed in absolute deviations.

Figure 7: Foreign Liabilities Shock



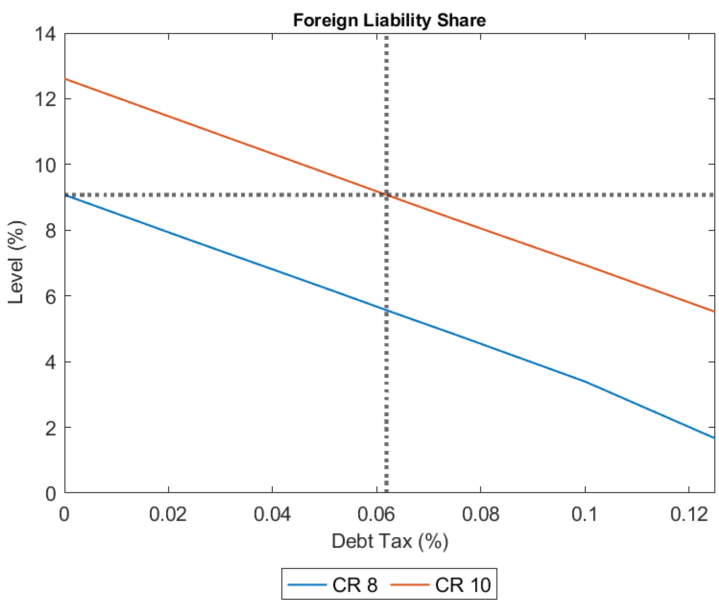
Notes: This figure presents the impulse response functions (IRFs) of model variables to a foreign funding shock, specifically a shock to the maximum amount of foreign debt, denoted as $\bar{d}^*_{t+1}$. The black solid line shows the response under the baseline capital requirement level of 8 %, while the blue solid line illustrates the same exercise with a capital requirement level of 10 %. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while the response for foreign debt is presented in absolute deviations.

Figure 8: Capital Requirements and Aggregate Risk Trade-Off



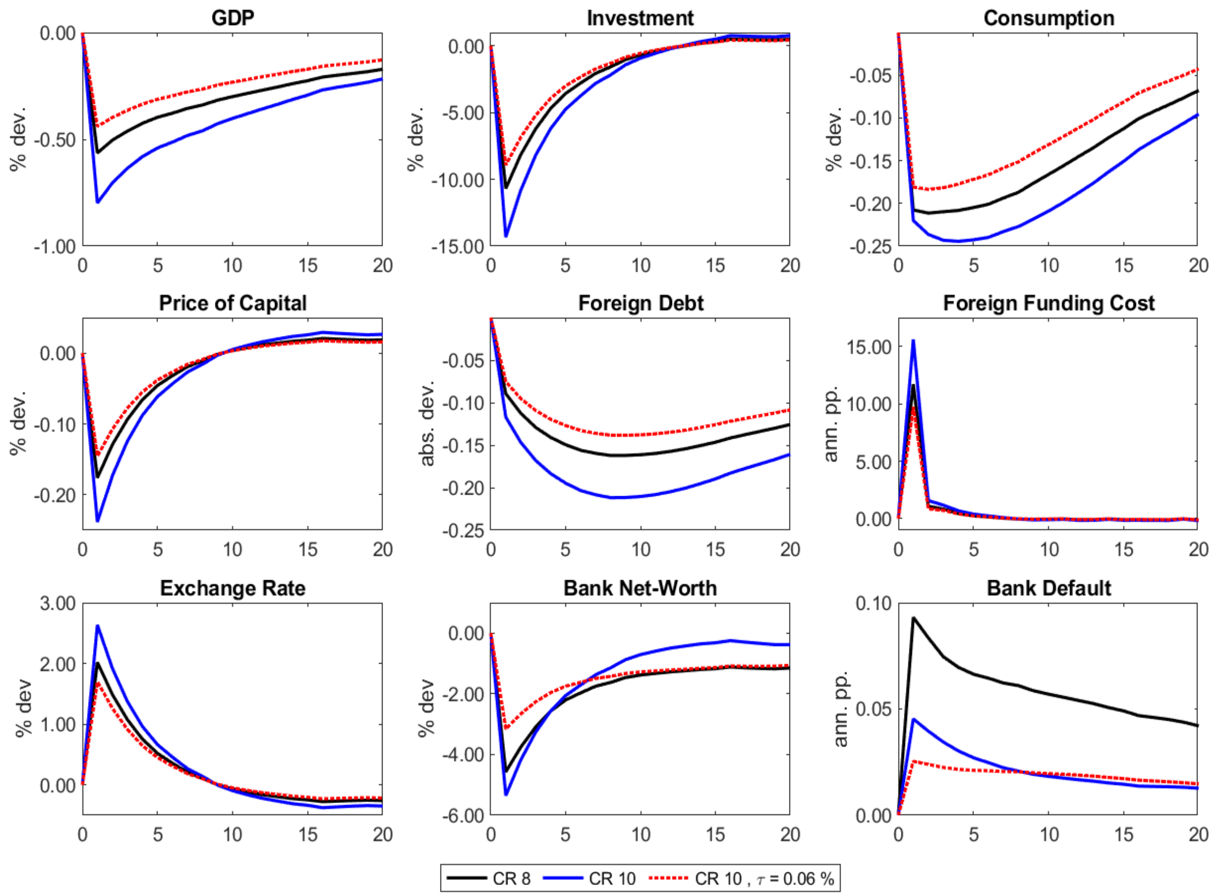
Notes: This figure illustrates the level of capital requirement that maximizes average consumption in response to changes in aggregate risk. We solve the model for each level of banks' capital requirements and then re-simulate the economy for 100,000 periods under varying probabilities of transitioning to a bad aggregate state. The left panel displays the optimal capital requirement (CR) for maintaining the economy in the good foreign risk state ($\bar{d}_1^*$). In the right panel, we keep the economy in the average domestic risk state ($\bar{\sigma}_\epsilon$).

Figure 9: Capital Requirements and Capital Flow Management tax



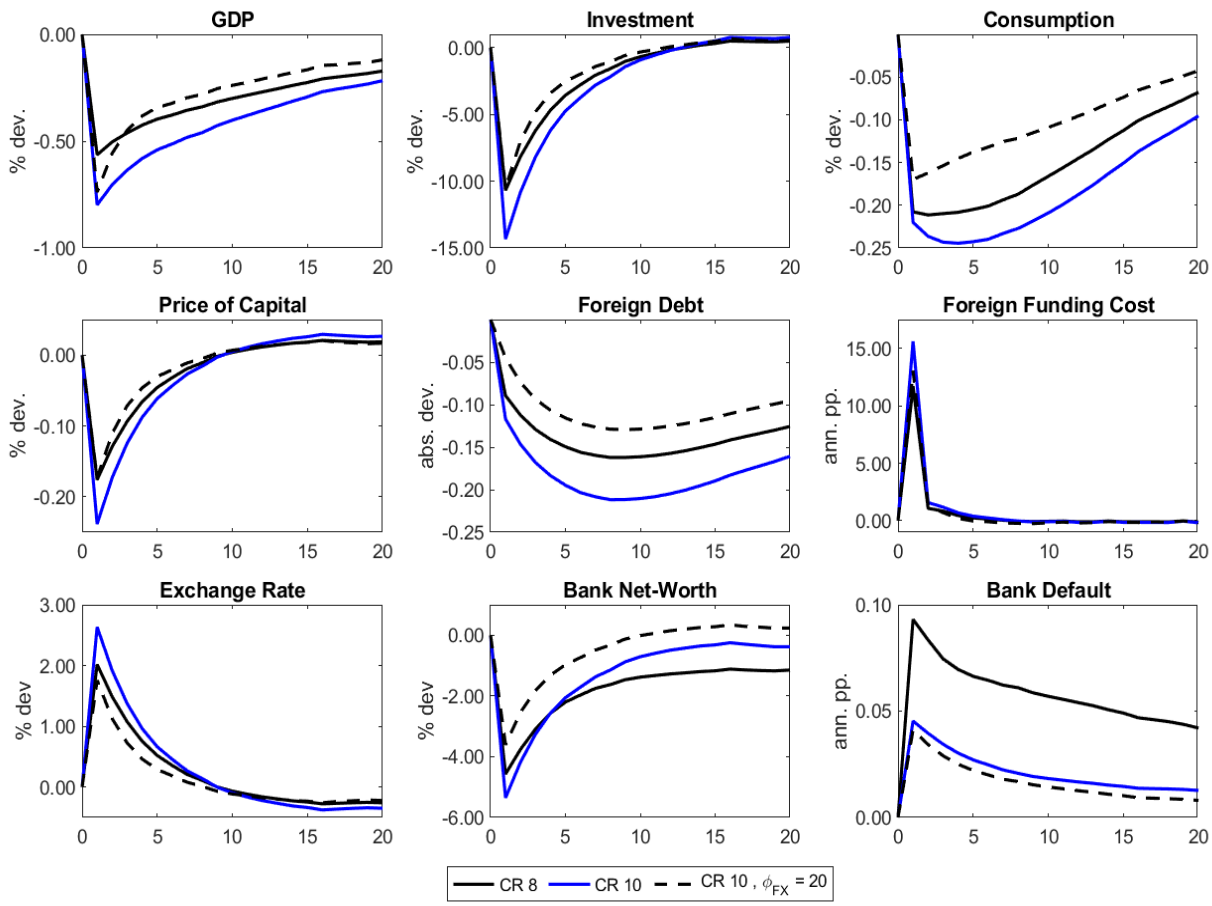
Notes: This figure presents the foreign liability share for different values of foreign debt taxes, τ, under capital requirements of 8 % (blue line) and 10 % (red line). For each combination of capital requirement and debt tax, we simulate the model for 100,000 periods and report the average foreign liability share, Θ.

Figure 10: Foreign Liabilities Shock



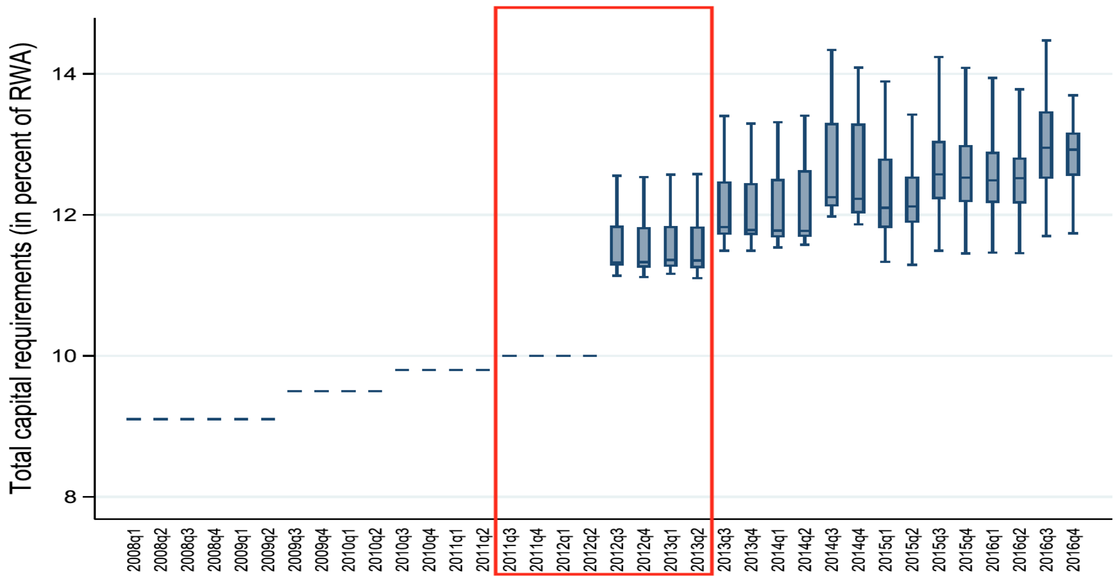
Notes: This figure presents the impulse response functions (IRFs) of model variables to a foreign funding shock, specifically a shock to the maximum amount of foreign debt, denoted as $\bar{d}^*_{t+1}$. The black solid line shows the response under the baseline capital requirement level of 8 %, while the blue solid line illustrates the same exercise with a capital requirement level of 10 %. The red dotted line depicts the responses of an economy with a capital requirement of 10 % and foreign debt taxes set at $\tau = 0.06\%$. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are presented in absolute deviations.

Figure 11: Foreign Liabilities Shock



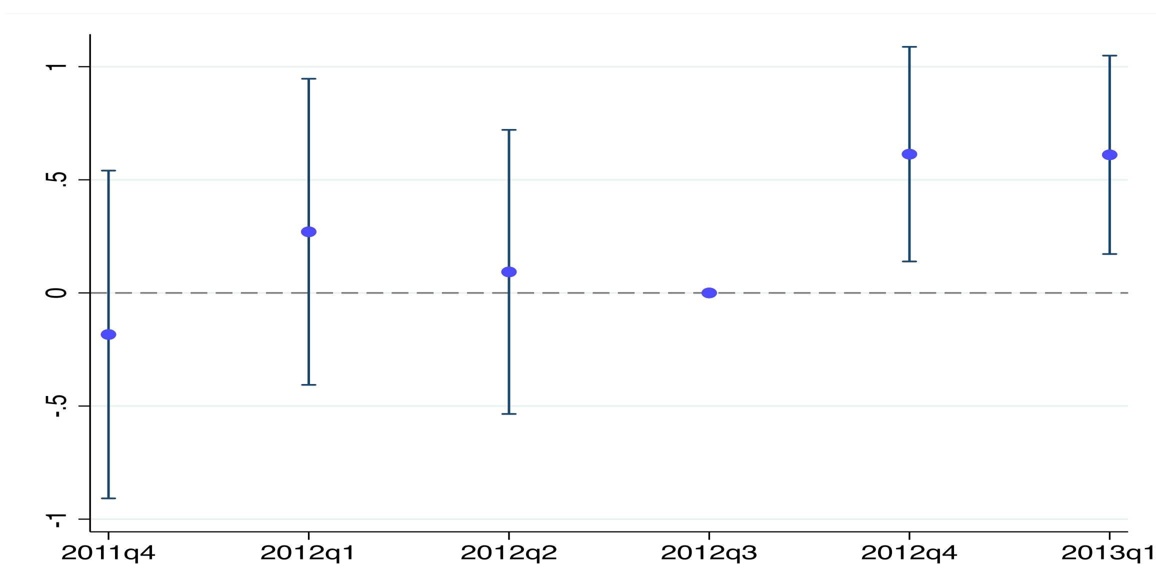
Notes: This figure presents the impulse response functions (IRFs) of model variables to a foreign funding shock, defined as a shock to the maximum amount of foreign debt, denoted as $\bar{d}^*_{t+1}$. The black solid line displays the response for the baseline level of capital requirements of 8%. The blue solid line presents the same exercise with a level of capital requirement of 10%. The black dashed line shows the responses of an economy with a capital requirement of 10% and FX interventions ($\phi_{FX} = 20$). IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are presented in absolute deviations.

Figure 12: Capital Requirement Increases in Peru



Notes: This figure presents the evolution of capital requirements across 16 commercial banks in Peru from 2008 until 2016. Up to the second quarter of 2012, capital requirements were uniform across banks. Starting from the third quarter of 2012, the box-whisker plot displays the capital requirement distribution among the banks. The box represents the interquantile range, the horizontal line is the median, and the whiskers are the 10th and the 90th percentiles of the distribution of bank capital requirements. The red box highlights the sample period used in the empirical analysis. Source: Fang et al. (2022).

Figure 13: Dynamic Effect of Capital Requirement Increases in Peru



Notes: This figure plots β_k coefficients from the regression $log(ForeignDebt_{b,t}) = \alpha_b + \alpha_t + \sum_{k \neq 2012q3} \beta_k HighCapReq_b \times 1_{k=t} + \gamma X_{b,t-1} + \epsilon_{b,t}$ along with 95% confidence interval based on robust standard errors. The outcome variable, $log(ForeignDebt_{b,t})$, represents the log amount of foreign debt. $HighCapReq_b$ is a dummy variable that takes the value of 1 for banks that were subject to a capital requirement in the top 25th percentile of the distribution after the reform, and 0 otherwise. The controls, $X_{b,t-1}$, include bank-level time-varying controls such as bank size, EBITA, liquidity position and risk-weighted assets. We saturate the model with bank fixed effects, α_b, and time fixed effects, α_t.

Internet Appendix

A Simple Economy

The economy consists of two periods, t $= \{1, 2\}$, and is populated by a unit measure of risk-neutral depositors, financial intermediaries, and foreign investors. Depositors discount the future at rate $\frac{1}{1+R^d}$, while intermediaries and foreign investors discount at rates $\frac{1}{1+R^e}$ and $\frac{1}{1+R^d}$, respectively. We assume that these discount factors satisfy $R^* < R^d < R^e$.

At time 1, banks purchase capital k at price p in a competitive market. Each unit of capital produces one unit of the consumption good. Banks finance these purchases using equity, fully insured deposits from domestic depositors, and debt issued to foreign investors. By time 2, bank assets generate a stochastic return $\epsilon \geqslant 0$, which is drawn from a distribution with cumulative distribution function $F(\epsilon) \equiv F_\epsilon$ and support $\text{supp}(\epsilon) = [0, \bar{\epsilon})$. Without loss of generality, we assume that the mean of the shocks is normalized to one, so that $E_\epsilon(\epsilon) = 1$.

The budget constraint of intermediaries at date 1 is given by

$$e_1 = pk + \Psi^\Theta(d, d^*) - qd - q^* f d^*, \tag{A.1}$$

where p denotes the price of capital, q and q^* denote the prices of deposits and foreign debt, respectively, d and d^* represent the face values of deposits and foreign debt, respectively, and f is the foreign exchange rate. The variable e_1 captures the equity issued if $e_1 > 0$ or the dividends paid if $e_1 < 0$. Borrowing in foreign currency bears an additional cost with functional form

$$\Psi^\Theta(d, d^*) = \kappa(fd^* + d)\left(\frac{fd^*}{fd^* + d}\right)^2,$$

which is increasing and convex in the foreign liability share $\Theta = \frac{fd^*}{fd^*+d}$. The budget constraint of intermediaries at date 2 in state ϵ is given by

$$\text{div}(\epsilon) = \max\{\epsilon k - d - fd^*, 0\}. \tag{A.2}$$

Following the realization of period 2 returns, intermediaries choose whether to default or not. In the event of default, shareholders receive nothing, depositors are fully insured, and foreign creditors are completely expropriated. If the intermediary does not default, it pays creditors in full, and shareholders receive the residual claim $\epsilon k - d - fd^*$ in the form of dividends. Consequently, the pricing equations for insured deposits and foreign debt are given by $q = \frac{1}{1+R^d}$ and $q^* = \frac{1-F_\epsilon(\hat{\epsilon})}{1+R^*}$, where $\hat{\epsilon}$ is the threshold value of ϵ below which the intermediary optimally defaults, a value we formally derive below, and $F_\epsilon(\hat{\epsilon})$ represents the default probability. Deposit insurance, debt adjustment costs and difference in discount rates invalidate the Modigliani-Miller theorem, ensuring a non-trivial choice of capital structure.

The intermediary's problem at time 1 is to chose d, d^* and k to maximize the expected value:

$$V = \max_{d,d^*,k} -e_1 + \frac{1}{1+R^e} \int \text{div}(\epsilon) dF(\epsilon)$$

subject to the budget constraints (A.1)-(A.2) and the leverage constraint

$$\theta \int \epsilon k dF(\epsilon) \geq f d^* + d, \tag{A.3}$$

which caps the total debt at a multiple θ of the period 2 asset expected returns. Therefore, $1-\theta$ is effectively the capital requirement. Foreign creditors recognize that higher intermediary leverage increases the probability of a default. The intermediary internalizes this effect when making its leverage decision.

Proposition 1 below states that the solution to the intermediary problem is such that the equilibrium foreign liability share Θ is always increasing in the level of regulatory capital requirement $1-\theta$. The reduction in bank leverage associated with a higher capital requirement leads to a reduction in bank default. As a result, higher capital requirements reduce the cost of foreign funding and induce banks to take a higher foreign liability share.

Proposition 1. *The solution to the intermediary's problem is such that* $\frac{\partial \Theta}{\partial \theta} < 0$.

The proof of Proposition 1 follows five steps. First, we establish the intermediary's optimal default decision. Let leverage be the ratio of debt over assets, $\ell = \frac{f d^* + d}{k}$. It follows that intermediaries optimally default at date 2 whenever $\epsilon < \ell$, and repay when $\epsilon \geqslant \ell$. Hence, the default threshold $\hat{\epsilon} = \ell$ and probability of default is $F(\ell)$.

Second, we show that the leverage constraint binds. Dividing the objective function by $f d^* + d$ yields

$$V = \max_{\ell,\Theta} -\frac{p}{\ell} - \kappa\,(\Theta)^2 + \frac{1-F(\ell)}{1+R^*}\Theta + \frac{1}{1+R^d}(1-\Theta) + \frac{1}{1+R^e}\int_{\ell}^{\bar{\epsilon}} \Big(\frac{\epsilon}{\ell} - 1\Big) dF(\epsilon).$$

Suppose, by way of contradiction, that the constraint does not bind, so that $\ell < \theta$. Then, the intermediary could increase its profits by setting $\Theta = 0$ and $\ell = \theta$. The reason is that by increasing ℓ, the intermediary raises dividends at time 1 while reducing them at time 2. This is a profitable deviation because the intermediary's equity rate of return, R^e, is higher than the depositors' rate of return R^d.

Third, we show that the liability structure is independent of the intermediary's choice of scale. Substituting $\ell = \theta$ into the problem gives

$$V = \max_{\Theta} -p\frac{1}{\theta} + \frac{1-F(\theta)}{1+R^*}\Theta + (1-\Theta)\frac{1}{1+R^d} - \kappa\Theta^2 + \frac{1}{1+R^e}\int_{\theta}^{\bar{\epsilon}} \left(\epsilon\frac{1}{\theta} - 1\right) dF(\epsilon)$$

where $k = \frac{fd^* + d}{\theta}$. Define $b = d + fd^*$ and the per-unit profit as $v \;=\; \frac{V}{b}$. The intermediary's optimal choice of scale b solves the problem

$$\max_{b \geq 0} \, b \, v.$$

We argue that the solution to this problem is such that $b > 0$ and $v = 0$. If the per-unit profit v is strictly positive, then the total expected profit $b \cdot v$ can be made arbitrarily large by choosing $b \to \infty$. Hence, if $v > 0$, the intermediary has an incentive to scale up without bound, which cannot persist in a competitive equilibrium. Conversely, if the per-unit profit is strictly negative $v < 0$, every additional unit of scale destroys value. In this case, the intermediary would choose $b = 0$ (i.e. it would not enter the market), thereby avoiding losses. In equilibrium, this results in no intermediation. If the per-unit profit is zero, the intermediary is *indifferent* about scale. A positive finite b leads to total profit $V = b \cdot v = b \cdot 0 = 0$. No profitable unbounded expansion is possible, and no losses occur for positive b. Hence a strictly positive scale $b > 0$ *can* be sustained only if $v = 0$. In equilibrium, any nontrivial (positive) scale $b > 0$ must imply that the per-unit profit is driven to zero:

$$v \;=\; \frac{V}{b} = 0.$$

Fourth, we characterize the choice of the foreign liability share, Θ. Since $V = 0$ whenever $b > 0$, we can rewrite the problem as

$$p = \max_{\Theta} \theta \left[\frac{1 - F(\theta)}{1 + R^*} \Theta + (1 - \Theta) \frac{1}{1 + R^d} - \kappa \Theta^2 + \frac{1}{1 + R^e} \int_{\theta}^{\bar{\epsilon}} \left(\epsilon \frac{1}{\theta} - 1 \right) dF(\epsilon) \right]$$

Taking the first order condition with respect to Θ yields

$$\Theta = \frac{2}{\kappa} \left[\frac{1 - F(\theta)}{1 + R^*} - \frac{1}{1 + R^d} \right].$$

Therefore, when choosing the optimal share of foreign funding, the intermediary trades-off the marginal cost of issuing foreign liabilities and the marginal benefits of lower cost of capital $R^* < R^d$.

Fifth, we show that the foreign liability share is increasing in the bank capital requirement $(1 - \theta)$. Since intermediaries are always at the leverage constraint, an increase in θ increases bank leverage and default probability, i.e. $\frac{\partial F(\theta)}{\partial \theta} = f(\theta) > 0$.[19] Hence, as the capital requirement decreases (i.e., as θ increases), the default risk $F(\theta)$ rises, which in turn leads to a reduction in the foreign liability share Θ, since

$$\frac{\partial \Theta}{\partial \theta} = -\frac{2}{\kappa} \frac{\partial F(\theta)}{\partial \theta} \frac{1}{1 + R^*} = -\frac{2 f(\theta)}{\kappa} \frac{1}{1 + R^*} < 0.$$

Therefore, the foreign liability share Θ is decreasing in the leverage restriction θ (or equivalently, increasing in the capital requirement $1 - \theta$). This completes the proof of Proposition 1.

[19] Recall that $\epsilon \in [0, \bar{\epsilon})$. Since $f(0) > 0$, it follows that for $\theta = 0$ we have $f(\theta) > 0$. Assuming $f(\epsilon) > 0$ for any $\epsilon > 0$ is sufficient for $f(\theta) > 0$ for any $\theta > 0$.

B Quantitative Model Details

Define the vector of aggregate state variables as $\mathcal{S}_t = [N_t, K_t, D_t, D^*_t, f_{t-1}, \sigma_\epsilon, \bar{d}^*_t]$.

B.1 Households

The problem of the representative household can be expressed recursively as:

$$V_t(W_t, \mathcal{S}_t) = \max_{C_t, K^H_{t+1}, D^H_{t+1}} U(C_t) + \beta \mathbb{E}_t[V_{t+1}(W_t, \mathcal{S}_{t+1})]$$

subject to

$$W_t + w_t + \Pi_t = C_t + q_{d,t} D^H_{t+1} + q_{k,t} K^H_{t+1} + \Psi^H(K^H_{t+1}) + T^{CB}_t + T^{DI}_t - T^{CC}_t, \tag{B.1}$$

$$W_{t+1} = [r_{k,t+1} + q_{k,t+1}(1-\delta)]\, K^H_{t+1} + D^H_{t+1}. \tag{B.2}$$

The optimality conditions with respect to deposits and capital are given by:

$$q_{d,t} = \mathbb{E}_t\{\mathcal{M}_{t+1}\} \tag{B.3}$$

$$q_{k,t} + \Psi^H_k(K^H_{t+1}) = \mathbb{E}_t\{\mathcal{M}_{t+1}[r_{k,t+1} + (1-\delta) q_{k,t+1}]\} \tag{B.4}$$

where

$$\mathcal{M}_{t+1} = \beta \frac{U_c(C_{t+1})}{U_c(C_t)} \tag{B.5}$$

is household's stochastic discount factor, and the marginal cost of holding capital is

$$\Psi^H_K(K^H_{t+1}) = \left(\frac{K^H_{t+1}}{\Psi_0} - \Psi_1 \right). \tag{B.6}$$

B.2 Financial Intermediaries

The problem of the individual intermediary is not scale-invariant with respect to net-worth, but we can aggregate into the problem of an aggregate bank under the following assumptions:

1. The intermediary's problem is linear in the idiosyncratic shock.

2. The idiosyncratic shocks ϵ_t affect the contemporaneous payouts π_t but not the the net worth n_t.

3. Defaulting intermediaries are replaced by new intermediaries with starting equity equal to that of the average non-defaulting intermediary.

We now prove this statement. Let the subscript i denote a non-defaulting intermediary. We can then rewrite the problem of the non-defaulting banks as:

$$V_t^I(n_{i,t}, \epsilon_{i,t}, S_t) = \max_{k^I_{i,t+1}, b^I_{i,t+1}, d^I_{i,t+1}, d^{*,I}_{i,t+1}, e_{i,t}} \{\pi_{i,t} + \mathbb{E}_t[\mathcal{M}_{t+1} \max\{V^I_{t+1}(n_{i,t+1}, \epsilon_{i,t+1}, S_{t+1}), 0\}]\}$$

subject to (12), (13), (14), (15), (16). From assumption (1) we define

$$\tilde{V}_t(n_{i,t}, S_t) = V_t(n_{i,t}, \epsilon_{i,t}, S_t) - \epsilon_{i,t} \tag{B.7}$$

and from assumption (2), we can rewrite the optimization problem of the non-defaulting banks as:

$$\tilde{V}_t^I(n_{i,t}, S_t) = \max_{k^I_{i,t+1}, b^I_{i,t+1}, d^I_{i,t+1}, d^{*,I}_{i,t+1}, e_{i,t}} \{(1-\phi^0)n_{i,t} - e_{i,t} + \mathbb{E}_t[\mathcal{M}_{t+1} \max\{\tilde{V}^I_{t+1}(n_{i,t+1}, S_{t+1}), 0\}]\}$$

subject to the same constraints. Note that since $\epsilon_{i,t}$ does not appear in the optimization problem, it follows that conditional on a level of initial net-worth $n_{t,i}$ all non-defaulting banks make the same choices $k_{i,t+1}, b_{i,t+1}, d^I_{i,t+1}, d^{I,*}_{i,t+1}, e_{i,t+1}$.

We conjecture that all non-defaulting banks have the same net-worth $N_t = n_{i,t}$. Since the problem above shows that they will make the same choices, and their future net-worth (conditional on non-defaulting) is unaffected by the idiosyncratic shock (assumption (2)), it follows that they must have the same net worth. Thus, we verify our conjecture that all the non-defaulting banks must have the same net-worth, allowing us to write $n_{i,t} = N_t$. Under assumption (3) all the defaulting banks are seeded with the same amount of net-worth than the average non-defaulting bank. Therefore, both non-defaulting and defaulting banks have the same net-worth, $n_t = N_t$.

Representative Intermediary

The optimization problem of the representative bank writes

$$\tilde{V}_t^I(N_t, S_t) = \max_{B^I_{t+1}, K^I_{t+1}, D_{t+1}, D^*_{t+1}, e_t} \{\phi^0 N_t - e_t + \mathbb{E}_t[\mathcal{M}_{t+1}(1-F_{\epsilon,t+1})(\tilde{V}(N_{t+1}, S_{t+1}) + \epsilon^+_{t+1})]\} \tag{B.8}$$

$$\text{s.t.} \tag{B.9}$$

$$N_t = K_t^I[r_t^k + (1-\delta)q_{k,t}] + B_t^I - D_t^I - f_t D_t^{*,I}, \tag{B.10}$$

$$(1-\phi^0)N_t + e_t - \Psi^{I,e}(e_t) - \Psi^{I,\Theta}(D^*_{t+1}, D_{t+1}) \geq q_{k,t}K^I_{t+1} + q_{b,t}B^I_{t+1} - q_{d,t}D_{t+1} - q^*_{d,t}(\mathcal{C}_t) f_t D^*_{t+1}(1-\tau), \tag{B.11}$$

$$q_{b,t}B^I_{t+1} + \theta q_{k,t}K^I_{t+1} \geq q_{d,t}D_{t+1} + q^*_{d,t}(\mathcal{C}_t) f_t D^*_{t+1}, \tag{B.12}$$

$$\bar{D}^*_{t+1} \geq D^*_{t+1}, \tag{B.13}$$

$$\mathcal{S}^I_{t+1} = h\left(\mathcal{S}^I_t\right). \tag{B.14}$$

Recall that the individual intermediary does not default at time $t+1$ as long as $\tilde{V}^I(N_{t+1}, S_{t+1}) > \epsilon_{t+1}$. The future share of non-defaulting banks can be expressed as follows:

$$Prob(\epsilon_{t+1} > -\tilde{V}(N_{t+1}, S_{t+1})) = 1 - F_\epsilon(-\tilde{V}(N_{t+1,S_{t+1}}) = 1 - F_{\epsilon,t+1}$$

Let $\epsilon^+_{t+1} = E_\epsilon[\epsilon|\epsilon > \tilde{V}(N_{t+1}, S_{t+1})]$ be the expected idiosyncratic profit conditional on non-defaulting. We can then rewrite the problem of the representative intermediary as

$$\tilde{V}^I_t(N_t, S_t) = \max_{B^I_{t+1}, K^I_{t+1}, D_{t+1}, D^*_{t+1}, e_t} \{\phi^0 N_t - e_t + \mathbb{E}_t[\mathcal{M}_{t+1}(1 - F_{\epsilon,t+1})(\tilde{V}(N_{t+1}, S_{t+1}) + \epsilon^+_{t+1})]\}$$

subject to the same constraints.

Derivatives of the Value Function

We start by defining $G_t = (1 - F_{\epsilon,t})(\tilde{V}_t + \epsilon^+_t)$ and computing

$$\frac{\partial G_t}{\partial N_t} = (1 - F_\epsilon)\tilde{V}^I_{N,t} + \tilde{V}^I_{N,t} f_{\epsilon,t}\tilde{V}^I_{N,t} - \tilde{V}^I_t f_{\epsilon,t}\tilde{V}_{N,t} = (1 - F_{\epsilon,t})\tilde{V}_{N,t} \tag{B.15}$$

We then compute the partial derivatives of N_t

$$\frac{\partial N_t}{\partial K^I_t} = r^k_t + (1 - \delta)q_{k,t} \tag{B.16}$$

$$\frac{\partial N_t}{\partial B^I_t} = 1 \tag{B.17}$$

$$\frac{\partial N_t}{\partial D^I_t} = -1 \tag{B.18}$$

$$\frac{\partial N_t}{\partial D^{*,I}_t} = -f_t \tag{B.19}$$

First-Order Conditions

Let ν_t, λ_t and $\lambda^{\bar{d}^*}_t$ be the multiplier on the budget, leverage and foreign debt limit constraints respectively. The first order condition with respect to equity issuance is

$$-1 + \nu^I_t(1 - \psi^I_e(e_t)) = 0 \Rightarrow \nu^I_t = \frac{1}{1 - \phi^1 e_t} \tag{B.20}$$

The FOC with respect to K^I_{t+1} is given by

$$\mathbb{E}_t\{\mathcal{M}_{t+1}\frac{\partial A_{t+1}}{\partial N_{t+1}}\frac{\partial N_{t+1}}{\partial K^I_{t+1}}\} - \nu^I_t q_{k,t} + \lambda^I_t \theta q_{k,t} + \nu^I_t f_t D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial K^I_{t+1}} - \lambda_t f_t D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial K^I_{t+1}}(1 - \tau) = 0$$

which substituting in and re-arranging becomes

$$\nu_t^I q_{k,t} - \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial K_{t+1}^I}(1-\tau) = \theta \lambda_t^I q_{k,t} - \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial K_{t+1}^I} + \mathbb{E}_t\{\mathcal{M}_{t+1}(1-F_{\epsilon_{t+1}})\tilde{V}_{N,t+1}(q_{k,t+1}(1-\delta)+r_{t+1}^K)\} \tag{B.21}$$

Similarly, the FOC for B_{t+1}^I yields

$$\mathbb{E}_t\{\mathcal{M}_{t+1} \ \frac{\partial A_{t+1}}{\partial N_{t+1}} \frac{\partial N_{t+1}}{\partial B_{t+1}^I}\} - \nu_t^I q_{b,t} + \lambda_t^I q_{b,t} + \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial B_{t+1}^I}(1-\tau) - \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial B_{t+1}^I} = 0$$

which simplifies to

$$\nu_t^I q_{b,t} - \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial B_{t+1}^I}(1-\tau) = \lambda_t^I q_{b,t} - \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial B_{t+1}^I} + \mathbb{E}_t\{\mathcal{M}_{t+1}(1-F_{\epsilon_{t+1}})\tilde{V}_{N,t+1}\} \tag{B.22}$$

The FOC for D_{t+1} yields

$$\mathbb{E}_t\{\mathcal{M}_{t+1} \ \frac{\partial A_{t+1}}{\partial N_{t+1}} \frac{\partial N_{t+1}}{\partial D_{t+1}}\} - \nu_t^I q_{d,t} + \lambda_t^I q_{d,t} - \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}}(1-\tau) + \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}} = 0$$

which simplifies to

$$\nu_t^I q_{d,t} + \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}}(1-\tau) = \lambda_t^I q_{d,t} + \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}} + \mathbb{E}_t\{\mathcal{M}_{t+1}(1-F_{\epsilon_{t+1}})\tilde{V}_{N,t+1}\} \tag{B.23}$$

Finally, the FOC with respect to D_{t+1}^* yields

$$\mathbb{E}_t\{\mathcal{M}_{t+1} \frac{\partial A_{t+1}}{\partial N_{t+1}} \frac{\partial N_{t+1}}{\partial D_{t+1}^{I,*}}\} - \nu_t^I(f_t q_{d,t}^* + \Psi'_{d*}(D_{t+1}^*)) + \lambda_t^I f_t q_{d,t}^* + \lambda_t^{\bar{d}^*} - \nu_t^I \frac{\partial q_{d,t}^*}{\partial D_{t+1}^*} f_t D_{t+1}^*(1-\tau) + \lambda_t^I \frac{\partial q_{d,t}^*}{\partial D_{t+1}^*} f_t D_{t+1}^* = 0$$

which simplifies to

$$\nu_t^I(f_t q_{d,t}^* - \Psi'_{D^*}(D_{t+1}^*)) + \nu_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}^*}(1-\tau) = \lambda_t^I f_t q_{d,t}^* + \lambda_t^{\bar{d}^*} + \lambda_t^I f_t D_{t+1}^* \frac{\partial q_{d,t}^*}{\partial D_{t+1}^*} + \mathbb{E}_t\{\mathcal{M}_{t+1}(1-F_{\epsilon_{t+1}})\tilde{V}_{N,t+1} f_{t+1}\} \tag{B.24}$$

Full optimality conditions

The marginal value of net-worth is given by:

$$\tilde{V}_{N,t} = \phi^0 + (1-\phi^0)\nu_t^I \tag{B.25}$$

substituting in for ν_t^I we get

$$\tilde{V}_{N,t} = \phi^0 + \frac{(1-\phi^0)}{1-\phi^1 e_t} \tag{B.26}$$

We then define the stochastic-discount factor of the intermediaries $\mathcal{M}_{t+1}^I$ as

$$\mathcal{M}_{t+1}^I = \mathcal{M}_{t+1}(1-\phi^1 e_t)(\phi^0 + \frac{1-\phi^0}{1-\phi^1 e_{t+1}})(1-F_{\epsilon_{t+1}}). \tag{B.27}$$

We can then divide by ν_t and re-write the first order conditions more compactly as

$$q_{k,t}(1-\theta\tilde{\lambda}_t) - (f_t D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial K^I_{t+1}})(1-\tau-\tilde{\lambda}_t) = \mathbb{E}_t\{\mathcal{M}^I_{t+1}(q_{k,t+1}(1-\delta)+r^K_{t+1})\} \tag{B.28}$$

$$q_{b,t}(1-\tilde{\lambda}_t) - (f_t D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial B^I_{t+1}})(1-\tau-\tilde{\lambda}_t) = \mathbb{E}_t\{\mathcal{M}^I_{t+1}\} \tag{B.29}$$

$$q_{d,t}(1-\tilde{\lambda}_t) + (f_t D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial D_{t+1}})(1-\tau-\tilde{\lambda}_t) - \Psi^{I,\Theta}_D = \mathbb{E}_t\{\mathcal{M}^I_{t+1}\} \tag{B.30}$$

$$f_t q^*_{d,t}(1-\tilde{\lambda}_t) + f_t(D^*_{t+1}\frac{\partial q^*_{d,t}}{\partial D^*_{t+1}})(1-\tau-\tilde{\lambda}_t) - \Psi^{I,\Theta}_{D^*} - \tilde{\lambda}^{\bar{d}^*}_t = \mathbb{E}_t\{\mathcal{M}^I_{t+1} f_{t+1}\} \tag{B.31}$$

$$\nu_t = \frac{1}{1-\phi^1 e_t} \tag{B.32}$$

where $\tilde{\lambda}_t = \lambda_t/\nu_t$, and $\tilde{\lambda}^{\bar{d}^*}_t = \lambda^{\bar{d}^*}_t/\nu_t$. Finally, the complementary slackness conditions are:

$$\min\{\lambda_t, B^I_{t+1} + \theta q_{k,t}K^I_{t+1} - q_{d,t}D_{t+1} - q^*_{d,t}D^*_{t+1}\} = 0 \tag{B.33}$$

$$\min\{\lambda^{d^*}_t, \bar{D}^*_{t+1} - D^*_{t+1}\} = 0 \tag{B.34}$$

Derivatives of price of foreign debt

Intermediaries internalize the effect of their choices on the price of foreign debt. Define $q^* = 1/R^*$ and $D^{tot}_{t+1} \equiv D_{t+1} + f_{t+1}D^*_{t+1}$. Recall that the price of debt is given by

$$q^*_{d,t} = q^*\mathbb{E}_t\Big\{F_{\epsilon,t+1}\frac{RV_{t+1}}{(D_{t+1}+f_{t+1}D^*_{t+1})} + (1-F_{\epsilon,t+1})\Big\}, \tag{B.35}$$

$$q^*_{d,t} = q^*\mathbb{E}_t\Big\{F_{\epsilon,t+1}A_{t+1} + H_{t+1} + (1-F_{\epsilon,t+1})\Big\}, \tag{B.36}$$

where

$$A_{t+1} = (1-\mu)[r_{k,t+1} + q_{k,t+1}(1-\delta)]K^I_{t+1} + B^I_{t+1}, \tag{B.37}$$

and

$$H_{t+1} = \frac{\epsilon^-_{t+1}F_{\epsilon_{t+1}}}{D_{t+1}+f_{t+1}D^*_{t+1}} = \frac{G_{t+1}}{D^{tot}_{t+1}}. \tag{B.38}$$

Take the derivative of the pricing function with respect to general choice x_{t+1}

$$\frac{\partial q^*_{d,t}}{\partial x_{t+1}} = q^*\mathbb{E}_t\Big\{\frac{\partial F_{\epsilon,t+1}}{\partial x_{t+1}}A_{t+1} + F_{\epsilon,t+1}\frac{\partial A_{t+1}}{\partial x_{t+1}} - \frac{\partial F_{\epsilon,t+1}}{\partial x_{t+1}} + \frac{\partial H_{t+1}}{\partial x_{t+1}}\Big\}, \tag{B.39}$$

$$\frac{\partial q^*_{d,t}}{\partial x_{t+1}} = q^*\mathbb{E}_t\Big\{\frac{\partial F_{\epsilon,t+1}}{\partial x_{t+1}}(A_{t+1}-1) + F_{\epsilon,t+1}\frac{\partial A_{t+1}}{\partial x_{t+1}} + \frac{\partial H_{t+1}}{\partial x_{t+1}}\Big\}. \tag{B.40}$$

We start with the derivatives of A_{t+1} with respect to intermediary choices:

$$\frac{\partial A_{t+1}}{\partial D_{t+1}} = (-1)\frac{A_{t+1}}{(D_{t+1}+f_{t+1}D^*_{t+1})^2} = (-1)\frac{\tilde{RV}_{t+1}}{(D^{tot}_{t+1})^2}, \tag{B.41}$$

$$\frac{\partial A_{t+1}}{\partial D^*_{t+1}} = (-f_{t+1})\frac{\tilde{RV}_{t+1}}{(D^{tot}_{t+1})^2}, \tag{B.42}$$

$$\frac{\partial A_{t+1}}{\partial K^I_{t+1}} = (1-\mu)\frac{\overbrace{(r_{k,t+1} + q_{k,t+1}(1-\delta))}^{r_{k,t+1}}}{D^{tot}_{t+1}}, \tag{B.43}$$

$$\frac{\partial A_{t+1}}{\partial B^I_{t+1}} = (1)\frac{1}{D^{tot}_{t+1}}. \tag{B.44}$$

Then we take derivatives of $F_{\epsilon,t+1}$:

$$\frac{\partial F_{\epsilon,t+1}}{\partial D_{t+1}} = \frac{\partial F_{\epsilon,t+1}}{\partial \tilde{V}_{t+1}}\frac{\partial \tilde{V}_{t+1}}{\partial n_{t+1}}\frac{\partial n_{t+1}}{\partial D_{t+1}} = f_{\epsilon,t+1}\Big[\phi^0 + \frac{1-\phi^0}{1-\phi^1 e_{t+1}}\Big](-1), \tag{B.45}$$

$$\frac{\partial F_{\epsilon,t+1}}{\partial D^*_{t+1}} = f_{\epsilon,t+1}\Big[\phi^0 + \frac{1-\phi^0}{1-\phi^1 e_{t+1}}\Big](-f_{t+1}), \tag{B.46}$$

$$\frac{\partial F_{\epsilon,t+1}}{\partial K^I_{t+1}} = f_{\epsilon,t+1}\Big[\phi^0 + \frac{1-\phi^0}{1-\phi^1 e_{t+1}}\Big]r_{k,t+1}, \tag{B.47}$$

$$\frac{\partial F_{\epsilon,t+1}}{\partial B^I_{t+1}} = f_{\epsilon,t+1}\Big[\phi^0 + \frac{1-\phi^0}{1-\phi^1 e_{t+1}}\Big](1). \tag{B.48}$$

Finally, we compute $\frac{\partial H_{t+1}}{\partial x_{t+1}}$

$$\frac{\partial H_{t+1}}{\partial x_{t+1}} = \frac{1}{D^{tot}_{t+1}}\Big[\frac{\partial F_{\epsilon_{t+1}}}{\partial x_{t+1}}\frac{\tilde{V}_{t+1}(N,\mathcal{S})}{\sigma_{\epsilon_{t+1}}} - H_{t+1}\frac{\partial D^{tot}_{t+1}}{\partial x_{t+1}}\Big]. \tag{B.49}$$

B.3 Market Clearings and Equilibrium

The market clearing conditions for aggregate labor, aggregate capital, and given by:

$$L_t = 1, \tag{B.50}$$

$$K_t = K^I_t + K^H_t, \tag{B.51}$$

$$D^I_t = D^H_t, \tag{B.52}$$

$$B^I_t = B_t. \tag{B.53}$$

Aggregate capital follows the standard law of motion

$$K_{t+1} = (1-\delta)K_t + X_t. \tag{B.54}$$

Equilibrium requires that financial flows from the home economy to the rest of the world equal the current account balance. Applying the above market clearing conditions, this condition, expressed in foreign currency, is given by:

$$\underbrace{q^*_{d,t}D^*_{t+1} - D^*_t(1-F_{\epsilon,t}) - \Theta_t RV_t F_{\epsilon,t}}_{\text{Financial flows from banking sector}} - \underbrace{q^*_s\mathcal{R}_{t+1} + \mathcal{R}_t}_{\text{Financial flows from CB}} = \underbrace{M_t - \frac{EX_t}{f_t}}_{\text{Current Account}} . \tag{B.55}$$

Finally, the goods market clearing condition is given by:

$$Y_t = \underbrace{C_t + X_t + EX_t}_{\text{Consumption + Investment + Exports}} + \underbrace{K_t\Psi + \Psi^H + \Psi^{I,\Theta} + \Psi^{I,e}}_{\text{Adjustment costs}} + \underbrace{\mu F_{\epsilon,t}[r_{k,t} + (1-\delta)q_{t,k})K^I_t]}_{\text{Dead-weight from bank default}} . \tag{B.56}$$

which states that total output produced, Y_t, must be either consumed, invested, exported or used to pay for the adjustment costs and the dead-weight losses from bank defaults.

We are now in a position to define the equilibrium. Given the aggregate state $\mathcal{S}_t$, a sequential competitive equilibrium consists of sequences of

- Prices: $\{q_{d,t}, q^*_{d,t}, q_{b,t}, q_{k,t}, f_t, r_{k,t}, w_t\}_{t=0}^{\infty}$
- Production inputs: $\{K_t, L_t, M_t\}_{t=0}^{\infty}$
- Households' plans $\{D^H_{t+1}, K^H_{t+1}, C_t\}_{t=0}^{\infty}$
- Intermediaries' plans: $\{K^I_{t+1}, B^I_{t+1}, e^I_t, D_{t+1}, D^*_{t+1}\}_{t=0}^{\infty}$
- Lagrangian multipliers: $\{\lambda^I_t, \lambda^{\bar{d}^*}_t\}_{t=0}^{\infty}$
- Exports: $\{EX_t\}_{t=0}^{\infty}$
- Taxes: $\{T^{CB}_t, T^{DI}_t, T^{CC}_t\}_{t=0}^{\infty}$
- Central Bank choices: $\{B^{CB}_{t+1}, \mathcal{R}_{t+1}\}_{t=0}^{\infty}$

such that, for all t, the following conditions hold:

- Producers' optimality conditions (6)-(8).
- Capital Producers' optimality condition (10).
- Households' optimality conditions (B.3)-(B.4), as well as their budget constraint (2).
- Intermediaries' optimality conditions (B.28)-(B.31) and budget constraint (B.11).
- Intermediaries complementary slackness conditions (B.33)-(B.34).
- Foreign sector zero profit condition (20) and exports demand (21).
- DI budget (19), Central Bank balance sheet, FX interventions rule and deficit, and capital control taxes (23)-(26).
- Market clearing conditions (B.50)-(B.53).
- International financial flows condition (22).

C Computational Method

We closely follow the work of Elenev, Landvoigt and Van Nieuwerburgh (2021). We choose our endogenous state variables to be $\mathcal{S}_{n,t} = [N_t, K_t, D_t, D_t^*, f_{t-1}]$, and the exogenous state variables $\mathcal{S}_{x,t} = [\sigma_\epsilon, \bar{d}_t^*]$. Therefore, the state variables are $\mathcal{S}_t = [\mathcal{S}_{n,t}, \mathcal{S}_{x,t}]$. Let the vector of policy functions we solve for be $\mathcal{P}(\mathcal{S}) = [C(\mathcal{S}), D^H(\mathcal{S}), K^H(\mathcal{S}), D^I(\mathcal{S}), K^I(\mathcal{S}), B^I(\mathcal{S}), D^*(\mathcal{S}), e(\mathcal{S}), \lambda(\mathcal{S}), \lambda^{\bar{d}^*}(\mathcal{S}), M(\mathcal{S}), q(\mathcal{S}), q_{d^*}(\mathcal{S}), q_b(\mathcal{S}), f(\mathcal{S})]$. The vector of transition functions be $\mathcal{T}(\mathcal{S}, \mathcal{S}_x^{'}) = [N(\mathcal{S}, \mathcal{S}_x^{'}),\ K(\mathcal{S}, \mathcal{S}_x^{'}), D(\mathcal{S}, \mathcal{S}_x^{'}), D^*(\mathcal{S}, \mathcal{S}_x^{'}), f(\mathcal{S}, \mathcal{S}_x^{'})]$.

We discretize the state space with the number of points given by the vector $[n_n, n_k, n_d, n_{d^*}, n_f, n_{\sigma_\epsilon}, n_{\bar{d}^*}]$, where each entry in the vector corresponds to one discretized dimension of the state vector. The exogenous state variables σ_ϵ and $\bar{d}_t^*$ are discretized through a Markov chain, with transition matrices denoted by P_{σ_ϵ} and P_{d^*}. We now introduce some notation. Let $\mathcal{J}_n$ and $\mathcal{J}_x$ be the set of points in the discretized endogenous and exogenous states at time t, respectively, and let $\mathcal{J}_x'$ be the set of points in the exogenous state vector at time $t+1$. Then, the discretized dimensions of the policy functions are $\mathcal{J} = [\mathcal{J}_n, \mathcal{J}_x]$, while those of the transition functions are $\mathcal{M} = [\mathcal{J}, \mathcal{J}_x']$. Denote $\hat{\mathcal{P}}_l$ as the l^{th} guess of all the policy functions for each $j \in \mathcal{J}$, and $\hat{\mathcal{T}}_l$ as l^{th} candidate solution transition functions for each $m \in \mathcal{M}$.

C.1 Step 1: Update Expectations

We need to compute the expectations terms of all inter-temporal optimality conditions. This includes the equilibrium conditions of households (B.3)-(B.4), of banks (B.28)-(B.31), as well as the the pricing equation for foreign debt (20). To accomplish this, we proceed as follows.

First, for each state at time t and each exogenous state at $t+1$ (i.e. for each $m \in \mathcal{M}$), we compute a guess for the state at time $t+1$ using our guess for the transition function $\hat{\mathcal{T}}_l$. Second, since we know the state tomorrow for each $m \in \mathcal{M}$, we can use our guess for the policy function $\hat{\mathcal{P}}_l$ to compute the implied choices and prices at $t+1$ [20]. Third, using the Markov chains P_{σ_ϵ} and $P_{\hat{d}^*}$, we can take expectations at time t about outcomes in $t+1$.

Repeating these steps for each $j \in \mathcal{J}$, results in a set of time t expectations for each point in discretized state-space. We denote the resulting set to be EV_l.

C.2 Step 2: Update Policy Functions

Since we have time t expectations about $t+1$ outcomes, we can now solve for optimal choices at time t for each point in the discretized state-space. To do so, note that for a given state j, and given candidate value of the policy functions at that state denoted $\hat{\mathcal{P}}_{j,l}$, we can compute a series of variables directly using

[20]Note that at this step, since future states need not to fall in the grid points, we need to use interpolation. We will provide details on this momentarily.

the equilibrium conditions [21].

We can use (10) and (6)-(8) to determine the prices $q_{k,t}$, $r_{k,t}$, w_t, and f_t. Moreover, we can use (23)-(26) to get T_t^{CB} and T_t^{CC} as well as $\mathcal{R}_{t+1}$ and B_{t+1}^{CB}. One can then back out T_t^{DI} using (17) and (19). These steps are sufficient to back out all the taxes paid by households. The returns from their savings W_t are given by (3) and their profits from the banking sector Π_t are given by (18). The total costs from investing in capital are determined by evaluating (4). Finally, we obtain EX_t from (21). We denote all these variables evaluated at guess l and state j to be $\mathcal{V}_{j,l}$.

For each guess $\hat{\mathcal{P}}_{j,l}$, and equipped with $\mathcal{V}_{j,l}$, and expectations EV_l we are in a position to compute the residuals of the remaining optimality conditions. These conditions are the households' optimality conditions (B.3)-(B.4) and (2), intermediaries' optimality conditions given by (B.28)-(B.31), (B.33)-(B.34) and (B.11), the foreign sector zero profit condition (20), market clearing conditions (B.52) and (B.53), producer optimality condition (8), and the flow of funds equation (22).

For each state $j \in \mathcal{J}$ we evaluate the 15 residuals until the it is approximate zero. This constitutes solving a non-linear system of 15 equations and 15 unknowns (the variables in policy function), which we do numerically using MATLAB's fsolve function. We store as the new guess of the policy function for that specific state $\mathcal{P}_{j,l+1}$, and repeat this process for all $j \in \mathcal{J}$. This procedure delivers a new guess $\hat{\mathcal{P}}_{l+1}$ of the policy functions.

C.3 Step 3: Update Transition Functions

Given an old guess for the transition function $\hat{\mathcal{T}}_l$ and new guess for the policy functions $\hat{\mathcal{P}}_{l+1}$, we obtain a new guess for the transition function $\hat{\mathcal{T}}_{l+1}$ as follows. Note that for the transition functions $K(\mathcal{S}, \mathcal{S}_x^{'})$, $D(\mathcal{S}, \mathcal{S}_x^{'})$, $D^{*}(\mathcal{S}, \mathcal{S}_x^{'})$ and $f(\mathcal{S}, \mathcal{S}_x^{'})$, the realizations are independent of time $t+1$ realizations of aggregate uncertainty. Therefore, we can directly use the policy functions evaluated at each $j \in \mathcal{J}$ [22].

For the new update of $N(\mathcal{S}, \mathcal{S}_x')$, the computation is slightly more involved. We start by evaluating the old transition functions $\hat{\mathcal{T}}_l$ at each point $m \in \mathcal{M}$, which gives us some realized states at $t+1$. Using the new guess for the policy functions $\hat{\mathcal{P}}_{l+1}$ at all the realized states at $t+1$, we obtain choices and prices at $t+1$ for each realization of aggregate uncertainty at $t+1$. We then evaluate the capital holding decision made by households and banks at $t+1$ (i.e., K_{t+2}^{H} and K_{t+2}^{I}). Evaluating (B.51) yields total investment X_{t+1} and evaluating (7) yields $q_{k,t+1}$. Similarly, we evaluate the policy function of the exchange rate $f(\mathcal{S}_{t+1})$. We can then use (B.10) at each $m \in \mathcal{M}$ to back out $N(\mathcal{S}, \mathcal{S}_x^{'})$.

The two steps detailed in this subsection provide us with a new guess for the transition function $\hat{\mathcal{T}}_{l+1}$.

[21] We refer the reader to the replication code for the details of this step, here we just provide an overview

[22] Recall that our state variable is f_{t-1} so that $f(\mathcal{S}_t, \mathcal{S}_{x,t+1})$ is just the evaluation of the policy function $f(\mathcal{S}_t)$.

C.4 Implementation

We start the algorithm by setting the initial guess $\hat{\mathcal{P}}_0$ and $\hat{\mathcal{T}}_0$ such that, for all $j \in \mathcal{J}$ and for all $m \in \mathcal{M}$ the candidate solution is simply the steady-state values. We set distance tolerance levels to $\epsilon_{\mathcal{T}}$ and $\epsilon_{\mathcal{P}}$ for transition and policy functions, respectively. We then proceed as follows:

1. Given $\hat{\mathcal{T}}_0$ and $\hat{\mathcal{P}}_0$ use Step 1 to compute expectations EV_1
2. Given EV_1, use Step 2 to compute a new guess for the policy functions $\hat{\mathcal{P}}_1$
3. Use $\hat{\mathcal{P}}_1$ and $\hat{\mathcal{T}}_0$ following Step 3 to compute a new guess for the transition functions $\hat{\mathcal{T}}_1$
4. Compute the distance between guesses $||\hat{\mathcal{P}}_1 - \hat{\mathcal{P}}_0|| = d_{\mathcal{P}}$ and $||\hat{\mathcal{T}}_1 - \hat{\mathcal{T}}_0|| = d_{\mathcal{T}}$
5. If either $d_{\mathcal{T}} > \epsilon_{\mathcal{T}}$ or $d_{\mathcal{P}} > \epsilon_{\mathcal{P}}$, set $\hat{\mathcal{T}}_0 = \hat{\mathcal{T}}_1$ and $\hat{\mathcal{P}}_0 = \hat{\mathcal{P}}_1$ and go to 1. Else, set $\mathcal{P} = \hat{\mathcal{P}}_0$ and $\mathcal{T} = \hat{\mathcal{T}}_0$.
6. Use $\mathcal{P}$ and $\mathcal{T}$ to simulate the economy for 100,000 periods, starting at the steady state.
7. If the realization of a state hits the bounds, widen the grid and go back to 1. Otherwise, stop.

C.5 Implementation details

We discretize the state-space as follows. First, regarding the exogenous state variables σ_ϵ and $\bar{d}_t^*$ are discretized through a Markov chain. For the bank-risk variable σ_ϵ we set $n_{\sigma_\epsilon} = 3$ and we use the Tauchen method to compute the discretized values of σ_ϵ and the corresponding transition probabilities. For the sudden stop variable $\bar{d}^*$, we set $n_{\bar{d}^*} = 2$. The discretized values of the Markov-chain are $D_{ss}^*[\bar{d}_1, \bar{d}_2]$, where D^* is the steady-state value of foreign debt. The transition probabilities of from sudden stop state i to j are denoted $P_{i,j}$. The calibrated values of the model parameters $[\rho_{\sigma_\epsilon}, \sigma_{\sigma_\epsilon}, \bar{d}_1, \bar{d}_2, P_{1,1}, P_{2,2}]$, are detailed in Section 2.

Second, for any endogenous state variable s, we set the bounds for each dimension to be s_l (lower-bound) and s_h (upper-bound). We then create a linearly spaced grid with n_s points and bounds given by s_l and s_h. Note that at any point in the state-space, the highest possible choice of banks' foreign debt D_{t+1}^* must be equal to the highest supply of bonds by the foreign sector. Thus. we set the restriction that $D_u^* = D_{ss}\bar{d}_2$. The number of points for each endogenous state is $[n_n, n_k, n_d, n_{d^*}, n_f] = [5, 3, 3, 7, 3]$. As a result, the discretized state-space contains 9,990 points.

For other aspects of implementation we borrow heavily from Elenev, Landvoigt and Van Nieuwerburgh (2021). In terms of interpolation, we use their codes with minor adjustments. These routines implement piece-wise linear interpolation for vectorized code. If the interpolation points are outside the bounds of the endogenous states, the code returns as output the value of the function at the bound of the endogenous state. We refer the reader to Elenev, Landvoigt and Van Nieuwerburgh (2021) for a discussion on how to deal with Lagrange multipliers λ_t and $\lambda_t^{\bar{d}^*}$ within Step 2 (non-linear solver). As stopping criteria in 5. we use a maximum error of 10^{-5} and an average error of 10^{-6} for both policy and transition functions. We implement the algorithm in MATLAB, and run the code in the European University Institute High Performance Computer (EUI-HPC) with 80GB of RAM, and parallelize the non-linear solver step over 36 cores. With this infrastructure the baseline model takes around 40 minutes to run.

D Data

D.1 Calibration Data

Real Economic Activity: We use National Accounts quarterly data from Peru's Central Bank (BCRP). The dataset includes seasonally adjusted figures for investment, gross domestic product (GDP), exports, and imports from 1999Q1 to 2022Q4. We adjust these series for inflation using the GDP deflator. To calculate the ratio of the volatility of investment to the volatility of GDP, we de-trend both series using the Hodrick-Prescott (HP) filter.

Exchange-Rate: We collect exchange rate data at monthly frequency from the SBS for the period 1999Q1-2022Q4. We choose the average monthly exchange rate in the interbank market. To compute the volatility of the exchange rate relative to the volatility of exports we proceed as follows: First, we convert the exchange rate series to a quarterly frequency by averaging the monthly rates within each quarter. Second, we de-trend the resulting quarterly series for the exchange rate and exports using the HP filter. Finally, we compute the ratio of the volatilities of both series. Finally, we calculate the ratio of the volatilities of both series.

Interest Rates: As a proxy for the safe U.S. interest rate, we use monthly data on the nominal 3-month yield on U.S. Treasury Securities, sourced from FRED, covering the period from 1990M1 to 2020M7. For Peru's safe rate, we utilize the BCRP's reference rate from 2003Q3 to 2023Q3.

Household Capital Holdings: We gather data from the "Nota Semanal" (weekly note) section of the BCRP. This includes monthly balance-sheet data on outstanding corporate loans from domestic depository institutions (code "PN00532MM") and domestic firms' corporate bonds outstanding (code "PN01101MM") from 2002M1 to 2023M8. We approximate the household capital share as the portion of total corporate debt outstanding that is not held by banks. To compute the volatility of the household capital share, we first de-trend the series using the HP filter, and then convert it to a quarterly frequency by averaging the monthly data for each quarter.

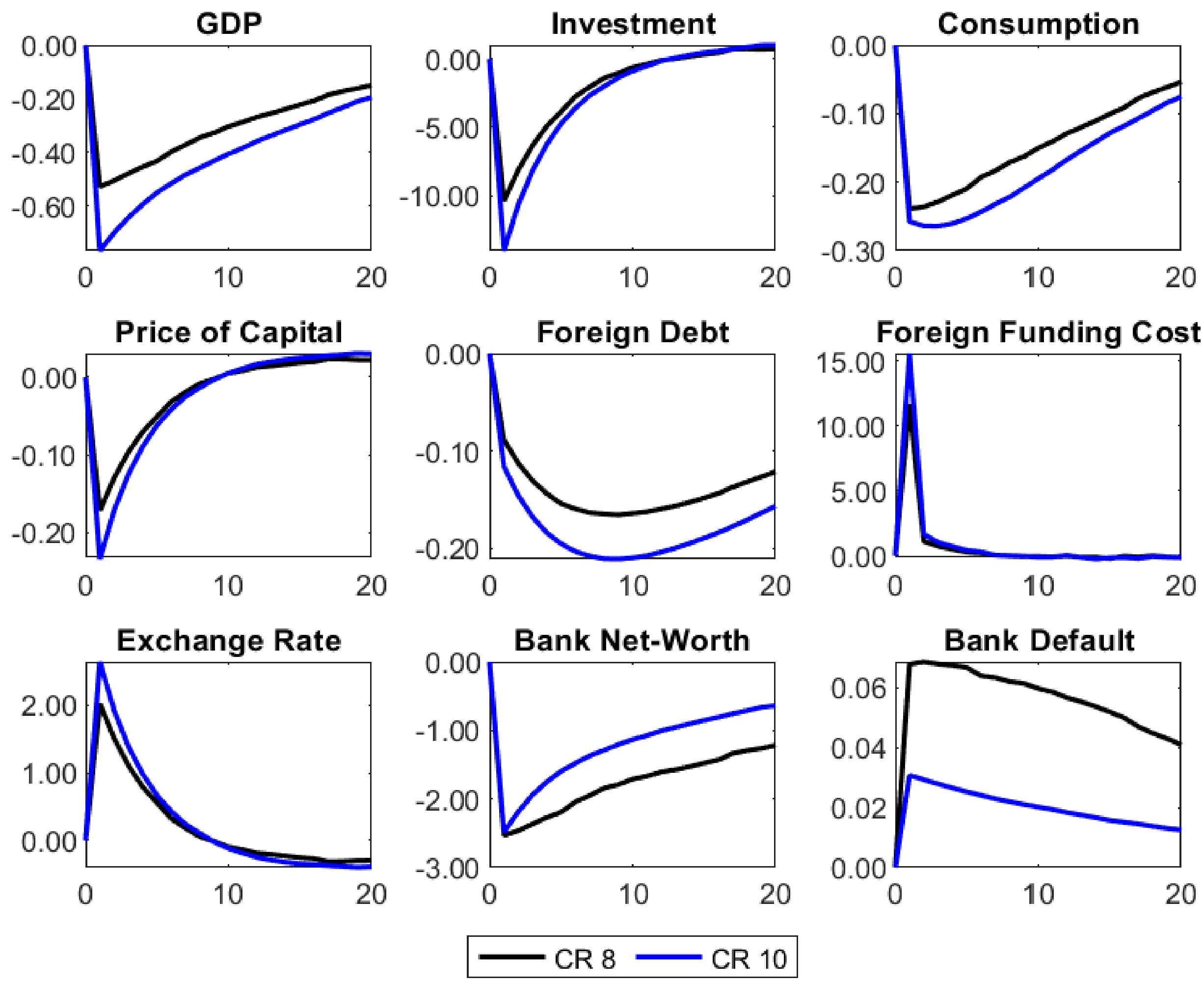
Banks' Foreign Liability Share: We collect monthly bank balance-sheet data from the SBS from 2002M1 to 2023M4. Although the data is bank-specific, we aggregate it to compute a measure of the banking sector's foreign debt share. In the model, Θ represents foreign debt over the sum of deposits to domestic households and foreign debt. We calculate deposits as the sum of "time deposits," "savings deposits," and "demand deposits". Foreign debt is reported in foreign currency, which we convert to domestic currency using the accounting exchange rate provided by the SBS. To compute the volatility and autocorrelation coefficient of the foreign liability share, we de-trend the series using the HP filter and convert it to a quarterly frequency by averaging the monthly data for each quarter.

Bank Default: We use Moody's monthly data on asset-weighted bank default rates for Peru from 1992M2 to 2019M7. To compute the volatility, we convert the data to a quarterly frequency by taking the monthly average for each quarter.

Central Bank Reserves: We access data on Peru's central bank international reserves from the BCRP, covering the period from 1995Q1 to 2022Q4. To calculate the share of reserves relative to (annual) GDP, we use the seasonally adjusted series and adjust it for inflation using the GDP deflator.

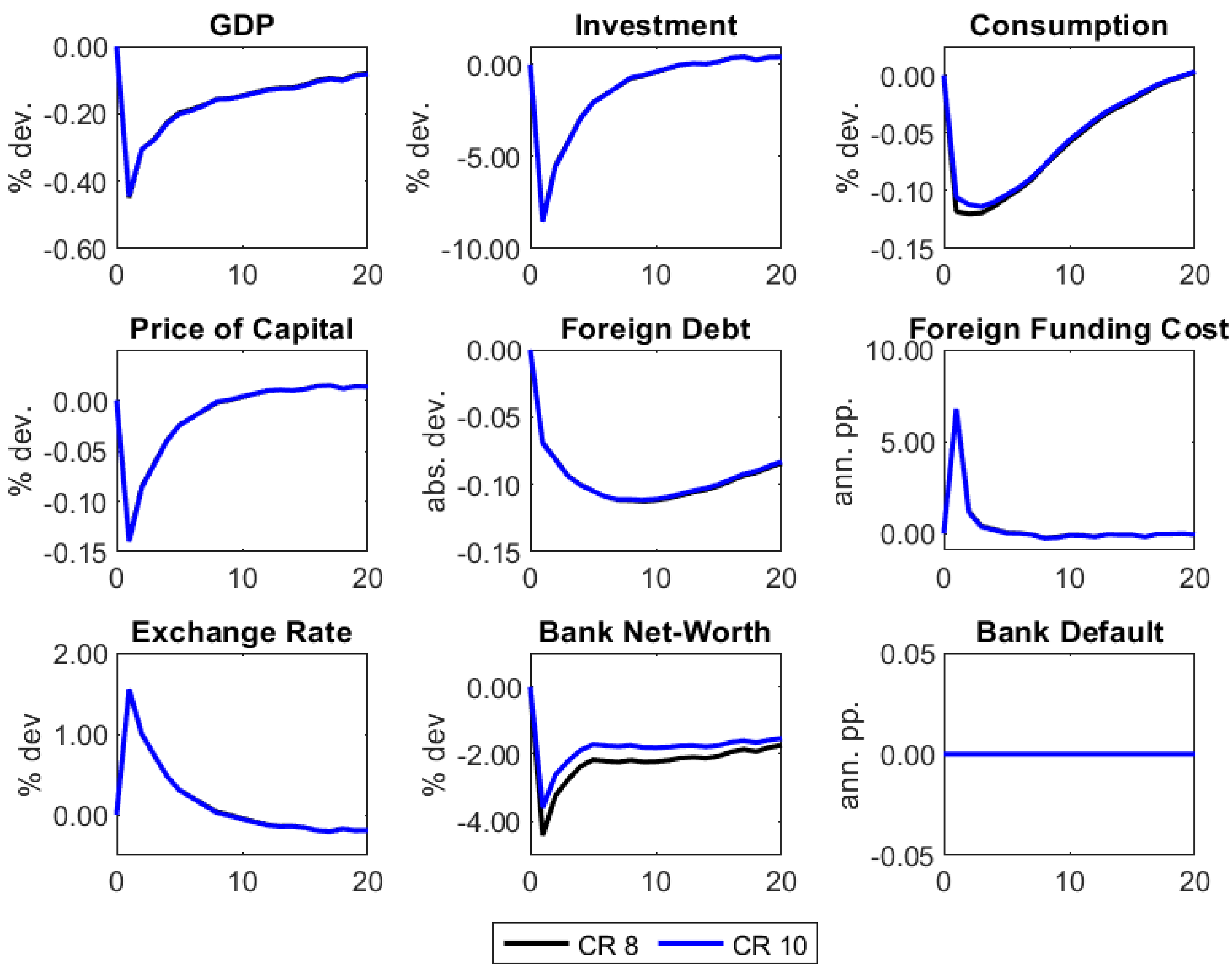
E Additional Results

Figure D.1: Foreign Liabilities Shock (No Bank FX Risk)



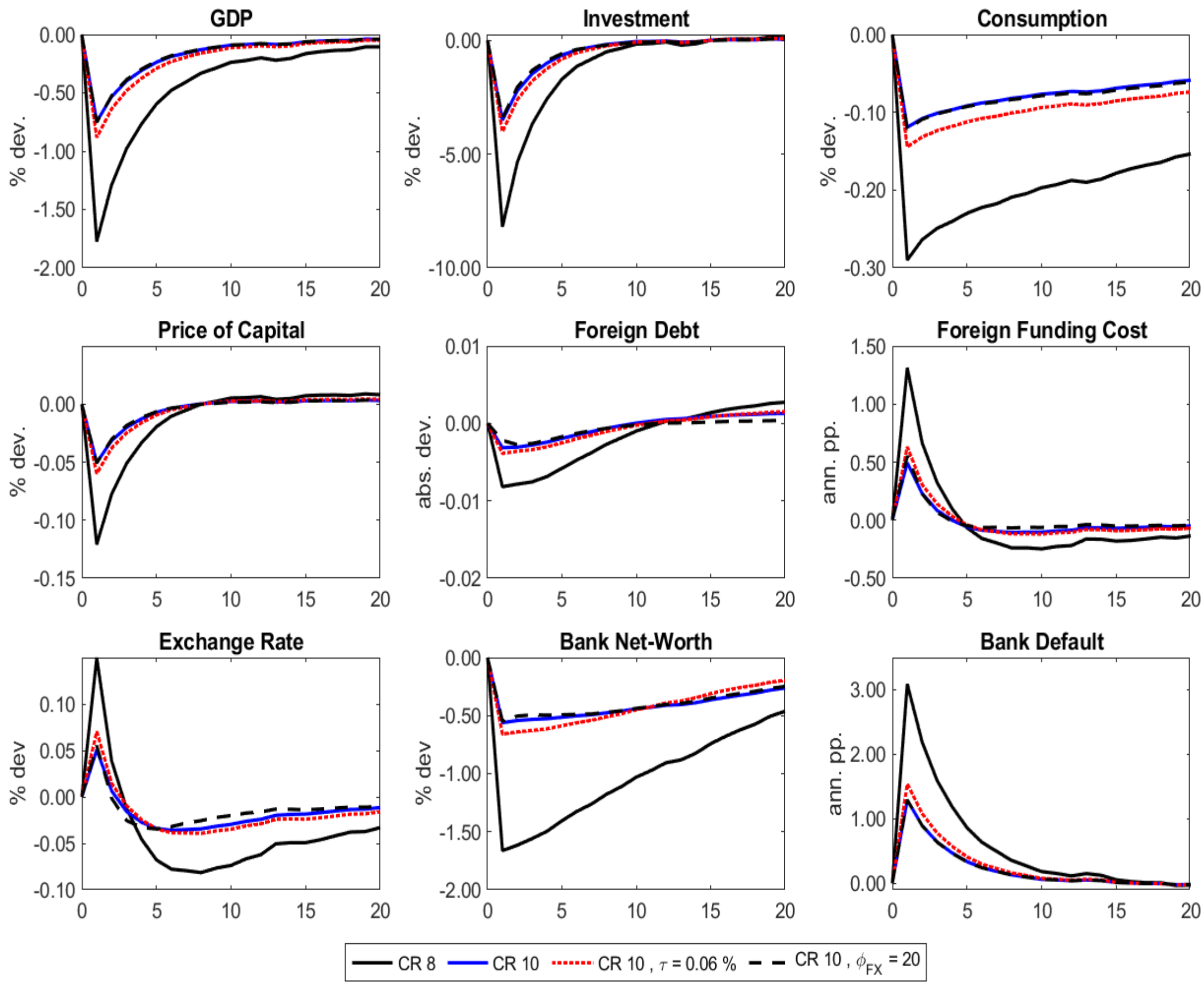
Notes: This figure presents the impulse response functions (IRFs) of model variables to a foreign funding shock, defined as a shock to the maximum amount of foreign debt, denoted as $\bar{d}^*_{t+1}$. We use the model solution of the baseline model (i.e Figure 7). When simulating the IRFs, we fix the path of the exchange rate to those from Figure 7 and adjust the path of bank net worth, assuming that exchange rate fluctuations do not directly affect bank net-worth. The black solid line shows the response under the baseline capital requirement level of %, while the blue solid line illustrates the same exercise with a capital requirement level of 10 %. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are presented in absolute deviations.

Figure D.2: Foreign Liabilities Shock (No Bank Default)



Notes: This figure presents the impulse response functions (IRFs) of model variables to a foreign funding shock, defined as a shock to the maximum amount of foreign debt, denoted as $\bar{d}^*_{t+1}$. We show the results for the version of the model without bank defaults (i.e. $\sigma_{\epsilon,t} = 0$ for all t). The black solid line displays the response under the baseline capital requirement level of 8 %, while the blue solid line presents the same exercise with a capital requirement level of 10 %. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are presented in absolute deviations.

Figure D.3: Bank Risk Shock



Notes: This figure presents the impulse response functions (IRFs) of model variables to a bank risk shock, defined as a mean-preserving shock to the standard deviation of the idiosyncratic shock to bank profits. The black solid line displays the response of the economy to a bank risk shock under the baseline capital requirement level of 8 %. The blue solid line reflects the same size of shock as in the black line scenario but with a capital requirement level of 10 %. The red dotted line shows the responses of the economy with a capital requirement of 10 % and foreign debt taxes of 0.06 %. The black dashed line shows the responses of the economy with capital requirements of 10% and FX interventions with parameter $\phi_{FX} = 20$. IRFs are computed starting from the ergodic means. We simulate the economy's response to the shock over 20 periods, repeating this process 10,000 times and averaging across the simulated paths. Responses are expressed as deviations from the ergodic means. For all variables except bank default, foreign debt, and foreign funding costs, responses are presented in percentage deviations. Responses for bank default and foreign funding costs are expressed in annual percentage point deviations, while responses for foreign debt are presented in absolute deviations.