

# Intermediary Balance Sheets and UIP Deviations in Emerging Markets\*

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## Abstract

Emerging market economies are highly exposed to global financial shocks because they rely more heavily on foreign currency borrowing and operate with shallower financial markets. This paper studies how such shocks affect deviations from uncovered interest parity. Using local projections in a panel of advanced and emerging economies, we show that UIP deviations rise persistently after a U.S. monetary tightening in emerging markets but fall in advanced economies. This differential response is stronger in countries whose banking sectors hold larger short foreign currency positions. We develop a dynamic small open economy model with financial frictions and market segmentation to interpret these facts. Banks borrow in foreign currency and lend domestically, subject to balance sheet constraints and forward looking portfolio decisions. Exchange rate movements revalue intermediary net worth, alter intermediation capacity, and generate endogenous UIP premia. The model matches the asymmetric response of UIP deviations to foreign monetary shocks and highlights intermediary balance sheets as a key determinant of international monetary transmission.

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# 1 Introduction

Some of the main features that distinguish emerging market economies from advanced economies are that they rely more heavily on foreign-currency borrowing, exhibit higher financial dollarization, and operate with shallower domestic financial markets.<sup>1</sup> These features make them especially vulnerable to changes in global funding conditions and amplify the domestic transmission of external monetary shocks, particularly those originating from U.S. monetary policy. As a result, domestic interest rates and exchange rates in emerging markets respond markedly differently to these shocks than their counterparts in advanced economies. A key manifestation of this asymmetry is the behavior of deviations from uncovered interest parity (UIP): in emerging markets, these deviations are larger, more persistent, and more sensitive to global funding conditions.<sup>2</sup> Understanding what drives UIP deviations in response to external shocks is therefore central both to explaining exchange rate dynamics in emerging markets and to tracing the international transmission of U.S. monetary policy.

This paper makes two contributions. Empirically, it documents a robust asymmetry in the behavior of UIP deviations after U.S. monetary policy shocks and relates that asymmetry to cross-country differences in banks' foreign currency exposure. Theoretically, it provides a framework in which UIP deviations are endogenous objects shaped by the joint evolution of exchange rates, intermediary net worth, and intertemporal portfolio decisions. More broadly, the paper shows that in economies with limited financial depth, UIP deviations are not merely pricing anomalies. They are equilibrium outcomes that encode how global shocks are transmitted through domestic balance sheets.

In this respect, the paper argues that there is a missing ingredient in recent models of UIP deviations: the interaction between foreign-currency funding and the balance sheets of financial intermediaries. While the role of balance sheets in amplifying exchange rate dynamics has a long history in open-economy macroeconomics, and the importance of intermediary balance sheets for asset pricing is well established in closed-economy settings, their joint implications for UIP deviations in emerging markets remain unexplored in the more recent literature, such as [Gabaix and Maggiori \(2015\)](#), [Liu and Spiegel \(2015\)](#) and [Itskhoki and Mukhin \(2021\)](#).<sup>3</sup> The empirical motivation is straightforward. Using survey-based exchange rate expectations from Consensus Economics in a panel of advanced and emerging market economies, we document that a U.S. monetary tightening raises UIP deviations in emerging markets but lowers them in advanced economies. We further show that this asymmetry

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<sup>1</sup>For studies documenting these features see [Calvo and Reinhart \(2002\)](#), [Eichengreen et al. \(2007\)](#), [Caballero et al. \(2008\)](#), [Ize and Levy-Yeyati \(2003\)](#), and [Levy-Yeyati \(2006\)](#).

<sup>2</sup>See [Rey \(2015\)](#), [Bruno and Shin \(2015\)](#), [Engel \(2016\)](#), [Miranda-Agrippino and Rey \(2020\)](#), [Kalemli-Özcan \(2019\)](#), [Lustig et al. \(2011\)](#), and [Cormún and De Leo \(2025\)](#). Some of these asymmetries also appear in deviations from covered interest parity; see [Du et al. \(2018\)](#).

<sup>3</sup>Seminal references on balance sheet effects in macroeconomics include [Krugman \(1999\)](#), [Calvo \(1998\)](#), [Aghion et al. \(2004\)](#), and [Céspedes et al. \(2004\)](#).

is systematically stronger in countries where financial intermediaries are more frequently in short foreign-currency positions. Together, these findings point to a balance sheet channel in which exchange rate movements induced by external monetary policy shocks compress intermediaries' net worth and, in turn, raise the risk premia required to hold domestic assets.

To interpret these facts, we begin by considering a simplified environment in which exchange-rate revaluation effects are absent. This allows us to focus on the core intermediation structure linking domestic borrowers, financial intermediaries, and international lenders, and to isolate how foreign interest rate shocks affect domestic credit conditions. We present a general setup in which households demand credit and intermediaries supply it by borrowing abroad and examine how the equilibrium spread responds to foreign rate shocks through the relative elasticities of demand and supply. In this setting, the cost of foreign borrowing in domestic currency is directly tied to the foreign interest rate, so any spread that emerges is a result of financial frictions. This framework clarifies which features of credit market equilibrium can and cannot generate a positive response of UIP deviations to an increase in the foreign interest rate. A key insight is that static or myopic intermediation is not sufficient. In the benchmark cases, a rise in foreign rates tends to reduce the equilibrium spread. Even models with dynamic intermediation (but without balance sheet effects) can barely match responses observed in the data. Reversing this prediction requires a genuinely dynamic supply side, where changes in intermediaries' net worth and intermediation capacity shape the response.

We then study open economy models with real exchange rate movements and foreign currency liabilities. Households consume tradable and nontradable goods, which makes the real exchange rate relevant for both intratemporal allocation and intertemporal borrowing decisions. Banks borrow abroad in foreign currency and lend domestically, so exchange rate movements change the domestic currency value of their liabilities and feed directly into net worth. As a result, the effective foreign funding cost is no longer pinned down by the foreign interest rate alone. It is jointly determined by foreign rates, intermediary balance sheets, and exchange rate dynamics.

The main theoretical result is that the response of the UIP premium to a foreign interest rate shock depends on the financial structure of intermediation. In the benchmark economy, where banks are static and balance sheet propagation is absent, a rise in the foreign interest rate lowers the UIP premium by compressing credit demand. Once banks are dynamic and exposed to exchange-rate revaluation effects, however, the same shock can generate a positive impact response. A foreign monetary tightening induces a depreciation that raises the domestic currency value of banks' foreign liabilities, erodes intermediary net worth, tightens intermediation constraints, and shifts domestic credit supply inward. When this balance sheet channel is sufficiently strong, the contraction in credit supply dominates the fall in credit demand, so the equilibrium UIP premium rises even though the underlying shock remains contractionary.

We then study this mechanism quantitatively and show that balance sheet effects are the key force overturning the benchmark prediction. First, a decomposition of the impulse responses separates the total adjustment into static, forward-looking, and balance sheet components. We show that the increase in the UIP premium mainly reflects tighter intermediary constraints due to net worth revaluation (i.e., balance sheet channel). Second, sensitivity exercises further show that the mechanism is stronger when banks are more leveraged and when net worth effects are more persistent. In this sense, the model provides a close theoretical counterpart to the empirical evidence: UIP deviations respond more strongly to U.S. monetary tightening in economies whose banking sectors hold larger short foreign currency positions.

**Related literature.** This paper contributes to several closely related literatures in international macroeconomics and international finance. First, the paper contributes to the literature on the international transmission of U.S. monetary policy and the global financial cycle. [Bruno and Shin \(2015\)](#) and [Miranda-Agrippino and Rey \(2020\)](#) highlight the role of intermediary balance sheets, dollar funding conditions, and global risk taking in transmitting U.S. shocks across countries. Related empirical work by [Kalemli-Özcan and Varela \(2021\)](#) and [Kalemli-Özcan et al. \(2024\)](#) shows that UIP premia are driven by local risk and respond asymmetrically to U.S. monetary tightening. This paper complements that literature by bringing UIP deviations to the center of the analysis. Rather than focusing on broad financial conditions or asset prices, it studies how external monetary shocks affect currency risk premia and identifies foreign currency mismatch as a key state variable governing that response. The main empirical contribution is to connect the global financial cycle literature to the behavior of UIP deviations measured using survey expectations.

Second, the paper contributes to the portfolio balance and limited arbitrage literature on exchange rate determination. The starting point is the portfolio balance view that exchange rates depend not only on interest differentials, but also on the relative supplies and demands for assets when those assets are imperfect substitutes. Building on the earlier contributions of [Kouri \(1976\)](#) and [Branson and Henderson \(1985\)](#), [Gabaix and Maggiori \(2015\)](#) provided a particularly influential microfoundation for this mechanism by showing how intermediary frictions can generate exchange rate risk premia.<sup>4</sup> This paper builds directly on that insight, but departs from the standard static or quasi-static formulation in two important ways. It embeds the portfolio balance mechanism in a dynamic open economy environment with endogenous credit demand and supply, and it gives intermediaries evolving net worth and forward-looking portfolio decisions. This framework makes it possible to study how dynamic intermediation and balance sheet effects shape the response of UIP premia to changes in global funding conditions.

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<sup>4</sup>Several recent studies have developed quantitative versions of this framework to address open economy macroeconomic questions. See [Cavallino \(2019\)](#), [Fanelli and Straub \(2021\)](#), [Itskhoki and Mukhin \(2021\)](#), and [Itskhoki and Mukhin \(2023\)](#).

Third, the paper contributes to the literature on financial intermediation and balance sheet constraints in macroeconomics. The banking block is closely related in spirit to intermediary models such as [Gertler and Kiyotaki \(2010\)](#) and [Gertler and Karadi \(2011\)](#), where net worth affects leverage and the ability to intermediate assets. The contribution here is to place that logic in an open economy setting in which banks borrow in foreign currency and lend domestically, so exchange rate movements directly revalue their liabilities and therefore their intermediation capacity. [Aoki et al. \(2025\)](#) and [Carrasco and Florián Hoyle \(2025\)](#) use related mechanisms to study the role of financial intermediaries in emerging market business cycles. Their focus, however, is on macroeconomic stabilization policy rather than on asymmetric UIP responses.<sup>5</sup>

In this regard, the paper builds on the literature showing that intermediary balance sheets are important for asset pricing in closed-economy settings (see [He and Krishnamurthy \(2013\)](#), [Brunnermeier and Pedersen \(2009\)](#), and [Adrian and Shin \(2014\)](#)). More related, [Kekre et al. \(2024\)](#) show that in segmented bond markets monetary policy affects term premia through wealth revaluation of duration exposed intermediaries. Our paper applies the same broad insight to international macroeconomics: when banks are exposed to foreign currency risk, U.S. monetary tightening revalues intermediary balance sheets, alters risk bearing capacity, and raises UIP premia in emerging markets.

Finally, the paper uses a recent sequence-space approach to macro finance. Using the sequence space logic of [Auclert et al. \(2021\)](#) and [Wolf \(2021\)](#), it summarizes the open economy financial block through elasticities that map foreign interest rate shocks into endogenous spreads, exchange rates, and balance sheet dynamics. This yields a tractable way to connect empirical impulse responses to a theoretically disciplined mechanism. More broadly, the paper shows how sequence space methods can be used not only for closed economy heterogeneous agent models, but also for open economy environments in which exchange rates, financial intermediation, and external balance sheet exposure jointly determine the transmission of global shocks.

**Outline.** The remainder of the paper is organized as follows. Section 2 presents the empirical evidence on the response of UIP deviations to U.S. monetary policy shocks and documents the role of banking sector foreign currency exposure. In Section 3, we describe the class of models that we explore in the paper. Section 4 develops a benchmark framework without exchange rate balance sheet effects and clarifies why standard or static intermediary models struggle to generate the empirical response. Section 5 introduces real exchange rate dynamics and intermediary balance sheets, and characterizes competitive equilibrium in the full model. Section 6 concludes.

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<sup>5</sup>Our paper also shares the emphasis on net worth dynamics and currency mismatches of [Korinek \(2011\)](#) and [Bocola and Lorenzoni \(2020\)](#) but differs in focus: rather than studying the emergence of dollarization or the case for prudential regulation, we ask how, given an existing currency mismatch on intermediaries' balance sheets, external monetary policy shocks transmit into UIP deviations through the net worth channel.

## 2 Empirical analysis

U.S. monetary policy shocks generate sharply different responses in uncovered interest parity (UIP) deviations across countries. Following a U.S. tightening, UIP deviations increase in emerging market economies (EMEs) but decrease in advanced economies (AEs). Moreover, this response is systematically stronger in countries whose banking sectors are exposed to foreign currency risk.

From an economic perspective, uncovered interest parity implies that differences in interest rates across countries should be offset by expected exchange rate movements. In other words, if a country offers a higher interest rate than the United States, its currency is expected to depreciate so that investors earn the same return across currencies. Deviations from UIP capture violations of this condition and can be interpreted as currency risk premia: when UIP deviations are positive, investors require additional compensation to hold local currency assets because they expect losses from exchange rate movements.

**UIP Deviations.** We measure UIP deviations as the difference between the nominal interest rate differential and expected exchange rate depreciation over a one-year horizon, using survey-based expectations. The use of survey data to measure exchange rate expectations and the study of UIP deviations dates back to the seminal work of [Frankel and Froot \(1987\)](#), who show that survey expectations provide a direct measure of expected depreciation. In that sense, the UIP deviation for country  $c$  at time  $t$  is given by:

$$\text{UIPDev}_{c,t} = \log(1 + i_{c,t}) - \log(1 + i_t^{US}) - (\log S_{c,t+12}^e - \log S_{c,t}) \quad (1)$$

where  $S_{c,t+12}^e$  is the twelve-month expected exchange rate obtained from Consensus Economics surveys,  $S_{c,t}$  is the spot nominal exchange rate from the IMF's International Financial Statistics, and  $i_{c,t}$  is the twelve-month money market interest rates from Bloomberg.

We begin by documenting that UIP deviations exhibit substantial heterogeneity across countries. Figure 1 plots the time series of UIP deviations for a set of advanced and emerging economies, showing large differences in both levels and volatility, even within the same income group. Table 1 confirms this pattern in the full sample: while average UIP deviations differ modestly across groups, dispersion is substantial, particularly in advanced economies. At the same time, both groups display economically large and persistent deviations from parity. Taken together, these results indicate that UIP deviations are not small or transitory anomalies, but rather a pervasive feature of international financial markets, pointing to an important role for country-specific factors beyond common global shocks.

**FX liabilities.** We then turn to study these patterns from the perspective of a balance sheet channel in the international transmission of monetary policy. When intermediaries hold net short positions

Figure 1: UIP Deviations Across Emerging and Advanced Economies

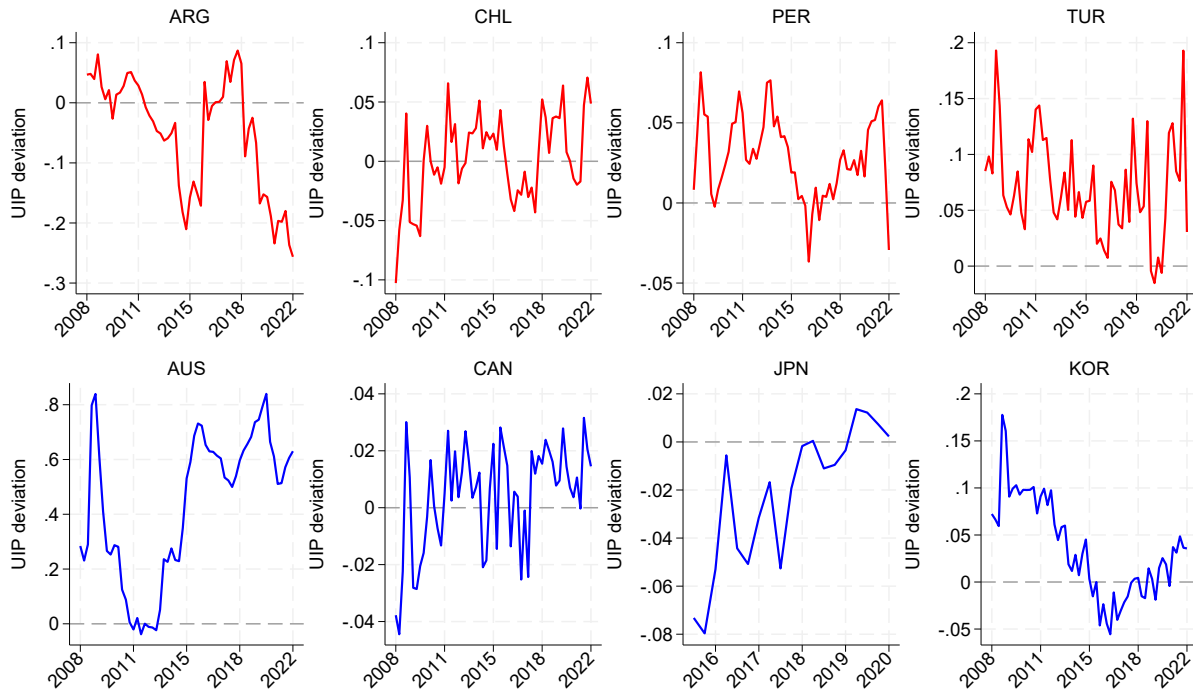
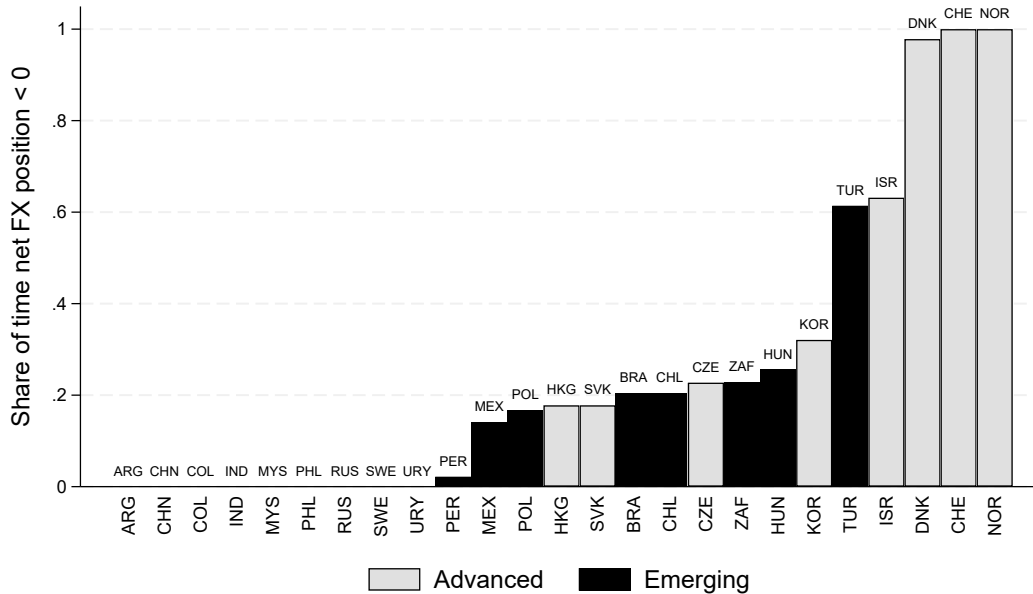


Table 1: Descriptive statistics of UIP deviations

	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>P25</i>	<i>Median</i>	<i>P75</i>	<i>Min</i>	<i>Max</i>
Total	1415	-0.02	0.27	-0.10	0.00	0.05	-1.30	1.26
EME	741	0.00	0.10	-0.02	0.02	0.06	-0.43	0.25
AE	674	-0.04	0.37	-0.22	-0.01	0.02	-1.30	1.26

in foreign currency, exchange rate movements induced by U.S. shocks affect their net worth and amplify the risk premia embedded in UIP deviations, consistent with models of global financial cycles and intermediary-based transmission (Bruno and Shin (2015) and Miranda-Agrippino and Rey (2020)). To characterize cross-country differences in balance sheet exposure, we construct a measure of foreign currency mismatch in the banking sector. Using data from the IMF Financial Soundness Indicators, we compute the net open FX position of banks relative to capital and aggregate it at the country level. A negative value indicates that banks are net short in foreign currency, that is, their foreign currency liabilities exceed their assets, making them vulnerable to balance sheet losses upon depreciation. Figure 2 reports the share of time each country’s banking sector is in a net short foreign currency position. There is substantial dispersion in this measure across countries, with some economies spending a large fraction of time in short FX positions, while others are rarely exposed. This cross-sectional heterogeneity motivates the classification of countries into high and low balance sheet constraint groups used in the analysis below.

Figure 2: Cross-Country Frequency of Short FX Positions



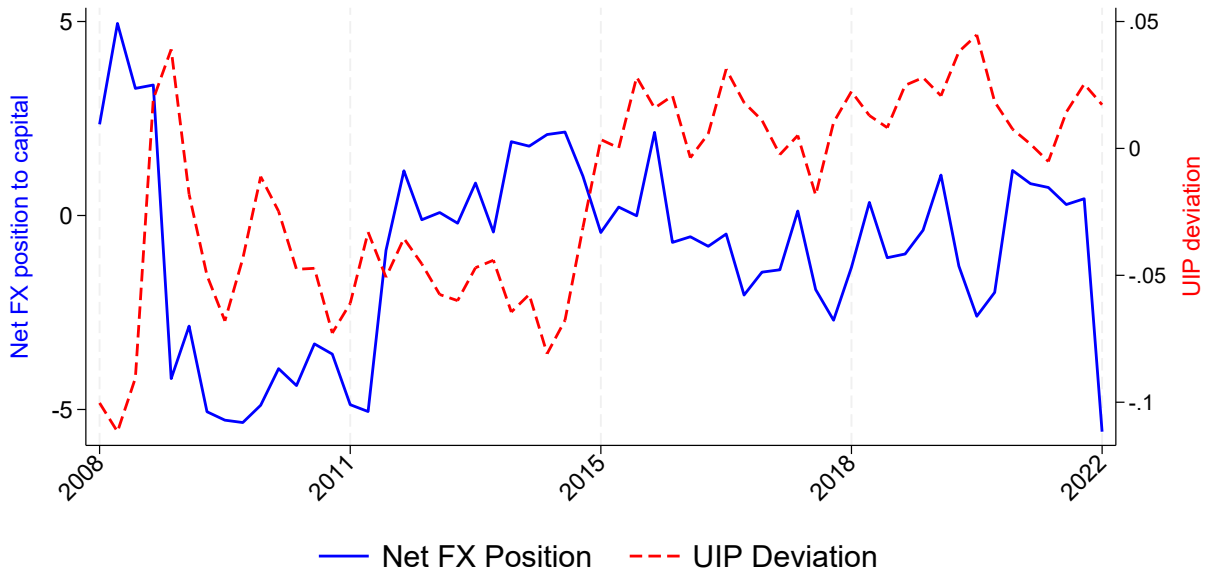
To understand the comovement between UIP deviations and the net FX position, we plot the average UIP deviation and the average net foreign currency position across countries over time, which can be seen in Figure 3. This illustrates that periods of elevated UIP deviations tend to coincide with changes in aggregate FX exposure, suggesting a potential link between balance sheet conditions and exchange rate risk premia.

**Responses to US monetary policy shock.** We now move on to analyze the response of UIP deviations to U.S. monetary policy shocks. The empirical analysis is conducted using a country–time panel dataset that combines macroeconomic and financial data with survey-based measures of exchange rate expectations. We work with a quarterly, unbalanced panel covering 35 countries (16 AEs, 19 EMEs)<sup>6</sup> and between 2008Q1 and 2025Q3. The main variable of interest is a twelve-month measure of UIP deviations, constructed in logs as the difference between the nominal interest rate differential and expected exchange rate depreciation over a one-year horizon. We restrict the sample to countries operating under managed or freely floating exchange rate regimes, following [Kalemli-Özcan and Varela \(2021\)](#) and [Kalemli-Özcan et al. \(2024\)](#), excluding economies with hard pegs or dual exchange rate systems based on the classification of [Ilzetzki et al. \(2022\)](#).

To estimate the dynamic impact of U.S. monetary policy shocks on UIP deviations, we use local

<sup>6</sup>AE: Australia Canada Switzerland Czech Republic Denmark United Kingdom Hong Kong Special Administrative Region, People’s Republic of China Israel Japan Korea, Republic of Norway New Zealand Singapore Slovak Republic Sweden United States, list EME: Argentina Brazil Chile China, People’s Republic of Colombia Hungary Indonesia India Mexico Malaysia Peru Philippines Poland, Republic of Russian Federation Thailand Tunisia Türkiye, Republic of Uruguay South Africa)

Figure 3: Average Net FX Position and UIP Deviations



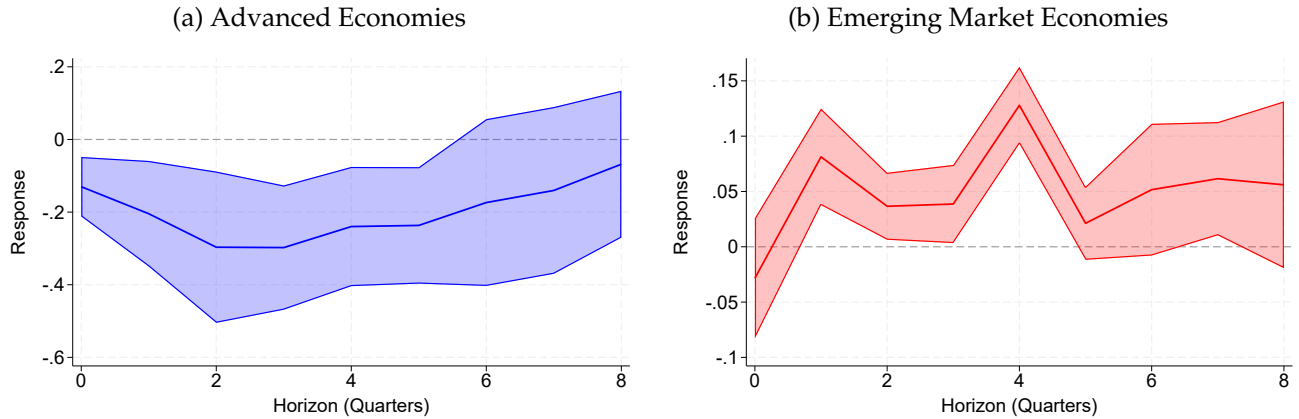
projections following [Jordà \(2005\)](#). For each horizon  $h = 0, \dots, 8$  we estimate

$$y_{c,t+h} = \alpha_c + \beta_h \cdot \text{MP}_t^{\text{US}} + \sum_{i=1}^4 \eta_i \cdot x_{c,t-i} + \varepsilon_{c,t+h} \quad (2)$$

where  $y_{c,t+h}$  is the UIP deviation,  $\text{MP}_t^{\text{US}}$  is the U.S. monetary policy shock  $x_{c,t-i}$ , includes lags of the dependent variable, inflation differentials relative to the U.S., and GDP growth,  $\alpha_c$  denotes country fixed effects. Real GDP data are taken from the World Economic Outlook and consumer price indices from the IFS. For identification, we rely on high-frequency monetary policy surprises constructed around FOMC announcements, orthogonalized following [Bauer and Swanson \(2023\)](#) to remove predictable components driven by publicly available macroeconomic information prior to each announcement. Specifically, the orthogonalized surprises remove predictable components by purging the raw series of first principal component of 30-minute changes in money market futures rates of the variation explained by publicly available economic and financial information prior to the announcements, yielding a cleaner measure of the new information conveyed by monetary policy decisions. The identifying assumption is that policy actions are predetermined within the announcement window and thus orthogonal to contemporaneous macroeconomic and financial conditions.

Figure 4 presents the baseline results. There is a clear contrast between emerging market economies and advanced economies. In EMEs, a positive U.S. monetary policy shock leads to a significant increase in UIP deviations. In contrast, for advanced economies, the response of UIP deviations to a U.S. monetary policy shock is negative.

Figure 4: Local Projections: UIP Deviation Response to MP Shock

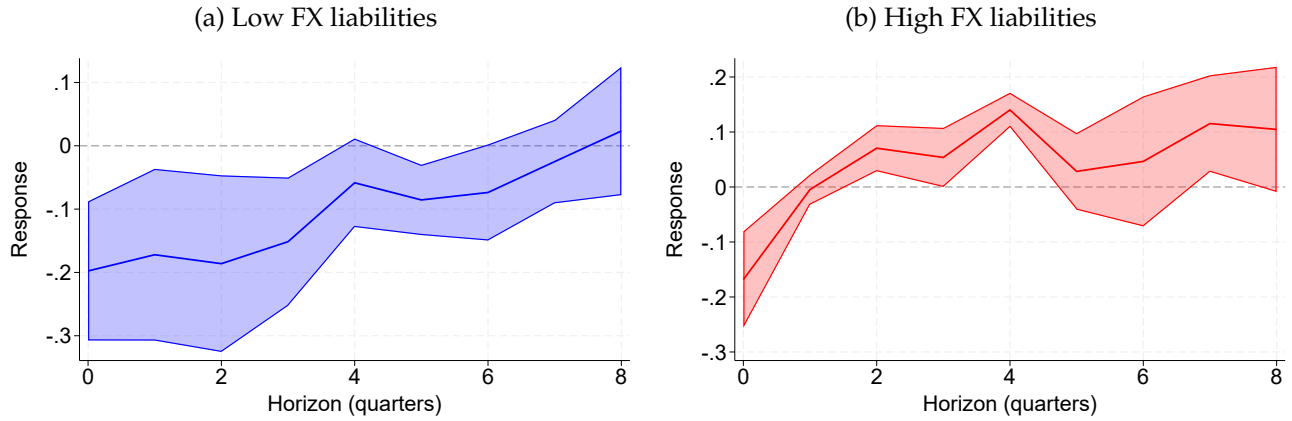


To investigate the mechanisms behind this asymmetry, we examine whether banks' balance sheet exposure to foreign currency risk shapes the heterogeneous transmission documented above. To capture the extent of exposure, we construct a country-level measure equal to the share of time a country's banking sector is in a net short FX position. This measure reflects how frequently banks operate under conditions of currency mismatch. We then split countries at the median of this distribution (computed among countries that exhibit some short FX exposure): those with a higher frequency of short FX positions are classified as high balance sheet constraint (high BSC) countries, while those with lower frequency or no short FX exposure are classified as low BSC countries.

Figure 5 presents the split-sample results. The responses within each group are not straightforward to interpret in isolation. Countries with high BSC display a response that starts negative on impact, recovers over the following quarters, and turns positive in the short to medium run before subsiding. Countries with low BSC also start negative but remain so for longer, with a more gradual recovery. The difference in the shape and timing of these responses across groups is suggestive of heterogeneous transmission, but the individual IRFs do not cleanly isolate the role of balance sheet exposure on their own.

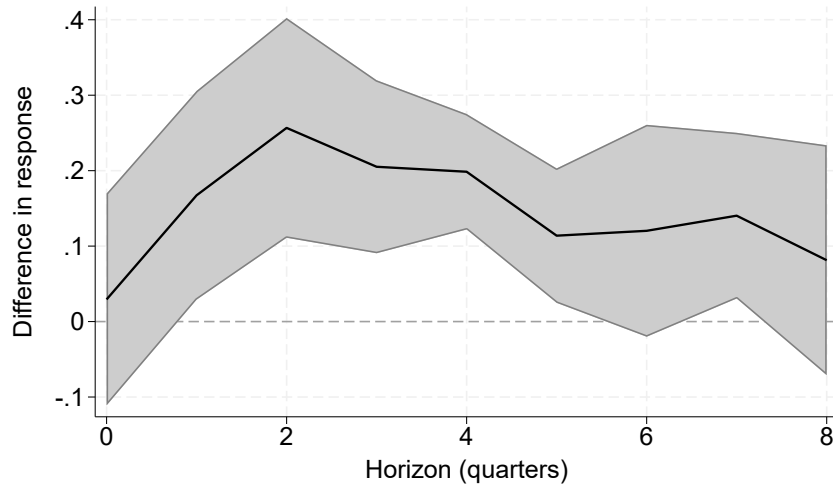
Figure 6 addresses this by plotting the differential IRF, defined as the difference between the high and low BSC impulse responses at each horizon. This differential is positive and statistically significant in the periods immediately following the shock, peaking in the first couple of quarters before gradually declining and becoming indistinguishable from zero after about 6 quarters. The differential isolates the incremental effect of balance sheet exposure: conditional on the common factors driving both groups, countries with greater short FX positions in their banking sector experience a systematically larger increase in UIP deviations following a U.S. monetary tightening. This is consistent with a balance sheet amplification channel in which exchange rate depreciation erodes banks' net worth and raises the risk premium embedded in UIP deviations, a mechanism that is weaker or absent in

Figure 5: Local Projections: UIP Response to MP Shock by Short FX



economies where banks are hedged or long FX.

Figure 6: Differential UIP Response to MP Shock: High vs Low Short FX



Together, these findings establish two empirical facts that discipline our theoretical framework. First, U.S. monetary policy shocks lead to an increase in UIP deviations in EMEs and a decrease in AEs. Second, across all countries, this response is stronger among those whose banking sectors carry significant short FX positions, pointing to balance sheet exposure as a key driver of heterogeneous transmission. Both facts directly motivate the model developed in the next section.

### 3 Modeling approach

Section 2 showed that U.S. monetary tightening raises UIP deviations in emerging markets and that the response is stronger when banks hold larger short foreign currency positions. The purpose of

this section is to introduce a common framework that nests the environments studied in Section 4 and Section 5 and isolates the mechanism governing the response of the UIP premium to a foreign interest rate shock. In the model, the UIP premium is the theoretical counterpart of the empirical UIP deviation: it is the wedge between domestic lending returns and the effective domestic-currency cost of foreign funding.

This section proceeds in three steps. First, it describes the common financial structure shared by all the models in the paper. Second, it defines equilibrium in the domestic credit market and introduces the key elasticities that summarize demand and supply responses. Third, it derives a general equilibrium representation that decomposes the UIP premium response into direct and indirect effects.

### 3.1 General model structure

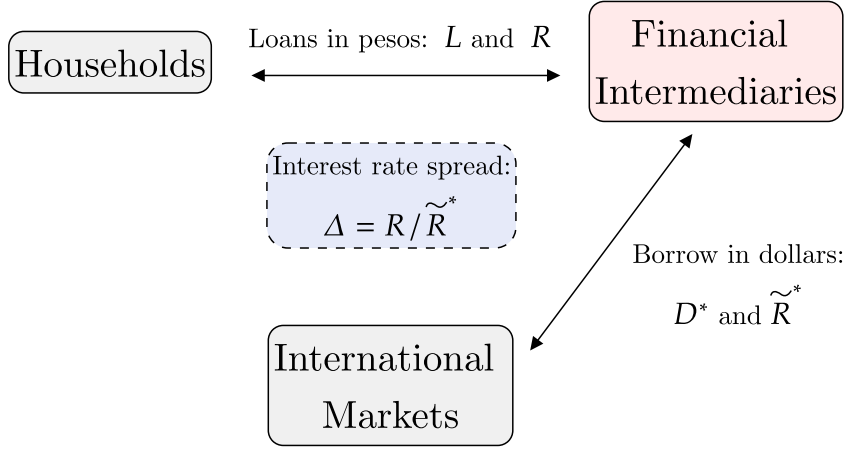
All models in the paper share the same intermediation structure. Households borrow domestically from financial intermediaries. Intermediaries fund themselves in international markets and transform foreign funding into domestic credit. The key price that links both sides is the UIP premium, defined as the wedge between the domestic lending return and the effective foreign funding cost measured in domestic currency. This wedge summarizes the degree of financial segmentation in the economy.

This representation is useful because it nests both environments studied later in the paper. In the benchmark model without exchange-rate revaluation, the effective foreign funding cost is pinned down by the foreign interest rate. In the richer model with foreign-currency liabilities, that funding cost also depends on exchange-rate movements, since exchange-rate changes revalue the domestic-currency cost of banks' foreign debt.

Figure 7 summarizes this common structure. Households borrow in domestic currency from financial intermediaries, with the quantity of loans denoted by  $L$  and the corresponding lending rate by  $R$ . Financial intermediaries, in turn, obtain funding from international markets by borrowing abroad, with foreign debt denoted by  $D^*$  and the corresponding effective borrowing cost by  $\tilde{R}^*$ .

We formulate equilibrium from the perspective of the domestic credit market. This is mainly a matter of analytical convenience. Since intermediaries connect domestic borrowers with foreign lenders, the same allocation can also be characterized from the external funding market. We focus on the domestic credit market because it provides the clearest lens for studying how foreign shocks pass through to local borrowing conditions, credit, and UIP premia.

Figure 7: Model structure



### 3.2 The domestic credit market model

Throughout the paper, time is indexed by  $t = 0, 1, \dots, T \in \mathbb{N} \cup \{\infty\}$ . For any variable  $z$ , let  $z_t \equiv \{z_{t+s}\}_{s=0}^{T-t}$  denote its path from date  $t$  onward. To simplify notation, we write  $z \equiv z_0$  for the date-0 path and  $z_+ \equiv z_1$  for the path starting at date 1.

We now formalize the competitive equilibrium concept used throughout the paper. Given a path for foreign interest rates, equilibrium can be described in three blocks. First, households generate a demand for domestic credit. Second, banks generate a supply of domestic credit by borrowing abroad and lending at home. Third, the exchange-rate block maps domestic returns into the real exchange rate. A competitive equilibrium is therefore a path of UIP premia such that domestic credit demand equals domestic credit supply period by period.

To capture both classes of models, let the effective foreign funding cost be denoted by  $\tilde{R}_{t+1}^* \equiv \mathcal{R}(R_{t+1}^*, E_{t+1}/E_t)$  where  $R_{t+1}^*$  is the foreign interest rate from period  $t$  to period  $t+1$  and  $E_t$  is the real exchange rate. In models without exchange-rate movements, this object is simply the foreign borrowing cost expressed in domestic currency. In models with exchange-rate movements, it also reflects the effect of exchange-rate changes on the domestic-currency cost of foreign debt. The UIP premium is then defined as the wedge between the domestic lending rate and this effective foreign funding cost,  $\Delta_{t+1} = R_{t+1}/\tilde{R}_{t+1}^*$  where  $R_{t+1}$  is the domestic interest rate from period  $t$  to period  $t+1$ .

**Credit demand.** Credit demand is represented by a schedule  $\mathcal{L}_t^d(\mathbf{R}_+, \mathbf{E})$  for all  $t = 0, 1, \dots, T-1$ , which depends on the relevant sequence of domestic borrowing conditions and, in the richer environment, on the exchange rate.

**Credit supply.** Credit supply is represented by a schedule  $\mathcal{L}_t^s(\Delta_+, \tilde{\mathbf{R}}_+, E_0)$  for all  $t = 0, 1, \dots, T - 1$ , which depends on the UIP premium, on effective foreign funding costs, and potentially on the initial exchange rate through balance-sheet effects.

**Exchange rate.** The exchange-rate block closes the system by linking domestic returns and the exchange rate,  $\mathcal{E}_t(\mathbf{R}_+)$  for all  $t = 0, 1, \dots, T$ .

This formulation is deliberately general. It allows the demand side to depend on domestic interest rates and exchange-rate movements, and it allows the supply side to depend on the UIP premium, the effective foreign funding cost, and the initial exchange rate. The benchmark model in Section 4 and the balance-sheet model in Section 5 differ in how these objects are pinned down, but both fit into the same equilibrium structure.

**Competitive equilibrium.** Given these objects, equilibrium requires that, for each date  $t$ , the quantity of loans demanded by households equals the quantity of loans supplied by intermediaries. Thus, a competitive equilibrium is a path for the UIP premium such that, given the exogenous path for the foreign interest rate, the credit market clears. Formally, given  $\mathbf{R}_+$ , the equilibrium path  $\Delta_+$  solves

$$\mathcal{L}_t^d(\mathbf{R}_+, E) = \mathcal{L}_t^s(\Delta_+, \tilde{\mathbf{R}}_+, E_0) \text{ for all } t = 0, \dots, T - 1 \quad (3)$$

where  $E_t = \mathcal{E}_t(\mathbf{R}_+)$ ,  $R_{t+1} = \Delta_{t+1} \tilde{R}_{t+1}^*$ , and  $\tilde{R}_{t+1}^* \equiv \mathcal{R}(R_{t+1}^*, E_{t+1}/E_t)$ .

To study how the equilibrium reacts to foreign monetary shocks, we summarize the demand and supply schedules with semi-elasticities. On the demand side,  $\mathbf{D}_{t,k}^r \equiv \frac{\partial \mathcal{L}_t^d}{\partial R_{k+1}} R_{k+1}$  measures the response of credit demand at date  $t$  to the domestic interest rate at date  $k + 1$ , while  $\mathbf{D}_{t,k}^e \equiv \frac{\partial \mathcal{L}_t^d}{\partial E_k} E_k$  measures the response of credit demand to the exchange rate at date  $k$ . On the supply side,  $\mathbf{S}_{t,k}^\delta \equiv \frac{\partial \mathcal{L}_t^s}{\partial \Delta_{k+1}} \Delta_{k+1}$  measures the response of credit supply to the UIP premium,  $\mathbf{S}_{t,k}^r \equiv \frac{\partial \mathcal{L}_t^s}{\partial R_{k+1}^*} R_{k+1}^*$  measures the response to effective foreign funding costs, and  $\mathbf{b}\mathbf{s}_t \equiv \frac{\partial \mathcal{L}_t^s}{\partial E_0} E_0$  captures the response to the initial exchange rate through balance-sheet revaluation. The last object is central in what follows because it captures shifts in bank credit supply driven by changes in intermediary net worth rather than by standard carry incentives alone.

For matrix notation, collect the semi-elasticities into matrices, so let  $\mathbf{Z} \equiv [\mathbf{Z}_{t,k}]$  for any set of elasticities  $\mathbf{Z}_{t,k}$ . Under this notation, the upper (lower) triangular block of these matrices captures the forward-looking (backward-looking) component of the corresponding schedule.

### 3.3 General equilibrium effects

We now study the response of the equilibrium to small unexpected changes in the foreign interest rate. The object of interest is the path of the UIP premium following that shock. The challenge is that

the shock can operate through several channels at once: it affects domestic borrowing conditions, it changes the effective cost of foreign funding, and, when exchange rates move, it may also affect intermediary balance sheets. The matrix representation below is useful because it organizes these channels in a compact way. We define  $x_t \equiv \frac{\partial X_t}{X_t}$  as the percentage changes of variable  $X_t$  at time  $t$ . Then, we are interested in characterizing the equilibrium path  $\delta_+$  for an exogenously given  $r_+^*$ .

**Lemma 1.** *The path of the real exchange rate can be written as*

$$e = E \cdot (\delta_+ + r_+^*) \quad (4)$$

where  $E$  is a matrix that depends on the elasticities of  $\mathcal{E}_t(\cdot)$ . Moreover,  $r_+ = (\mathbf{I} + \mathbf{FE})(\delta_+ + r_+^*)$  and  $\tilde{r}_+^* = \mathbf{FE}\delta_+ + (\mathbf{I} + \mathbf{FE})r_+^*$  where  $F$  is a first-order difference matrix defined in Appendix A.1.

Lemma 1 shows that exchange-rate movements can be written as a linear function of the joint path of UIP premia and foreign interest rates. This is useful because it allows all exchange-rate effects to be substituted into the credit-market equilibrium conditions. As a result, the problem can be summarized in terms of how foreign shocks shift credit demand and credit supply, both directly and indirectly through the exchange rate.

Perturbing the system around an equilibrium state yields

$$\mathbf{S}^\delta \cdot \delta_+ + \mathbf{S}^{r^*} \cdot \tilde{r}_+^* + \mathbf{bs} \cdot e_0 = \mathbf{D}^r \cdot r_+ + \mathbf{D}^e \cdot e. \quad (5)$$

In our discussion below,  $\mathbf{bs}$  plays an important role as it generates credit supply shifts that cannot be obtained with standard models. Combining (5) and (4) leads to the following lemma.

**Lemma 2.** *Let  $\mathbf{D} \equiv \mathbf{D}^r(\mathbf{I} + \mathbf{FE}) + \mathbf{D}^e\mathbf{E}$ ,  $\mathbf{S} \equiv \mathbf{S}^\delta + \mathbf{S}^{r^*}\mathbf{FE} + \mathbf{bsE}_{0,\bullet}$ , and  $\mathbf{X} = \mathbf{S}^{r^*}(\mathbf{I} + \mathbf{FE}) + \mathbf{bsE}_{0,\bullet}$  where  $\mathbf{E}_{0,\bullet}$  is the first row of matrix  $\mathbf{E}$ . Moreover, let  $\mathbf{M} \equiv \mathbf{S}^{-1} \cdot \mathbf{D}$  and suppose  $\mathbf{I} - \mathbf{M}$  is invertible. Then, the equilibrium response of interest rate spreads is pinned down by*

$$\delta_+ = \mathbf{G} \cdot r_+^* \quad \text{with} \quad \mathbf{G} \equiv \tilde{\mathbf{M}} \cdot \mathbf{H} \quad (6)$$

where  $\tilde{\mathbf{M}} \equiv (\mathbf{I} - \mathbf{M})^{-1} \mathbf{M}$  where  $\mathbf{H} \equiv \mathbf{I} - \mathbf{D}^{-1}\mathbf{X}$ .

Lemma 2 shows that the response of the UIP premium depends on relative elasticities. Matrix  $\mathbf{D}$  summarizes how a foreign interest rate shock affects credit demand, both directly through domestic borrowing conditions,  $\mathbf{D}^r$ , and indirectly through exchange-rate movements affecting credit conditions,  $\mathbf{D}^r\mathbf{FE}$ , and the trade balance,  $\mathbf{D}^e\mathbf{E}$ . Matrix  $\mathbf{S}$ , by contrast, summarizes how changes in the UIP premium affect credit supply, directly,  $\mathbf{S}^\delta$ , and indirectly by exchange-rate movements affecting the effective foreign funding cost,  $\mathbf{S}^{r^*}\mathbf{FE}$ , and the balance-sheet channel,  $\mathbf{bsE}_{0,\bullet}$ . Similarly,  $\mathbf{X}$  captures the direct effect of foreign shocks on credit supply. The sign of the UIP response therefore depends

on whether the contraction in credit demand or the contraction in credit supply dominates at each horizon.

Notice that the  $k$ -th column of this matrix  $\mathbf{G}$ , say  $\mathbf{G}_{\bullet,k}$ , denotes the impulse response function for a news shock of a temporary movement in foreign interest rate at date  $k + 1$ . As we are interested in characterizing matrix  $\mathbf{G}$ , Lemma 2 suggests that the key object is the matrix of relative elasticities  $\mathbf{M}$ . The key equilibrium object is  $\tilde{\mathbf{M}}$  which captures the general equilibrium dynamic interactions.

**Lemma 3.** Let  $\max_t \sum_{j \neq t} \frac{|M_{t,j}|}{|1 - M_{t,t}|} < 1$ . Up to second-order approximation, the matrix  $\tilde{\mathbf{M}}$  is characterized by

$$\tilde{\mathbf{M}}_{t,k} \simeq \frac{1}{1 - \mathbf{M}_{t,t}} \times \left[ \underbrace{\frac{\mathbf{M}_{t,k}}{1 - \mathbb{1}_{k \neq t} \cdot \mathbf{M}_{k,k}}}_{\text{Direct effect}} + \underbrace{\sum_{j \neq t,k} \frac{\mathbf{M}_{t,j} \mathbf{M}_{j,k}}{(1 - \mathbf{M}_{j,j})(1 - \mathbf{M}_{k,k})}}_{\text{Indirect effect}} \right]. \quad (7)$$

Moreover, for an upper or lower triangular matrix  $\mathbf{M}$ , the matrix  $\tilde{\mathbf{M}}$  inherits this property and equation (7) is exact for  $k \in \{t - 2, t - 1, t, t + 1, t + 2\}$ .

Lemma 3 provides the key economic decomposition of the equilibrium response captured in  $\tilde{\mathbf{M}}$ . Direct effects capture how the UIP premium responds at a given date when one looks only at that market in isolation. For instance,  $\mathbf{M}_{t,t}$  measures the static responses of  $\delta_{t+1}$  to movements to  $r_{t+1}^*$ . Indirect effects capture the propagation of the shock through other dates and state variables. For example,  $\frac{\mathbf{M}_{t,j} \mathbf{M}_{j,t}}{(1 - \mathbf{M}_{j,j})(1 - \mathbf{M}_{t,t})}$  measures the roundabout effect of  $r_{t+1}^*$  on  $\delta_{t+1}$  operating through changes in  $\delta_{j+1}$ . This is where dynamics matter. A model with little intertemporal propagation behaves essentially like a static model. A model with strong intertemporal linkages can produce richer responses, but the sign of the response depends on which side of the market carries the relevant state variable. In this paper, the crucial state variable is intermediary net worth.

**Example.** In a two-period credit market model (i.e.,  $T = 2$ ),

$$\tilde{\mathbf{M}}_{t,t} = \frac{1}{1 - \mathbf{M}_{t,t}} \left[ \mathbf{M}_{t,t} + \frac{\mathbf{M}_{0,1} \mathbf{M}_{1,0}}{(1 - \mathbf{M}_{0,0})(1 - \mathbf{M}_{1,1})} \omega \right] \quad \text{and} \quad \tilde{\mathbf{M}}_{t,k} = \frac{\mathbf{M}_{t,k}}{(1 - \mathbf{M}_{0,0})(1 - \mathbf{M}_{1,1})} \omega \quad (8)$$

where  $\omega \equiv \left[ 1 - \frac{\mathbf{M}_{0,1} \mathbf{M}_{1,0}}{(1 - \mathbf{M}_{0,0})(1 - \mathbf{M}_{1,1})} \right]^{-1}$  is the correcting factor. Approximation (7) works well as long as  $\omega \simeq 1$ .<sup>7</sup>□

Although we need further structure to fully characterize  $\mathbf{G}$ , a natural regularity condition is that the demand schedule is “downward sloping” and supply schedule is “upward sloping”.

**Assumption 1.** The demand and supply of credit are such that  $\mathbf{D}_{t,k} \leq 0 \leq \mathbf{S}_{t,k}$  for all  $t \leq k$ .

<sup>7</sup>Equivalently, matrix  $\mathbf{M}$  has a strong diagonal dominance which is the assumption in Lemma 3.

Under Assumption 1, it follows that upper triangular blocks of  $\mathbf{D}$  and  $\mathbf{S}$  are nonpositive and nonnegative, respectively. Next, we characterize  $\mathbf{G}$  under different market structures. We argue that most of the models considered in this paper satisfy this well-behaved assumption. Throughout this paper, we assume that matrix  $\mathbf{S}$  and  $\mathbf{D}$  are invertible.

The framework above already suggests the main message of the paper. If a foreign interest rate shock primarily reduces domestic credit demand, the UIP premium tends to fall after a foreign tightening. Reversing that prediction requires supply-side forces that offset or dominate this effect. Section 4 and Section 5 study that issue in two steps. Section 4 shuts down exchange-rate revaluation and shows that static or myopic intermediation is generally not enough to produce the empirical response. Section 5 then reintroduces exchange-rate movements and foreign-currency liabilities, generating a balance-sheet channel through intermediary net worth that can raise the UIP premium after a foreign tightening.

## 4 A model without balance-sheet effects

This section studies a benchmark environment without exchange-rate revaluation. In this case, the effective foreign funding cost is pinned down by the foreign interest rate, so the UIP premium is simply the wedge between the domestic lending return and the foreign borrowing cost. This benchmark is useful because it isolates the core intermediation structure linking domestic borrowers, intermediaries, and foreign lenders, without the additional amplification that operates through intermediary net worth.

The goal of the section is to ask whether dynamic demand or dynamic supply alone can generate the positive UIP response observed in the data. The answer is generally no. Once exchange-rate revaluation is shut down, a rise in the foreign interest rate tends to lower the UIP premium. We show this first in a reduced-form environment and then in a microfounded model.

### 4.1 Some general results

Absent exchange-rate movements, the effective foreign funding cost equals the foreign interest rate. Competitive equilibrium is therefore determined by a path for the UIP premium such that domestic credit demand equals domestic credit supply at each date. Using the notation from Section 3, the framework studied in this section is one where the exchange-rate block is one with  $E = \mathbf{0}$  and  $\tilde{\mathbf{R}}_+^* = \mathbf{R}_+^*$ , and semi-elasticity matrices are given by  $\mathbf{D} = \mathbf{D}^r$ ,  $\mathbf{S} = \mathbf{S}^\delta$ , and  $\mathbf{X} = \mathbf{S}^{r^*}$ .

This benchmark isolates a simple question: if a rise in the foreign interest rate affects domestic borrowing conditions only through the credit market, what happens to the UIP premium? The basic

force is straightforward. For a given premium, a higher foreign interest rate raises the domestic lending rate and depresses household credit demand. Unless credit supply shifts strongly in the opposite direction, market clearing requires the UIP premium to fall.

**Static supply model.** Consider an economy where  $\mathbf{X} = \mathbf{0}$  and  $\mathbf{S}$  is a diagonal matrix, i.e.,

$$\mathbf{S} = \text{diag}(\mathbf{S}_{0,0}, \mathbf{S}_{1,1}, \dots, \mathbf{S}_{T-1,T-1}) \quad (9)$$

but the demand block matrix  $\mathbf{D}$  is only restricted by Assumption 1. This economy captures models with fully fledged dynamic consumers, but static or myopic banks. These are the more popular models in the open macro literature explaining UIP deviations and their dynamics, so this is a good starting point.

**Proposition 1.** *Suppose  $\mathbf{S}$  is diagonal (as in (9)) and Assumption 1 holds. Then, for all  $k \geq t$ ,  $\mathbf{G}_{t,k} \leq 0$  if*

$$\sum_{j \neq t,k} \frac{\mathbf{M}_{t,j} \mathbf{M}_{j,k}}{(1 - \mathbf{M}_{j,j})(1 - \mathbf{M}_{k,k})} < \frac{|\mathbf{M}_{t,k}|}{1 - \mathbf{1}_{k \neq t} \cdot \mathbf{M}_{k,k}}. \quad (10)$$

*Moreover, if  $\mathbf{D}$  is upper triangular, then both the impact response and the one period ahead anticipated response are negative, i.e.,  $\mathbf{G}_{t,t}, \mathbf{G}_{t,t+1} < 0$ .*

Proposition 1 formalizes the static logic of the benchmark. When banks are static or myopic, foreign tightening reduces domestic credit demand at the prevailing premium and generates excess supply in the domestic credit market. The equilibrium adjustment is therefore a decline in the UIP premium. This is the basic benchmark prediction that the rest of the section keeps coming back to.

**Fully static model.** As a special case, suppose demand is also static (i.e.,  $\mathbf{D}$  is diagonal too), so both sides of the credit market respond only contemporaneously. Proposition 1 implies that interest rate spreads always respond in the opposite direction of the foreign interest rate movement. This fully static benchmark makes the sign of the result transparent: a higher foreign rate reduces credit demand at the prevailing spread, creates excess supply in the domestic credit market, and therefore requires a lower equilibrium spread.

**A two-period model.** The important question is whether dynamics alone can overturn this result. The two-period case is useful because it shows exactly where such a reversal could come from. If supply remains static, then the only candidate force is a sufficiently strong intertemporal feedback from the demand side. That is a very restrictive route to getting a positive response, and the discussion below shows why.

Proposition 1 is particularly powerful in a two-period setting. The first part of this proposition suggests that a forward-looking dynamic block is not enough to generate a positive response of

interest rate spreads. So if anything, in the two-period dynamic model, the only way to obtain positive responses in  $\delta_{t+1}$  is by a backward-looking component of  $\mathbf{D}$ .

Let us suppose that the economy is such that  $\mathbf{D}$  is a full matrix. As we maintain the assumption that  $\mathbf{S}$  is diagonal, the relative-elasticity matrix is given by  $\mathbf{M}_{t,k} = \frac{\mathbf{D}_{t,k}}{\mathbf{S}_{t,t}}$  for all  $t, k$ . Based on (7), we know that  $\mathbf{G}_{t,k} \leq 0$  iff  $\mathbf{D}_{t,k} \leq 0$  for  $k \neq t$ , while  $\mathbf{G}_{t,t} < 0$  if

$$\frac{\mathbf{M}_{0,1}\mathbf{M}_{1,0}}{(1 - \mathbf{M}_{0,0})(1 - \mathbf{M}_{1,1})} < |\mathbf{M}_{t,t}|.$$

Since  $\mathbf{M}_{0,1} < 0$ , the only problematic case is when  $\mathbf{M}_{1,0} < 0$  which may emerge when the demand system is heavily backward-looking.

## 4.2 A microfounded model

The reduced-form analysis shows that dynamics do not automatically overturn the benchmark sign. We now make that result more concrete in a simple microfounded model. The purpose is not yet to introduce the balance-sheet mechanism that drives the full model, but to isolate how dynamic borrowing decisions and dynamic intermediation affect the UIP premium when exchange-rate revaluation is absent.

### 4.2.1 Credit demand: Households

There is a representative household that lives for  $T + 1$  periods and values consumption over time. Given an initial debt  $R_0L_{-1}$  and the path for domestic interest rates  $\mathbf{R}_+$ , the household chooses the consumption and borrowing  $\mathbf{C}$  and  $\mathbf{L}$  to maximize

$$\sum_{\tau=0}^T \beta^\tau \frac{C_\tau^{1-\gamma} - 1}{1-\gamma} \quad \text{subject to: } C_\tau + R_\tau L_{\tau-1} = Y + L_\tau$$

for  $\tau = 0, \dots, T$ , where  $\beta \in (0, 1)$  is the subjective discount factor and  $Y_\tau$  the households' endowment income. We constrain households' behavior by the No-Ponzi scheme terminal condition,  $L_T \leq 0$ . The optimality condition is captured by the Euler equation

$$(C_{t+1}/C_t)^\gamma = \beta R_{t+1}. \tag{11}$$

The key implication of the household problem is a credit-demand schedule. In particular, combining (11) and the household's budget constraint leads to  $\mathcal{L}_t^d(\mathbf{R}_+)$ . Thus, borrowing today depends not only on the current lending rate, but also on future lending conditions through the Euler equation. This is the source of dynamic demand in this benchmark model.

## 4.2.2 The supply of credit: Banks

To maintain generality, let us formulate the supply side using the effective cost of foreign borrowing,  $\tilde{R}_t^*$ .

**“Short-run” banks.** We begin with the simplest supply side. Short-run banks behave myopically: they do not accumulate net worth and care only about current carry-trade profits. At each date, they borrow abroad and lend domestically, but their balance-sheet size is limited by an intermediation friction of the [Gabaix and Maggiori \(2015\)](#) type. In this case, the supply of credit is static in the sense that it depends only on the current premium, not on future conditions. At each date  $t = 0, \dots, T - 1$ , their problem is

$$V_t \equiv \max_{L_t} \frac{1}{\tilde{R}_{t+1}^*} (R_{t+1} - \tilde{R}_{t+1}^*) L_t \quad \text{subject to: } \Theta L_t^2 \leq V_t.$$

The solution for this model is simply  $\mathcal{L}_t^s(\Delta_+, \tilde{\mathbf{R}}_+^*) = \Theta^{-1}(\Delta_{t+1} - 1)$ .

**“Long-run” banks.** We next allow banks to be long-lived. This adds two elements to the supply side. First, current lending decisions depend on expected future franchise values, which introduces forward-looking behavior. Second, aggregate net worth evolves over time, which introduces a state variable into credit supply. These are genuine dynamic supply forces, but they are not yet balance-sheet revaluation effects, since exchange-rate movements remain shut down in this section.

Consider a bank that lives up to  $T$  periods, but faces a mortality rate of  $1 - \sigma \in (0, 1)$  each period. To separate some mechanisms in the model, we assume that the subjective survival probability is  $\tilde{\sigma}$  but they never learn about the true probability  $\sigma$ . This is useful to isolate the backward-looking and forward-looking component of the supply side of the economy. Banks start with an initial capital  $N_0$  and rebate all the cumulated financial returns upon death to foreign households. Given any capital  $N_t$ , the balance sheet imposes the restriction

$$L_t = N_t + D_t^* \tag{12}$$

where  $D_t^*$  denotes the debt from foreign households. The evolution of net worth is

$$N_{t+1} = R_{t+1} L_t - \tilde{R}_{t+1}^* D_t^*. \tag{13}$$

We assume that they face a constraint similar to [Gertler and Karadi \(2011\)](#), limiting their intermediation capacity:

$$\Theta L_t \leq V_t(N_t) \tag{14}$$

where  $\Theta$  is the degree of the financial friction and  $V_t(N_t)$  denote the continuation value of a surviving individual bank with capital  $N_t$  at date  $t$ .

*Agency problem.* At the beginning of each period, bankers can act honestly or divert funds from their assets. If bank managers act honestly, assets will be retained until payoffs are realized in the next period, allowing them to repay their liabilities to creditors. Conversely, if bank managers divert funds, those assets are secretly redirected from lending and consumed by their households. To ensure that creditors are willing to supply funds to the banker, any financial arrangement satisfies an incentive constraint:  $V_t \geq \Theta L_t$  where  $V_t$  is the continuation value of banks,  $L_t$  denotes their balance sheet size, and  $\Theta \in (0, 1)$  is the fraction of divertable assets.  $\square$

Given  $V_T = 0$ , the individual bank's problem is: For  $t = 0, \dots, T - 1$ ,

$$V_t(N_t) \equiv \max_{L_t, D_t} \frac{1}{\tilde{R}_{t+1}^*} [(1 - \tilde{\sigma})N_{t+1} + \tilde{\sigma} \cdot V_{t+1}(N_{t+1})]$$

subject to (12), (13), and (14). In Appendix B, we show that the optimal leverage ratio solves:

$$\phi_t = \frac{1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1}}{\Theta - (\Delta_{t+1} - 1)(1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1})}. \quad (15)$$

with the terminal condition  $\psi_T = 0$ . As a result, we can write the optimal leverage ratio as  $\phi_t(\Delta_{t+1})$ .

At the aggregate level, banks exiting the financial market are replaced by a continuum of new bankers with initial capital  $\zeta$ . Therefore, the evolution of the aggregate net worth is

$$N_t = \sigma \tilde{R}_t^* ((\Delta_t - 1)L_{t-1} + N_{t-1}) + (1 - \sigma)\zeta. \quad (16)$$

Using this equation, together with the solution for the leverage ratio, we can write  $\mathcal{L}_t^s(\Delta_+, \tilde{R}_+^*) = \phi_t(\Delta_{t+1}) \cdot N_t(\Delta_+, \tilde{R}_+^*)$ .

The financial dynamics are governed by two parameters. On the one hand,  $\tilde{\sigma}$  controls how strongly individual banks value future franchise profits, and therefore how forward-looking their lending decisions are. On the other hand,  $\sigma$  controls the persistence of aggregate net worth by determining how much of the existing banking sector remains active over time. In this way,  $\tilde{\sigma}$  governs the forward-looking component of supply, while  $\sigma$  governs the backward-looking component through net-worth dynamics.

### 4.2.3 Competitive equilibrium and quantitative exercises

Recall that the competitive equilibrium in this economy is a path for the UIP premium such that, given the path for the foreign interest rate, domestic credit demand equals domestic credit supply at each date. In our quantitative exploration, we use two complementary solution strategies depending on whether the model admits a stationary benchmark. For the infinite horizon models, we compute a steady state and study the response to shocks using a local approximation around that stationary

allocation. Initial debt, interest rates, and the remaining state variables are therefore set at their steady state values, so the resulting impulse responses are best interpreted as local dynamics around the long run benchmark. This exercise is useful for isolating persistence and for decomposing the mechanisms that shape the transmission of shocks near a stationary environment.

For the finite horizon models, no nontrivial steady state is available, so we solve for the full equilibrium path under each parameterization and approximate the responses around that path. To keep the exercises comparable across parameter values, we hold fixed the initial conditions at the artificial infinite horizon steady state corresponding to the benchmark calibration. As a result, the finite horizon exercises should be interpreted as transitional responses under common inherited initial conditions. They capture how alternative parameterizations modify the full equilibrium adjustment path, rather than how the economy behaves locally around each specification's own steady state.<sup>8</sup>

### 4.3 Dynamic demand and static supply

We first ask whether dynamic credit demand, by itself, can overturn the benchmark prediction. Figure 8 reports the response of the UIP premium to a foreign interest rate shock when households are forward-looking but banks remain short-run. This case isolates the role of intertemporal borrowing decisions on the demand side while shutting down dynamic adjustment in intermediary balance sheets and franchise values.

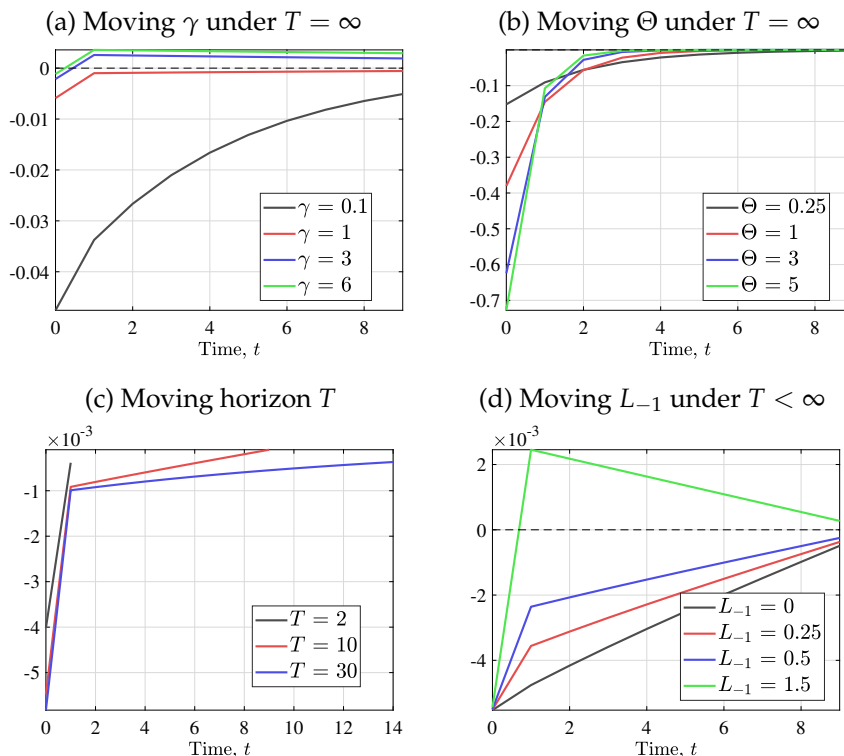
The main result is that dynamic demand, by itself, does not provide a robust explanation for the empirical response of UIP deviations. Across most parameterizations, the UIP premium falls on impact after a rise in the foreign interest rate. The reason is the same benchmark force emphasized above: for a given premium, higher foreign rates raise domestic borrowing costs and reduce credit demand, generating excess supply in the domestic credit market. Market clearing therefore requires a lower premium on impact.

The only case in which the dynamics become less standard is when inherited debt is sufficiently large. In that case, borrowing decisions become more backward-looking, which can generate a hump-shaped or mildly non-monotonic adjustment path and, in some specifications, a temporary positive response at later horizons. But this is not the central margin in the model. Even when debt dynamics make the response more persistent or less monotone, the impact effect remains negative. The conclusion is therefore that dynamic demand can modify the shape of the transition, but it does not overturn the benchmark sign in a robust way.

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<sup>8</sup>In the main text we only discuss a bunch of numerical exercises we explore. In Appendix D, we present additional numerical results.

Figure 8: Dynamic demand and short-run banks



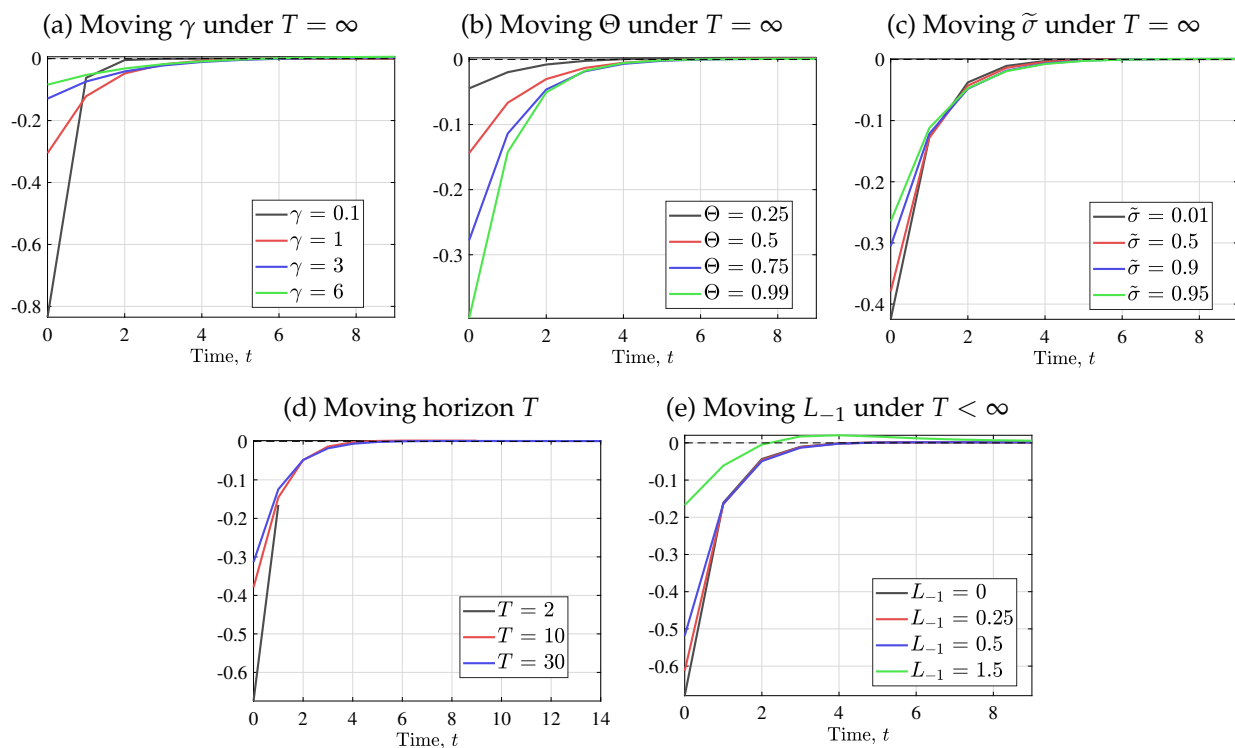
## 4.4 Dynamic demand and dynamic supply

We next allow the supply side to be dynamic as well by introducing long-lived banks that accumulate net worth and value future profits. This extension adds forward-looking behavior to credit supply and introduces net worth as a state variable at the aggregate level. Importantly, however, the model still shuts down exchange-rate revaluation effects, so this subsection isolates dynamic intermediation without the balance-sheet channel that will be central in Section 5.

Figure 9 shows that adding dynamic supply leaves the main qualitative conclusion largely unchanged. After a rise in the foreign interest rate, the UIP premium still falls on impact in every specification and then gradually converges back toward steady state. Relative to the short-run banking case, long-lived banks modify the transition path and can make the response somewhat more persistent, but they do not overturn the benchmark sign.

This is an important negative result for the paper. A forward-looking intermediary sector is not enough, by itself, to generate the positive response of UIP deviations observed in the data. In the class of models studied in this section, the dominant force remains the contraction in domestic credit demand induced by tighter foreign funding conditions. Dynamic supply changes how the economy moves back to equilibrium, but not the basic direction of the initial adjustment. This is precisely

Figure 9: Dynamic demand and “long run” banks



why the next section introduces exchange-rate movements and foreign-currency liabilities: without balance-sheet revaluation, even genuinely dynamic intermediaries are generally unable to match the empirical response.

## 5 A model with balance-sheet effects

This section introduces the mechanism that can overturn the benchmark result from Section 4. Once banks borrow in foreign currency and lend domestically, exchange rate movements affect the domestic currency value of their liabilities and therefore intermediary net worth. A foreign monetary tightening induces a depreciation, worsens banks’ balance sheets, tightens their borrowing capacity, and shifts credit supply inward. As a result, the equilibrium UIP premium can rise after a foreign tightening even though the shock is contractionary. Forward-looking portfolio choice then shapes the persistence and propagation of that initial balance sheet effect.

This mechanism also provides the natural model counterpart to the cross sectional evidence in Section 2. Economies whose banking sectors are more net short in foreign currency are precisely the economies in which a given depreciation produces larger valuation losses, tighter intermediary constraints, and a stronger increase in the UIP premium after a foreign monetary tightening.

## 5.1 Households

There is a representative household that derives utility from consumption of tradable and non-tradable,  $C_t^T$  and  $C_t^N$ . This household gets endowments of each type of goods,  $Y^T$  and  $Y^N$ . The representative household can borrow in short-term assets that are denominated in domestic currency (pesos),  $L_t^{\text{nom}}$ , with a nominal return  $i_t$ . Let  $P_t$  be the consumer price index which is a composite of the price of tradable  $P_t^T$  and nontradable goods,  $P_t^N$ . Given prices and initial bond holdings  $L_{-1}^{\text{nom}}$ , the representative household solves

$$\max_{C^T, C^N, \tilde{L}} \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma} - 1}{1-\gamma}$$

subject to

$$P_t C_t \equiv P_t^T C_t^T + P_t^N C_t^N = P_t^T Y^T + P_t^N Y^N + L_t^{\text{nom}} - (1 + i_{t-1}) L_{t-1}^{\text{nom}}$$

where  $C_t$  is the consumption-basket aggregator

$$C_t = \mathbf{C}(C_t^T, C_t^N) \equiv \left( \omega^{\frac{1}{\eta}} (C_t^T)^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} (C_t^N)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}. \quad (17)$$

**Optimal intratemporal decision and real exchange rate.** The household effectively solves the following intratemporal problem

$$\min_{C_t^T, C_t^N} P_t^T C_t^T + P_t^N C_t^N \quad \text{subject to: } C_t = \mathbf{C}(C_t^T, C_t^N).$$

The first-order condition is  $Q_t \equiv \frac{P_t^T}{P_t^N} = \frac{\partial_T \mathbf{C}(C_t^T, C_t^N)}{\partial_N \mathbf{C}(C_t^T, C_t^N)}$  where  $Q_t$  measures the price of tradable goods relative to the price of nontradable goods. Under the functional form (17), the national price index (i.e., the Lagrange multiplier) is given by  $P_t = (\omega (P_t^T)^{1-\eta} + (1-\omega) (P_t^N)^{1-\eta})^{\frac{1}{1-\eta}}$ .

Tradable goods are homogeneous and there are not trade costs, so that the price of tradable goods verifies the law of one price:  $P_t^T = E_t^{\text{nom}} P_t^{*,T}$  where  $E_t^{\text{nom}}$  denotes the nominal exchange rate and  $P_t^{*,T}$  is the price of tradable goods in the international markets. The rest of the world is infinitely large relative to the domestic economy and foreign households only consume tradable goods, implying that  $P^{*,T} = P^*$ . Thus, the real exchange rate  $E_t \equiv \frac{E_t^{\text{nom}} P_t^*}{P_t}$  is pinned down by

$$E_t = \left( \omega + (1-\omega) Q_t^{\eta-1} \right)^{\frac{1}{\eta-1}} \implies Q_t = \left( \frac{E_t^{\eta-1} - \omega}{1-\omega} \right)^{\frac{1}{\eta-1}} \quad (18)$$

playing the role of the relevant relative price of goods. As a result, the household's intratemporal optimal decisions are characterized by

$$C_t^N = (1-\omega) (E_t/Q_t)^{-\eta} C_t \quad (19)$$

$$C_t^T = \omega E_t^{-\eta} C_t. \quad (20)$$

**Optimal intertemporal decisions.** Given the optimal intratemporal decisions, the budget constraint of the households can be written as

$$C_t = E_t Y^T + \frac{E_t}{Q_t} Y^N + L_t - R_t L_{t-1} \quad (21)$$

where  $L_t \equiv L_t^{\text{nom}}/P_t$  is debt in real terms and  $R_t \equiv \frac{1+i_{t-1}}{P_t/P_{t-1}}$  is the gross real interest rate. As a result, the optimal intertemporal decisions are determined with the standard Euler equation (11) for all  $t$  and the transversality condition,  $\lim_{t \rightarrow \infty} \beta^t C_t^{-\gamma} L_t = 0$ .

## 5.2 Financial intermediaries

All international capital flows are intermediated by specialized financial intermediaries who reside in the foreign country. Relative to the model in Section 4, the UIP deviations now are given by  $\Delta_{t+1} = R_{t+1}/\tilde{R}_{t+1}^*$  where  $\tilde{R}_{t+1}^* \equiv R_{t+1}^* E_{t+1}/E_t$  is the effective cost of foreign funds expressed in domestic currency.

**Individual banks' decisions.** As in the previous section, let  $1 - \sigma$  be the exit rate of an individual bank. To separate some mechanisms in the model, we assume that the subjective survival probability is  $\tilde{\sigma}$  but they never learn about the true probability  $\sigma$ . This is useful to isolate the backward-looking and forward-looking component of the supply side of the economy. Banks start with an initial capital  $N_t$  and rebate all the cumulated financial returns upon death to foreign households. As a result, given  $N_t$ , each bank solves

$$V_t(N_t) \equiv \max_{L_t, D_t} \frac{1}{\tilde{R}_{t+1}^*} [(1 - \tilde{\sigma})N_{t+1} + \tilde{\sigma} \cdot V_{t+1}(N_{t+1})] \quad (22)$$

subject to: (i) the bank's balance sheet:

$$L_t = N_t + E_t D_t^*, \quad (23)$$

(ii) evolution of individual net worth:

$$N_{t+1} = R_{t+1} L_t - R_{t+1}^* E_{t+1} D_t^*, \quad (24)$$

and (iii) the incentive compatibility constraint (14). Thus, the solution is given by the infinite-horizon counterparts for (15), which leads to the recursion for the same recursive equation plus a transversality condition, leading to  $\phi_t(\Delta_{t+1})$ .

**Financial aggregates.** At the aggregate level, banks exiting the financial market are replaced by a continuum of new bankers with initial capital  $\zeta$ . Therefore, the evolution of the aggregate net worth is

$$N_t = \sigma (R_t L_{t-1} - R_t^* E_t D_{t-1}^*) + (1 - \sigma)\zeta.$$

which rearranging leads to (16), but with the real exchange rate implicitly determining the effective cost of foreign funds,  $\tilde{R}_{t+1}^* = R_{t+1}^* E_{t+1} / E_t$ . The key difference relative to the model discussed in Section 4 is that  $\Delta_0$  is no longer exogenous, but it can change through movements in  $E_0$ .

### 5.3 Competitive equilibrium

Given a path of foreign interest rates  $\mathbf{R}_+$ , a competitive equilibrium is given by an allocation  $\{C^T, C^N, L\}$  and price system  $\{\Delta_+, \mathbf{R}_+, E\}$  such that (i) households and financial intermediaries behave optimally, and (ii) markets clear. Two clearing market conditions are central: (a) non-tradable goods  $C_t^N = Y^N$  for all  $t \geq 0$ , and (b) credit markets:  $L_t = L_t^d = L_t^s$  for all  $t \geq 0$ .

We do not write the tradables market clearing condition separately because, once household and intermediary budget constraints are imposed, it is redundant after consolidation with the economy's external borrowing position. The trade balance is therefore determined jointly with intermediated foreign borrowing rather than imposed as an independent equilibrium condition.

**Demand for credit.** In this economy, the non-financial block includes the households' *intertemporal* optimal decisions. That is, the demand for credit is pinned down by (11), (18), and (21). From this system, we can solve the key schedule of this non-financial block,  $\mathcal{L}_t^d(\mathbf{R}_+, E)$ . Relative to Section 4, this demand schedule also depends on the real exchange rate through the valuation of domestic endowments (i.e., trade-balance effects).

**Supply of credit.** We can write the supply side of credit in this economy as

$$\mathcal{L}_t^s(\Delta_+, \tilde{\mathbf{R}}_+, E_0) = \phi_t(\Delta_{t+1}) \cdot N_t(\Delta_+, \tilde{\mathbf{R}}_+, E_0). \quad (25)$$

Note that there are two aspects of the supply of credit in this model relative to the one in Section 4. First, the cost of foreign debt  $\tilde{\mathbf{R}}_+$  is endogenous now as it is affected by the real depreciation rate. Second, the initial exchange rate will affect the credit market conditions through unanticipated balance sheet effects.

**Exchange rate block.** In this model, the exchange rate block is given by the optimal *intratemporal* decisions of households and the *clearing market conditions in the non-tradable goods*. This block, however, is indirectly affected by the intertemporal decisions as we should take the solution for consumption, i.e.,  $C_t = C_t(\mathbf{R}_+, E)$ , as given. Using (19) and the clearing market condition:

$$Y^N = (1 - \omega) (E_t / Q_t)^{-\eta} C_t(\mathbf{R}_+, E) \quad (26)$$

where  $Q_t$  is given by (18). Moreover, using (26), we can get the exchange rate path as a function of the domestic interest rate

$$E_t = \mathcal{E}_t(\mathbf{R}_+). \quad (27)$$

**Competitive equilibrium.** Merging the demand and supply schedule, given the path of foreign interest rate  $\mathbf{R}_+^*$ , the competitive equilibrium is given by  $\Delta_+$  such that (i) the credit markets clear

$$\mathcal{L}_t^s(\Delta_+, \tilde{\mathbf{R}}_+^*, E_0) = \mathcal{L}_t^d(\mathbf{R}_+, E) \text{ for all } t = 0, 1, \dots \quad (28)$$

where  $\tilde{R}_{t+1}^* = R_{t+1}^* \frac{E_{t+1}}{E_t}$  and  $\Delta_{t+1} = R_{t+1} / \tilde{R}_{t+1}^*$ , and (ii) the exchange rate is given by (27). This is the same equilibrium object we introduced in Section 3, so we know how to study the equilibrium responses. The details about the construction of the relevant matrices are in Appendix C.

## 5.4 Studying the responses to foreign interest rate shocks

We study the response of the equilibrium UIP premium  $\Delta_{t+1}$  to unanticipated movements of foreign interest rates,  $\mathbf{R}_+^*$ . We approximate by first-order responses around the steady state equilibrium.

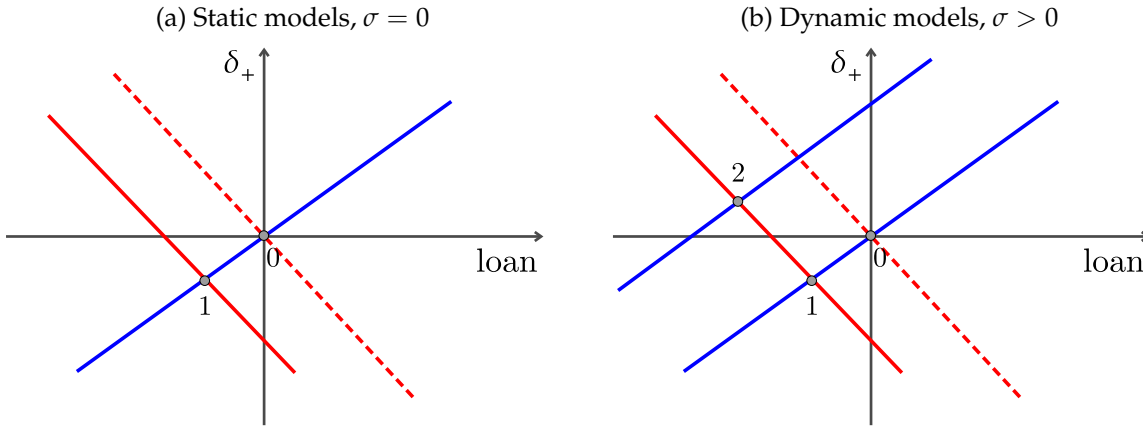
**Proposition 2.** *Consider an unexpected increase in the foreign interest rate at date 0, i.e.,  $r_1^* > 0$  and  $r_{t+1}^* = 0$  for all  $t \geq 1$ . The impact response of the real exchange rate is positive,  $e_0 > 0$ , so the economy depreciates on impact. If balance sheet propagation is weak, then the UIP premium falls as in Section 4,  $\delta_{t+1} < 0$  for all  $t \geq 0$ . By contrast, if leverage and balance sheet propagation are high enough, the UIP premium rises on impact, i.e.,  $\delta_{t+1} > 0$  for  $t = 0, \dots, \tau$  and  $\delta_{t+1} < 0$  for  $t = \tau + 1, \dots$*

Figure 10 summarizes the equilibrium adjustment in the domestic credit market. The red schedule is credit demand and the blue schedule is credit supply. Point 0 denotes the initial equilibrium before a foreign interest rate shock. After a foreign tightening, credit demand shifts inward because the higher foreign rate raises the domestic lending rate for any given UIP premium. In a static model, credit supply does not shift to offset that decline in demand, so the equilibrium UIP premium falls. Graphically, the economy moves from point 0 to point 1, and as a result  $\delta_{t+1} < 0$ .

In the balance sheet model, however, the induced depreciation raises the domestic currency value of banks' foreign liabilities, lowers intermediary net worth, and shifts credit supply inward. If that inward shift is sufficiently strong, the equilibrium moves to a point with a higher UIP premium even though credit and foreign borrowing both fall. For sufficiently strong backward-looking effects, the new equilibrium is given by point 2 rather than point 1. The impact increase in the UIP premium therefore reflects tighter intermediary constraints, not stronger borrowing demand.

Our mechanism is closely related to [Kekre et al. \(2024\)](#)'s analysis of monetary policy and the term structure. They show that in segmented bond markets, policy shocks affect term premia by revaluing

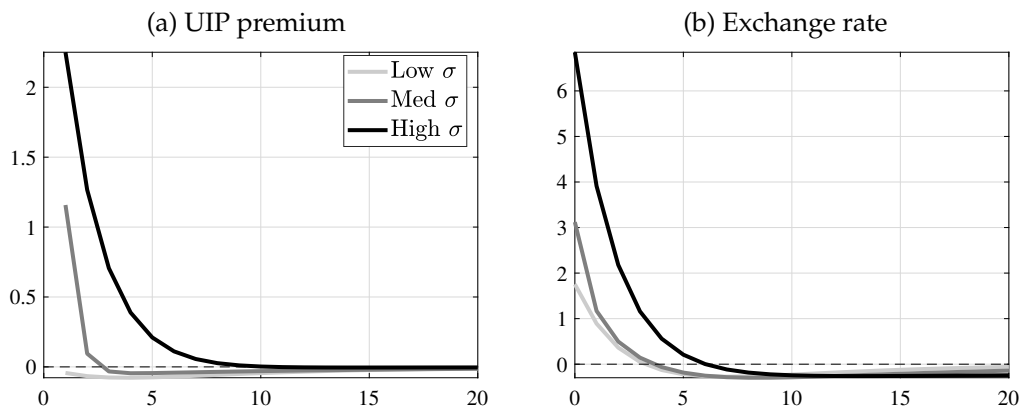
Figure 10: Equilibrium in the credit market in response to foreign interest rate shock



the wealth of duration exposed intermediaries and thereby changing their capacity to bear risk. We apply the same logic to international financial intermediation. In our model, the relevant exposure is foreign currency mismatch rather than duration, so a foreign monetary tightening moves UIP premia by changing exchange rates, intermediary net worth, and the effective supply of cross border funding. This connection helps place our results in a broader asset pricing perspective: both term premia and UIP premium can be understood as endogenous risk premia shaped by intermediary balance sheets, but in our setting the open economy dimension makes currency exposure the key state variable.

**Illustration.** Figure 11 reports the general equilibrium responses to a positive foreign interest rate shock under alternative values of the parameter that governs the degree of backward and forward-looking behavior on the banking supply side. That is, we want to show that Proposition 2 is relevant even in the case where  $\sigma = \tilde{\sigma}$ . Panel (a) shows the response of the UIP premium and panel (b) the exchange rate. Across all specifications, the shock generates a depreciation of the exchange rate, but the response of the UIP premium differs.

Figure 11: General equilibrium responses to foreign interest rate shock



The figure shows that the banking supply parameter is quantitatively important for the transmission of the shock. When the banking side is more affected by past foreign debt decisions, the responses become much stronger: the UIP premium jumps more on impact, the exchange rate depreciates more sharply, and banks reduce their foreign borrowing by more, with the contraction in external funding remaining more persistent over time. However, because this exercise varies backward-looking and forward-looking forces jointly, it is not clear what is the role of each of the mechanisms. Next, we argue that balance sheet channel is the crucial mechanism.

**Decomposing the channels.** To clarify the mechanisms behind the general equilibrium response of the UIP premium, we decompose the impulse responses into economically meaningful components. Let  $z$  denote any equilibrium object of interest, such as the UIP premium or the exchange rate. We first isolate the balance sheet component by comparing the full model response with the response obtained when the balance sheet channel is shut down. Formally, we define the balance sheet effect as  $z^{BS} = z - z|_{bs=0}$  where  $z|_{bs=0}$  is the response when intermediaries are not exposed to balance sheet revaluation effects. This object measures how much of the total response is accounted for by the feedback from exchange rate movements to intermediaries' net worth and borrowing capacity.

The decomposition is most useful for separating sign reversal from propagation. The balance sheet channel is the force that can overturn the benchmark sign from Section 4 by shifting credit supply inward after a depreciation. The forward looking channel mainly governs how that initial effect propagates over time through franchise values and intertemporal portfolio adjustment. In this sense, balance sheet exposure explains why the UIP premium can rise on impact, while forward looking behavior explains why that response can be persistent.

Figure 12: Decomposition of general equilibrium responses to foreign interest rate shocks

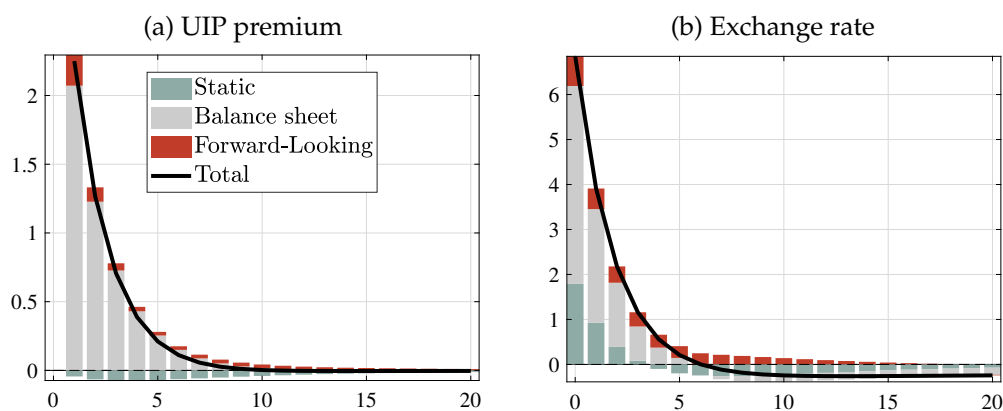


Figure 12 implements this decomposition for the main general equilibrium responses to a foreign interest rate shock. Panel (a) shows the decomposition for the UIP premium and panel (b) for the exchange rate. In each panel, the black line corresponds to the total response, while the stacked bars

separate the contribution of the static, forward looking, and balance sheet channels. This quantitative exercise makes it possible to assess not only whether a given variable responds strongly to the shock, but also which mechanism is responsible for that response at each horizon.

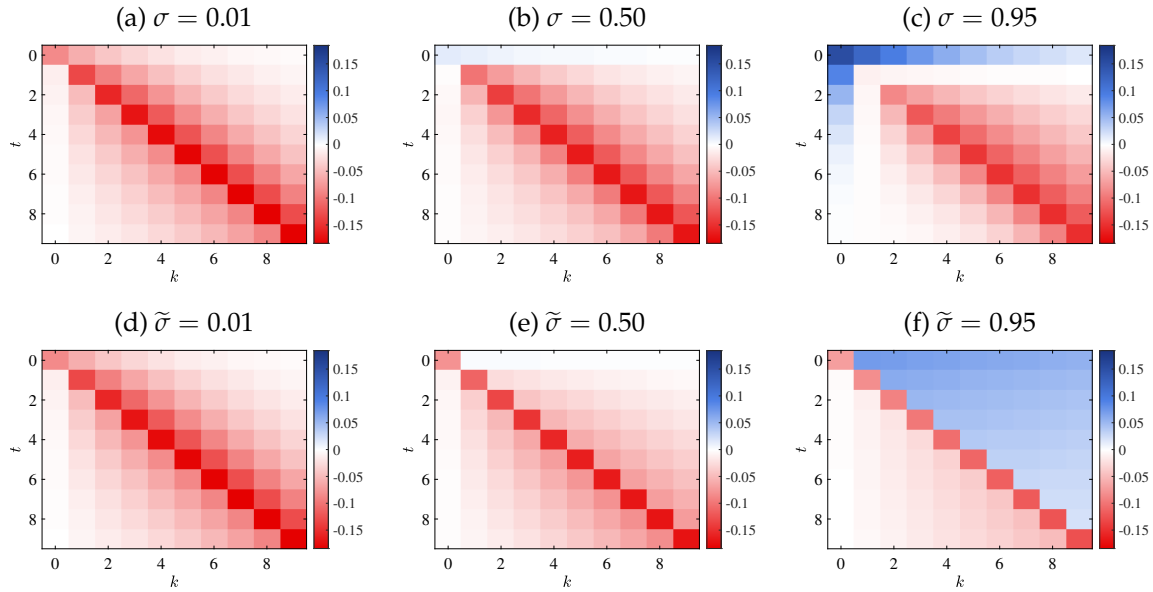
The figure shows that the forward looking channel is a central driver of the dynamics. In both the UIP premium and the exchange rate, the red bars account for an important fraction of the overall response, especially beyond the initial periods, indicating that dynamic portfolio adjustment by intermediaries substantially amplifies the effect of the foreign interest rate shock. The balance sheet channel, shown in light gray, also contributes positively, particularly on impact, but its role is more complementary than dominant in these two variables. There, the decomposition shows that valuation effects on intermediaries' net worth are crucial for understanding the contraction in external borrowing, while forward looking behavior shapes the persistence and gradual adjustment of the response over time. Overall, the decomposition confirms that the rise in the UIP premium after a foreign monetary tightening is not driven by a single mechanism, but by the interaction of a direct static tightening effect, an intertemporal amplification channel, and balance sheet effects operating through the financial sector.

## 5.5 Sensitivity analysis

Proposition 2 emphasizes that the response of the UIP premium depends on the dynamic structure of the financial block. We now illustrate this dependence by varying the parameters that govern banks' intertemporal behavior and net worth dynamics. Figure 13 reports the response matrix of the UIP premium to foreign interest rate shocks under alternative values of  $\sigma$  and  $\tilde{\sigma}$ . The main purpose of this exercise is not to recalibrate the model, but to show more transparently which dynamic margin is responsible for the sign and persistence of the response.

The first row varies  $\sigma$ , the parameter that governs the backward-looking component of the banking block through the persistence of aggregate net worth. When  $\sigma$  is low, the response matrix remains close to the benchmark without meaningful balance sheet propagation: most entries are negative, and the effects of foreign tightening are concentrated around the static component of the adjustment. As  $\sigma$  increases, this pattern changes systematically. The negative diagonal weakens, the response becomes more persistent, and a larger region of the matrix turns positive. Economically, higher persistence in intermediary net worth strengthens the balance sheet channel, since exchange-rate revaluations have longer lasting effects on lending capacity and therefore on the equilibrium UIP premium. In this sense, the figure makes clear that the backward-looking component is not a secondary detail of the model, but an important determinant of whether the balance sheet mechanism is quantitatively strong enough to overturn the benchmark prediction.

Figure 13: Heatmap for elements of the general equilibrium matrix,  $\mathbf{G}$



The second row varies  $\tilde{\sigma}$ , which governs the forward looking component of banks' decisions. Changes in this parameter also affect the shape of the response matrix, especially by amplifying intertemporal spillovers across horizons. However, the comparison with the first row shows that forward looking behavior alone is generally not enough to generate the strongest positive responses. What is more decisive is the interaction between forward looking portfolio choice and sufficiently persistent net worth dynamics. Put differently, anticipated future returns matter for banks' behavior, but their quantitative importance is much larger when the balance sheet effects generated by current exchange rate movements survive into future periods.

Taken together, these exercises reinforce the interpretation of Proposition 2. A model with weak net worth persistence behaves much like the benchmark environment without revaluation effects, in the sense that foreign interest rate shocks mainly depress credit demand and reduce the UIP premium. By contrast, when the banking sector has a sufficiently strong backward-looking component, exchange rate induced changes in intermediary net worth propagate forward and become an important source of amplification. The positive response of the UIP premium then emerges not from a purely static tightening effect, but from the interaction of balance sheet revaluation with the dynamic financial structure of intermediation.

## 6 Concluding remarks

This paper studies how external monetary shocks shape uncovered interest parity deviations in economies with limited financial depth. Empirically, it documents a sharp asymmetry in the transmission of U.S. monetary policy shocks: following a U.S. tightening, UIP deviations rise in emerging market economies but fall in advanced economies, and this differential response is stronger in countries whose banking sectors are more exposed to short foreign currency positions. These findings suggest that balance sheet exposure is not a peripheral feature of the data, but a central determinant of how global financial shocks are transmitted across countries.

More broadly, the paper points to a view of UIP deviations as equilibrium objects shaped by the financial structure of the economy rather than as isolated anomalies in asset pricing. In economies where intermediaries are exposed to currency mismatch and face binding balance sheet constraints, exchange rate movements and credit market conditions become tightly interconnected, and global shocks are amplified through the domestic financial sector. This perspective helps explain why similar external disturbances can have very different effects across countries, and why emerging markets are particularly vulnerable to shifts in global dollar funding conditions.

Several extensions remain for future work. On the empirical side, it would be useful to further distinguish the role of bank exposure from other forms of external vulnerability, including corporate foreign currency borrowing, sovereign balance sheet risk, and differences in hedging capacity. On the theoretical side, a natural next step is to embed the financial block in a fuller quantitative environment with richer nominal rigidities, policy rules, and endogenous risk taking, so as to study not only positive comovement but also optimal stabilization policy. These directions would help clarify how monetary, macroprudential, and foreign exchange policies should jointly respond when global financial shocks interact with domestic balance sheet fragilities.

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# Appendix

## A Proofs

### A.1 Proof of Lemma 1

Whenever the model includes a real exchange rate, it is partially determined by  $E_t = \mathcal{E}_t(\mathbf{R}_+)$ ,  $R_{t+1} = \Delta_{t+1} \tilde{R}_{t+1}^*$ , and  $\tilde{R}_{t+1}^* \equiv \mathcal{R}(R_{t+1}^*, E_{t+1}/E_t)$ . Up to first-order, this system solves

$$e_t = \sum_{k=0}^{T-1} \frac{\partial \mathcal{E}_t}{\partial R_{k+1}} \frac{R_{k+1}}{E_t} \cdot r_{k+1}, \quad r_{t+1} = \delta_{t+1} + \tilde{r}_{t+1}^*, \quad \text{and} \quad \tilde{r}_{t+1}^* = r_{t+1}^* + e_{t+1} - e_t.$$

In matrix form,

$$\mathbf{e} \equiv \tilde{\mathbf{E}} \cdot \mathbf{r}_+ \quad \text{and} \quad \mathbf{r}_+ = \boldsymbol{\delta}_+ + \mathbf{r}_+^* + \mathbf{F} \cdot \mathbf{e}$$

where  $\tilde{\mathbf{E}}_{t,k} = \frac{\partial \mathcal{E}_t}{\partial R_{k+1}} \frac{R_{k+1}}{E_t}$  and  $\mathbf{F}$  is a first-order difference matrix, i.e.,

$$\mathbf{F}_{t,k} = \begin{cases} 1 & k = t + 1 \\ -1 & k = t \\ 0 & \text{otherwise} \end{cases}.$$

Solving this linear equation leads to

$$\mathbf{e} \equiv (\mathbf{I} - \tilde{\mathbf{E}}\mathbf{F})^{-1} \tilde{\mathbf{E}} \cdot (\boldsymbol{\delta}_+ + \mathbf{r}_+^*).$$

Defining  $\mathbf{E} \equiv (\mathbf{I} - \tilde{\mathbf{E}}\mathbf{F})^{-1} \tilde{\mathbf{E}}$  and rearranging yields (4).

### A.2 Proof of Lemma 2

The equilibrium response to foreign interest rate movements satisfies

$$\sum_{k=0}^{T-1} \mathbf{S}_{t,k}^\delta \cdot \delta_{k+1} + \sum_{k=0}^{T-1} \mathbf{S}_{t,k}^{r^*} \cdot \tilde{r}_{k+1}^* + \mathbf{bs}_t \cdot e_0 = \sum_{k=0}^{T-1} \mathbf{D}_{t,k}^r \cdot r_{k+1} + \sum_{k=0}^T \mathbf{D}_{t,k}^e \cdot e_k$$

for all  $t = 0, \dots, T-1$ . Using the matrix formulation together with the real exchange rate block yields the following equilibrium system

$$\begin{aligned} \mathbf{S}^\delta \cdot \boldsymbol{\delta}_+ + \mathbf{S}^{r^*} \cdot \tilde{\mathbf{r}}_+^* + \mathbf{bs} \cdot e_0 &= \mathbf{D}^r \cdot \mathbf{r}_+ + \mathbf{D}^e \cdot \mathbf{e} \\ \mathbf{e} &= \mathbf{E} \cdot (\boldsymbol{\delta}_+ + \mathbf{r}_+^*) \end{aligned}$$

$$\begin{aligned} \mathbf{r}_+ &= (\mathbf{I} + \mathbf{FE}) \cdot (\boldsymbol{\delta}_+ + \mathbf{r}_+^*) \\ \tilde{\mathbf{r}}_+^* &= \mathbf{FE} \cdot \boldsymbol{\delta}_+ + (\mathbf{I} + \mathbf{FE}) \cdot \mathbf{r}_+^* \end{aligned}$$

Solving this linear system

$$\begin{aligned} \mathbf{S}^\delta \cdot \boldsymbol{\delta}_+ + \mathbf{S}^{r^*} (\mathbf{FE} \cdot \boldsymbol{\delta}_+ + (\mathbf{I} + \mathbf{FE}) \cdot \mathbf{r}_+^*) + \mathbf{bsE}_{0,\bullet} \cdot (\boldsymbol{\delta}_+ + \mathbf{r}_+^*) &= \mathbf{D} \cdot (\boldsymbol{\delta}_+ + \mathbf{r}_+^*) \\ \left( \mathbf{S}^\delta + \mathbf{S}^{r^*} \mathbf{FE} + \mathbf{bsE}_{0,\bullet} - \mathbf{D} \right) \cdot \boldsymbol{\delta}_+ &= \left( \mathbf{D} - \mathbf{S}^{r^*} (\mathbf{I} + \mathbf{FE}) - \mathbf{bsE}_{0,\bullet} \right) \cdot \mathbf{r}_+^* \\ (\mathbf{S} - \mathbf{D}) \cdot \boldsymbol{\delta}_+ &= (\mathbf{D} - \mathbf{X}) \cdot \mathbf{r}_+^* \end{aligned}$$

where  $\mathbf{D} \equiv \mathbf{D}^r(\mathbf{I} + \mathbf{FE}) + \mathbf{D}^e\mathbf{E}$  is the matrix for the total foreign-interest-rate elasticity,  $\mathbf{S} \equiv \mathbf{S}^\delta + \mathbf{S}^{r^*} \mathbf{FE} + \mathbf{bsE}_{0,\bullet}$  is the matrix for the total interest-rate-spread elasticity of supply, and  $\mathbf{X} = \mathbf{S}^{r^*} (\mathbf{I} + \mathbf{FE}) + \mathbf{bsE}_{0,\bullet}$  is the matrix for the total foreign-interest-rate elasticity of supply. Premultiplying the resulting system by  $\mathbf{S}^{-1}$  and rearranging yields to the main result in the lemma.

### A.3 Proof of Lemma 3

Define  $\mathbf{M} = \Lambda + \mathbf{U} + \mathbf{L}$  where  $\Lambda$  is the diagonal part,  $\mathbf{U}$  the strictly upper-triangular part and  $\mathbf{L}$  the strictly lower-triangular part. Let  $\tilde{\mathbf{M}} \equiv \tilde{\Lambda} \cdot (\mathbf{U} + \mathbf{L})$  where

$$\tilde{\Lambda} \equiv (\mathbf{I} - \Lambda)^{-1} = \text{diag} \left( \frac{1}{1 - \mathbf{M}_{0,0}}, \frac{1}{1 - \mathbf{M}_{1,1}}, \dots, \frac{1}{1 - \mathbf{M}_{T-1,T-1}} \right)$$

. Thus,

$$(\mathbf{I} - \mathbf{M})^{-1} = (\mathbf{I} - \tilde{\mathbf{M}})^{-1} \tilde{\Lambda} = \sum_{j=0}^{\infty} \tilde{\mathbf{M}}^j \cdot \tilde{\Lambda}.$$

For a second-order approximation we use is  $\mathbf{G} \simeq \tilde{\Lambda}\mathbf{H} + \tilde{\mathbf{M}}\tilde{\Lambda}\mathbf{H} + \tilde{\mathbf{M}}^2\tilde{\Lambda}\mathbf{H}$ . Characterizing the first term is easy:  $(\mathbf{M} - \mathbf{I})_{t,t} = \frac{\mathbf{X}_{t,t}}{1 - \mathbf{X}_{t,t}}$  and  $(\mathbf{M} - \mathbf{I})_{t,k} = 0$  for  $t \neq k$ . The second term  $(\tilde{\mathbf{M}}\tilde{\Lambda})_{t,k} = \tilde{\Lambda}_{t,t}\tilde{\Lambda}_{k,k}(\mathbf{U} + \mathbf{L})_{t,k}$ . The third term is

$$(\tilde{\mathbf{M}}^2\tilde{\Lambda})_{t,k} = \sum_{j=0}^{T-1} \left( \tilde{\Lambda}(\mathbf{U} + \mathbf{L}) \right)_{t,j} \left( \tilde{\Lambda}\mathbf{U} + \mathbf{L} \right)_{j,k} \tilde{\Lambda}_{k,k} = \sum_{j=0}^{T-1} \tilde{\Lambda}_{t,t}\tilde{\Lambda}_{j,j}\tilde{\Lambda}_{k,k}(\mathbf{U} + \mathbf{L})_{t,j}(\mathbf{U} + \mathbf{L})_{j,k}.$$

Adding the first and third terms for  $k = t$  yields  $\mathbf{G}_{t,t}$ . Adding the second and third term for  $k \neq t$  yields  $\mathbf{G}_{t,k}$ . Without loss of generality, suppose  $\mathbf{L} = \mathbf{0}$  so that  $\mathbf{X}$  is upper triangular. As a result,  $\mathbf{N}$  is nilpotent and  $\mathbf{G}$  has ta exact form

$$\mathbf{G} = \mathbf{M} - \mathbf{I} + \mathbf{N}\mathbf{M} + \mathbf{N}^2\mathbf{M} + \dots + \mathbf{N}^{T-1}\mathbf{M}.$$

Since, for a strictly upper triangular matrix  $\mathbf{N}$ , the term  $\mathbf{N}^m\mathbf{M}$  can only affect entries on the  $m$ -th and higher superdiagonals, the exact expression for  $\mathbf{G}_{t,k}$  coincides with its second order approximation for  $k = t, t + 1, t + 2$ , while  $\mathbf{G}_{t,k} = 0$  for all  $k < t$ . The lower triangular case is symmetric. Hence, for an upper or lower triangular matrix  $\mathbf{X}$ , the formula is exact for  $k \in \{t - 2, t - 1, t, t + 1, t + 2\}$ .

## A.4 Proof of Proposition 1

As  $\mathbf{S}$  is diagonal,  $\mathbf{M}_{t,k} = \mathbf{D}_{t,k}/\mathbf{S}_{t,t}$  for all  $t, k$ . Then, the direct effect of  $\mathbf{G}_{t,k}$  is negative and we need to bound the indirect effect properly. if  $\mathbf{D}$  is upper triangular then there is not indirect effects for  $\mathbf{G}_{t,t}$  and  $\mathbf{G}_{t,t+1}$ .

## B Derivations for Section 4

### B.1 Households

There is a representative household that lives for  $T + 1$  periods and derives utility from consuming final goods. Given the initial debt  $R_0 L_{-1}$  and the path for domestic interest rates  $\mathbf{R}_+$ , the household chooses the consumption path  $\mathbf{C}$  to maximize

$$\sum_{\tau=0}^T \beta^\tau \frac{C_\tau^{1-\gamma} - 1}{1-\gamma}$$

subject to

$$C_\tau + R_\tau L_{\tau-1} = Y_\tau + L_\tau \text{ for } \tau = 0, \dots, T$$

where  $\beta \in (0, 1)$  is the subjective discount factor and  $Y_\tau$  the households' endowment income. We constraint households' behavior by the No-Ponzi scheme terminal condition,  $L_T \leq 0$ . Combining all the budget constraints, we can write the lifetime budget constraint as

$$\sum_{\tau=0}^T q_\tau C_\tau = W \equiv \sum_{\tau=0}^T q_\tau Y_\tau - R_0 L_{-1}$$

where  $q_\tau$  is the financial discount factor:  $q_\tau = 1 / \prod_{\tau'=0}^{\tau-1} R_{\tau'+1}$  for all  $\tau = 1, \dots, T$  and  $q_0 = 1$ . The solution to this problem is  $C_\tau = \mathcal{M}_\tau \cdot W$  where  $\mathcal{M}_\tau \equiv \frac{q_\tau^{-1/\gamma} \beta^{\tau/\gamma}}{\sum_{\tau'=0}^T q_{\tau'}^{-1/\gamma} \beta^{\tau'/\gamma}}$  is the marginal propensity to consume at date  $t$  out of wealth. Thus, the demand for credit is given by

$$L_t^d(\mathbf{R}_+) = \sum_{\tau=0}^t \frac{q_\tau}{q_t} \cdot (\mathcal{M}_\tau W - Y_\tau) + \frac{R_0 L_{-1}}{q_t} \text{ for all } t = 0, 1, \dots, T-1 \quad (\text{B.1})$$

To measure the semi-elasticities of credit demand, we need the semi-elasticities of the  $q$ 's variables:

$$\frac{\partial q_\tau}{\partial R_{k+1}} R_{k+1} = \begin{cases} -q_\tau & \tau > k \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad \frac{\partial(q_\tau/q_t)}{\partial R_{k+1}} R_{k+1} = \begin{cases} q_\tau/q_t & \tau \leq k \leq t-1 \\ 0 & \text{otherwise} \end{cases}.$$

Taking first-order derivatives, we can show that the semi-elasticities of demand for credit at date  $t$  with respect to changes in the domestic interest rates at date  $k$  are

$$\frac{\partial L_t^d}{\partial R_{k+1}} R_{k+1} = \sum_{\tau=0}^t \left[ \frac{q_\tau}{q_t} \left( W \frac{\partial \mathcal{M}_\tau}{\partial R_{k+1}} R_{k+1} + \mathcal{M}_\tau \frac{\partial W}{\partial R_{k+1}} R_{k+1} \right) + (\mathcal{M}_\tau W - Y_\tau) \frac{\partial(q_\tau/q_t)}{\partial R_{k+1}} R_{k+1} \right] - \frac{R_0 L_{-1}}{q_t^2} \frac{\partial q_t}{\partial R_{k+1}} R_{k+1}$$

where

$$\frac{\partial W}{\partial R_{k+1}} R_{k+1} = \sum_{\tau'=0}^T Y_{\tau'} \frac{\partial q_{\tau'}}{\partial R_{k+1}} R_{k+1} = - \sum_{\tau'=k+1}^T Y_{\tau'} q_{\tau'}$$

$$\begin{aligned}\frac{\partial \mathcal{M}_\tau}{\partial R_{k+1}} R_{k+1} &= \mathcal{M}_\tau \cdot \left[ -\frac{1}{\gamma} q_\tau^{-1} \frac{\partial q_\tau}{\partial R_{k+1}} R_{k+1} - \left(1 - \frac{1}{\gamma}\right) \sum_{\tau'=0}^T \mathcal{M}_{\tau'} \frac{\partial q_{\tau'}}{\partial R_{k+1}} R_{k+1} \right] \\ &= \mathcal{M}_\tau \cdot \left[ \frac{1}{\gamma} \mathbb{1}_{\tau > k} + \left(1 - \frac{1}{\gamma}\right) \sum_{\tau'=k+1}^T q_{\tau'} \mathcal{M}_{\tau'} \right]\end{aligned}$$

**The elasticity matrix.** The elasticity matrix is pinned down

$$\frac{\partial L_t^d}{\partial R_{k+1}} R_{k+1} = \sum_{\tau=0}^t \frac{q_\tau}{q_t} \left( W \cdot \frac{\partial \mathcal{M}_\tau}{\partial R_{k+1}} R_{k+1} + \mathcal{M}_\tau \cdot \frac{\partial W}{\partial R_{k+1}} R_{k+1} \right) + \frac{q_k}{q_t} L_k^d \cdot \mathbb{1}_{t > k}.$$

**Infinite horizon model.** In an infinite horizon model, the equilibrium is shocked around the steady state. Although many of our reasoning prevails, we should adapt the equations accordingly.

*Closed form consumption solution.* If we use the same approach, this implies  $R_{ss} = \beta^{-1}$ ,  $q_t = \beta^t$ ,  $\mathcal{M}_t = 1 - \beta$ , and  $W = \frac{Y}{1-\beta} - R_{ss} L_{ss}$ . Consistently,

$$\begin{aligned}\frac{\partial W}{\partial R_{k+1}} R_{k+1} &= -Y \frac{\beta^{k+1}}{1-\beta} \\ \frac{\partial \mathcal{M}_\tau}{\partial R_{k+1}} R_{k+1} &= \mathcal{M}_\tau \cdot \left[ \frac{1}{\gamma} \mathbb{1}_{\tau > k} + \left(1 - \frac{1}{\gamma}\right) (1-\beta) \frac{\beta^{k+1}}{1-\beta} \right].\end{aligned}$$

*Matrix formulation plus infinite transversality condition.* An alternative way to compute this matrix is by log-linearizing the first-order conditions:

$$\begin{aligned}\partial C_t &= \partial C_{t+1} - \frac{\beta C}{\gamma} \partial R_{t+1} \\ \partial L_t &= \partial C_t + L_{ss} \partial R_t + R_{ss} \partial L_{t-1}\end{aligned}$$

with  $\partial L_{-1} = 0$  and  $\lim_{t \rightarrow \infty} \beta^t \partial L_t = 0$ . Thus, solving the system yields

$$\begin{aligned}\partial C_t &= \partial C_0 + \frac{\beta C}{\gamma} \sum_{k=0}^{t-1} \partial R_{k+1} \implies \partial C_+ = \mathbf{1} \cdot \partial C_0 + \frac{\beta C}{\gamma} \boldsymbol{\Sigma} \cdot \partial \mathbf{R}_+ \\ \partial L_{t-1} &= - \sum_{k=0}^{\infty} \beta^{k+1} (\partial C_{t+k} + L_{ss} \partial R_{t+k}) \implies \partial \mathbf{L} = -\mathbf{B} \cdot (\partial C_+ + L_{ss} \cdot \partial \mathbf{R}_+)\end{aligned}$$

and the budget constraint at date 0, where  $\boldsymbol{\Sigma}_{t,s} = \mathbb{1}_{t \geq s}$  and  $\mathbf{B}_{t,s} = \beta^{s-t+1} \mathbb{1}_{t \leq s}$ . Let  $\mathbf{b} \equiv \mathbf{B}_{0,\bullet}$  be the first row of matrix  $\mathbf{B}$ , then the lifetime budget constraint is

$$\begin{aligned}0 &= -\mathbf{b} \cdot \partial C - \beta L_{ss} \mathbf{b} \cdot \partial \mathbf{R}_+ \\ &= -\beta \cdot \partial C_0 - \beta \mathbf{b} \left( \mathbf{1} \cdot \partial C_0 + \frac{\beta C}{\gamma} \boldsymbol{\Sigma} \cdot \partial \mathbf{R}_+ \right) - \beta L_{ss} \mathbf{b} \cdot \partial \mathbf{R}_+ \\ &= -(1 + \mathbf{b} \mathbf{1}) \cdot \partial C_0 - \mathbf{b} \left( \frac{\beta C}{\gamma} \boldsymbol{\Sigma} + L_{ss} \mathbf{I} \right) \cdot \partial \mathbf{R}_+\end{aligned}$$

where we use the structure of  $\mathbf{b}$  to rearrange equations. Since  $1 + \mathbf{b}\mathbf{1} = \frac{1}{1-\beta}$ , then the initial consumption verifies

$$\partial C_0 = \mathbf{c} \cdot \partial \mathbf{R}_+ \text{ where } \mathbf{c} \equiv -(1-\beta)\mathbf{B}_0 \bullet \left( \frac{\beta C}{\gamma} \boldsymbol{\Sigma} + L_{ss} \mathbf{I} \right).$$

As a result matrix is given by

$$\mathbf{D}' \equiv -\beta^{-1} \mathbf{B} \cdot \left( \mathbf{1} \cdot \mathbf{c} + \frac{\beta C}{\gamma} \boldsymbol{\Sigma} + L_{ss} \mathbf{I} \right).$$

*Matrix formulation plus approximated transversality condition.* Whenever  $T$  is high enough, a second alternative way to solve this is by solving this system

$$\begin{aligned} \partial C_t - \partial C_{t+1} &= -\frac{\beta C}{\gamma} \partial R_{t+1} \text{ for } t = 0, 1, \dots, T-1 \\ -\partial C_t + \partial L_t - R_{ss} \partial L_{t-1} &= L_{ss} \partial R_t \text{ for } t = 0, 1, \dots, T \end{aligned}$$

with  $\partial L_{-1} = 0$  and  $\partial L_T = 0$ . We can directly solve for  $\partial \mathbf{C}$  and  $\partial \mathbf{L}$  for a given  $\partial \mathbf{R}_+ = (\partial R_1, \partial R_2, \dots, \partial R_T)^\top$  (recall that  $\partial R_0 = 0$ ). In fact, we have a  $2T + 1$  equations and  $2T + 1$  unknowns,  $\partial \mathbf{C} = (\partial C_0, \partial C_1, \dots, \partial C_T)^\top$  and  $\partial \mathbf{L} = (\partial L_0, \partial L_1, \dots, \partial L_{T-1})^\top$ .

## B.2 Financial Intermediaries

We describe two types of financial intermediaries: short-run and long-run banks.

### B.2.1 Short-run banks

Financial intermediaries do not have capital and, at each date, rebate all the cumulated financial returns to foreign households who are the owners of these banks. However, in order to lend to domestic residents they face a constraint captured by [Gabaix and Maggiori \(2015\)](#)'s friction. Then, at each date  $t = 0, \dots, T-1$ , their problem is

$$V_t \equiv \max_{L_t} \frac{1}{R_{t+1}^*} (R_{t+1} - R_{t+1}^*) L_t \text{ subject to: } \tilde{\Theta} L_t \leq V_t$$

where  $\tilde{\Theta} = \Theta L_t$ . Banks are going to leverage as much as they can, leading to the following supply schedule

$$L_t^s(\Delta_+) = \Theta^{-1} (\Delta_{t+1} - 1). \tag{B.2}$$

**The elasticity matrix.** the elasticity matrix is very simple in this case:

$$\frac{\partial L_t^s}{\partial \Delta_{k+1}} \Delta_{k+1} = \begin{cases} \Theta^{-1} \Delta_{t+1} & t = k \\ 0 & t \neq k \end{cases}.$$

## B.2.2 Long-run banks

**Individual's bank problem.** Now let us assume that each bank lives up to  $T + 1$  periods. To have a natural infinite-horizon extension of this structure, we assume that banks die with probability  $1 - \sigma \in (0, 1)$ . To separate some mechanisms in the model, we assume that the subjective survival probability is  $\tilde{\sigma}$  but they never learn about the true probability  $\sigma$ . This is useful to isolate the backward-looking and forward-looking component of the supply side of the economy.

Banks start with an initial capital  $N_0$  and rebate all the cumulated financial returns upon death to foreign households. Given any capital  $N_t$ , the balance sheet imposes the restriction where  $D_t^*$  denotes the debt from foreign households. Given  $V_T = 0$ , the individual's problem is: For  $t = 0, \dots, T - 1$

$$V_t(N_t) \equiv \max_{L_t, D_t} \frac{1}{R_{t+1}^*} [(1 - \tilde{\sigma})N_{t+1} + \tilde{\sigma} \cdot V_{t+1}(N_{t+1})]$$

subject to

$$\begin{aligned} L_t &= N_t + D_t^* \\ N_{t+1} &= R_{t+1}L_t - R_{t+1}^*D_t^* \\ \Theta L_t &\leq V_t(N_t) \end{aligned}$$

Combining the first and second equation yields

$$N_{t+1} = (R_{t+1} - R_{t+1}^*)L_t + R_{t+1}^*N_t.$$

Let  $\psi_t \equiv V_t(N_t)/N_t$  be the unit franchise value of the bank and  $\phi_t \equiv L_t/N_t$  be the leverage ratio. Then, the franchise value evolves according to

$$\psi_t = (1 - \tilde{\sigma} + \tilde{\sigma}\psi_{t+1}) (1 + (\Delta_{t+1} - 1)\phi_t)$$

with  $\psi_T = 0$ . It follows that the supply schedule has two regimes: (i) the unconstrained regime: Whenever  $\Delta_{t+1} = 1$ , the bank is indifferent to hold any  $\phi \in (0, \underline{\phi}_t)$  where

$$\underline{\phi}_t = \Theta^{-1}(1 - \tilde{\sigma} + \tilde{\sigma}\psi_{t+1});$$

and (ii) the constrained regime: When  $\Delta_{t+1} > 1$ , then

$$\phi_t = \frac{1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1}}{\Theta - (\Delta_{t+1} - 1)(1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1})}.$$

We assume this case throughout this paper and solve the model recursively with this equation and final condition  $\phi_T = 0$ . Thus, this justifies to write the leverage ratio as completely forward-looking term function:  $\phi_t(\Delta_{t+1})$ .

**Aggregate net worth.** Banks exiting the financial market are replaced by a continuum of new bankers with initial capital  $\zeta$ . Therefore, the evolution of the aggregate net worth is

$$N_t = \sigma R_t^* ((\Delta_t - 1)L_{t-1} + N_{t-1}) + (1 - \sigma)\zeta.$$

Note that the evolution of net worth is ruled by the true survival rate,  $\sigma$ , instead of the bank's perceived one. As a result,

$$L_t^s(\Delta_+, R_+^*) = \phi_t(\Delta_{t+1}) \cdot N_t(\Delta_+, R_+^*).$$

**The elasticity matrix.** Note first that

$$\begin{aligned} \frac{\partial N_t}{\partial \Delta_{k+1}} \Delta_{k+1} &= \sigma R_t^* L_{t-1} \Delta_{k+1} \mathbb{1}_{k+1=t} + \sigma R_t^* \left[ (\Delta_t - 1) \frac{\partial L_{t-1}^s}{\partial \Delta_{k+1}} \Delta_{k+1} + \frac{\partial N_{t-1}}{\partial \Delta_{k+1}} \Delta_{k+1} \right] \\ \frac{\partial N_t}{\partial R_{k+1}^*} R_{k+1}^* &= \sigma R_t^* ((\Delta_t - 1)L_{t-1} + N_{t-1}) \mathbb{1}_{k+1=t} + \sigma R_t^* \left[ (\Delta_t - 1) \frac{\partial L_{t-1}^s}{\partial R_{k+1}^*} R_{k+1}^* + \frac{\partial N_{t-1}}{\partial R_{k+1}^*} R_{k+1}^* \right] \end{aligned}$$

The elasticity matrix is more complicated in this case

$$\begin{aligned} \frac{\partial L_t^s}{\partial \Delta_{k+1}} \Delta_{k+1} &= N_t \frac{\partial \phi_t}{\partial \Delta_{k+1}} \Delta_{k+1} + \phi_t \frac{\partial N_t}{\partial \Delta_{k+1}} \Delta_{k+1} \\ \frac{\partial L_t^s}{\partial R_{k+1}^*} R_{k+1}^* &= \phi_t \frac{\partial N_t}{\partial R_{k+1}^*} R_{k+1}^*. \end{aligned}$$

This system can be solved recursively once we compute, under the assumption of binding constraints,

$$\frac{\partial \phi_t}{\partial \Delta_{k+1}} = \phi_t^2 \left[ \mathbb{1}_{k=t} + \frac{\tilde{\sigma} \Theta^2}{(1 - \tilde{\sigma} + \tilde{\sigma} \Theta \phi_{t+1})^2} \frac{\partial \phi_{t+1}}{\partial \Delta_{k+1}} \right]$$

**Infinite horizon model.** In an infinite horizon model, the equilibrium is shocked around the steady state. We can use the matrix form with the infinite horizon transversality condition. To simplify things however we proceed with the approximated transversality condition.<sup>9</sup> Thus,

$$\begin{aligned} \partial \phi_t &= \phi_{ss}^2 \partial \Delta_{t+1} + \frac{\tilde{\sigma} \Theta^2 \phi_{ss}^2}{(1 - \tilde{\sigma} + \tilde{\sigma} \Theta \phi_{ss})^2} \partial \phi_{t+1} \\ \partial N_t &= \sigma ((\Delta_{ss} - 1)L_{ss} + N_{ss}) \partial R_t^* + \sigma R_{ss}^* L_{ss} \partial \Delta_t + \sigma R_{ss}^* (\Delta_{ss} - 1) \partial L_{t-1} + \sigma R_{ss}^* \partial N_{t-1}. \end{aligned}$$

Rearranging yields the following system

$$\begin{aligned} \partial \phi_t - \frac{\tilde{\sigma} \Theta^2 \phi_{ss}^2}{(1 - \tilde{\sigma} + \tilde{\sigma} \Theta \phi_{ss})^2} \partial \phi_{t+1} &= \phi_{ss}^2 \partial \Delta_{t+1} \quad \text{for } t = 0, 1, \dots, T-1 \\ -\sigma R_{ss}^* (\Delta_{ss} - 1) N_{ss} \partial \phi_{t-1} + \partial N_t - \sigma R_{ss}^* [1 + (\Delta_{ss} - 1) \phi_{ss}] \partial N_{t-1} \\ &= \sigma ((\Delta_{ss} - 1)L_{ss} + N_{ss}) \partial R_t^* + \sigma R_{ss}^* L_{ss} \partial \Delta_t \quad \text{for } t = 1, 2, \dots, T \end{aligned}$$

with  $\partial N_0 = 0$  and  $\partial \phi_T = 0$ . Therefore, we have a  $2T$  equations and  $2T$  unknowns,  $\partial \phi = (\partial \phi_0, \partial \phi_1, \dots, \partial \phi_{T-1})^\top$  and  $\partial N = (\partial N_1, \partial N_2, \dots, \partial N_T)^\top$ .

<sup>9</sup>Having leverage ratios in a closed form solution is harder in this case.

### B.3 Competitive equilibrium

Given the foreign interest rate path  $\mathbf{R}_+^*$ , the interest rate spread of equilibrium  $\Delta_+$  solves

$$L_t^s(\Delta_+, \mathbf{R}_+^*) = L_t^d(\mathbf{R}_+) \text{ for all } t = 0, 1, \dots, T-1$$

where  $R_{t+1} = \Delta_{t+1}R_{t+1}^*$ . As a benchmark, let us compute the stationary equilibrium in the infinite horizon model. Suppose  $T = +\infty$  and  $R_t^* = R^*$  for all  $t = 0, 1, \dots$  and let us compute that steady state in the model with short- and long-run banks. By definition this equilibrium is given by a UIP deviation  $\Delta$  such that  $L_t^d = L_t^s = L$  for all  $t$  under  $\Delta_t = \Delta$  and  $R_t^* = R^*$  for all  $t$ . We assume that  $\beta^{-1} > R^*$ .

**Households.** From the demand side, stationarity requires  $R = \beta^{-1}$  and households hold the same initial debt throughout their lifetime,  $L_t = L_{-1}$ . Thus, the spread is given by  $\Delta = \frac{1}{\beta R^*}$  and the level of debt is pinned down by the supply side of the economy.

**Short-run banks.** In this model,  $L = \Theta^{-1}(\Delta - 1)$  with  $\Delta = \frac{1}{\beta R^*}$ .

**Long run banks.** Under these conditions, we can solve for  $\psi$  by the following fixed-point equation:

$$\psi = \frac{\Theta(1 - \tilde{\sigma} + \tilde{\sigma}\psi)}{\Theta - (\Delta - 1)(1 - \tilde{\sigma} + \tilde{\sigma}\psi)}.$$

Then,  $\phi = \Theta^{-1}\psi$  and the net worth is computed by

$$N = \frac{(1 - \sigma)\zeta}{1 - \sigma R^*(1 + (\Delta - 1)\phi)}.$$

As a result,  $L = \phi N$ .

## C Derivations for Section 5

Note that in this model, we can define the net foreign asset position as  $\underline{\text{NFA}}_t = -E_t D_t^*$  and the gross domestic product (expressed in the national consumption bundle) is  $\text{GPD}_t = E_t Y_t^T + E_t Q_t^{-1} Y_t^N$ .

### C.1 Non-financial block

#### C.1.1 Demad for credit

The optimal intertemporal decisions are given by

$$\begin{aligned} C_t^{-\gamma} &= \beta R_{t+1} C_{t+1}^{-\gamma} \\ -C_t + L_t - R_t L_{t-1} &= -E_t Y^T - \frac{E_t}{Q_t} Y^N \\ Q_t &= \left( \frac{E_t^{\eta-1} - \omega}{1 - \omega} \right)^{\frac{1}{\eta-1}}. \end{aligned}$$

Approximating movements around the steady state leads to

$$\begin{aligned} \partial C_t - \partial C_{t+1} &= -\frac{\beta C}{\gamma} \partial R_{t+1} \text{ for } t = 0, 1, \dots, T-1 \\ -\partial C_t + \partial L_t - R_{ss} \partial L_{t-1} &= L_{ss} \partial R_t + \left( -Y^T + \frac{\omega E_{ss}^{1-\eta}}{1 - \omega E_{ss}^{1-\eta}} \frac{Y^N}{Q_{ss}} \right) \partial E_t \text{ for } t = 0, 1, \dots, T \end{aligned}$$

with  $\partial L_{-1} = 0$  and  $\partial L_T = 0$ . We can directly solve for  $\partial \mathbf{C} = (\partial C_0, \partial C_1, \dots, \partial C_T)^\top$  and  $\partial \mathbf{L} = (\partial L_0, \partial L_1, \dots, \partial L_{T-1})^\top$  for a given  $\partial \mathbf{R}_+ = (\partial R_1, \partial R_2, \dots, \partial R_T)^\top$  (recall that  $\partial R_0 = 0$ ) and  $\partial \mathbf{E} = (\partial E_0, \partial E_1, \dots, \partial E_T)^\top$ .

#### C.1.2 Exchange rate block

The real exchange rate block is given by

$$\begin{aligned} Y^N &= (1 - \omega) (E_t / Q_t)^{-\eta} C_t(\mathbf{R}_+, \mathbf{E}) \\ Q_t &= \left( \frac{E_t^{\eta-1} - \omega}{1 - \omega} \right)^{\frac{1}{\eta-1}}. \end{aligned}$$

Up-to-first order,

$$0 = \eta \frac{\omega E_{ss}^{1-\eta}}{1 - \omega E_{ss}^{1-\eta}} e_t + \sum_{k=0}^{\infty} \mathbf{C}_{t,k}^E e_k + \sum_{k=0}^{\infty} \mathbf{C}_{t,k}^R r_{k+1}.$$

In matrix form, we can write  $\mathbf{e} = \tilde{\mathbf{E}} \cdot \mathbf{r}_+$  where

$$\tilde{\mathbf{E}} \equiv - \left( \eta \frac{\omega E_{ss}^{1-\eta}}{1 - \omega E_{ss}^{1-\eta}} \mathbf{I} + \mathbf{C}^E \right)^{-1} \mathbf{C}^R.$$

### C.1.3 Steady states

Note that in all steady states:  $\beta R_{ss} = 1$ ,  $\Delta_{ss} = R_{ss}/R_{ss}^* = \beta^*/\beta$  and  $E_{ss+1}/E_{ss} = 1$ . The models differ on the supply side which is going to pin down  $L_{ss}$ . Then, given  $L_{ss}$ , the exchange rate level is determined by the aggregate resource constraint

$$E_{ss}C^T(E_{ss}) - E_{ss}Y^T = (1 - R_{ss})L_{ss}.$$

Moreover, the net foreign asset position is  $\underline{NFA}_{ss} = N_{ss} - L_{ss}$  and the gross domestic product as  $GDP_{ss} = E_{ss}Y_{ss}^T + E_{ss}Q_{ss}^{-1}Y_{ss}^N$ .

## C.2 Financial block

### C.2.1 Short-run banks

**Dynamic system.** The nonlinear system is given by the exchange rate block together with

$$L_t = \Theta^{-1}(\Delta_{t+1} - 1).$$

The net foreign asset position as  $\underline{NFA}_t = -L_t$ .

**Steady state.** The steady state level of loans is  $L_{ss} = \Theta^{-1}(\Delta_{ss} - 1)$ .

**Linearized supply side.** Log-linearizing yields

$$\partial L_t = \Theta^{-1}\Delta_{ss}\delta_{t+1}.$$

### C.2.2 Long-run banks

**Dynamic system.** The nonlinear system is given by the exchange rate block together with

$$\begin{aligned} \phi_t &= \frac{1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1}}{\Theta - (\Delta_{t+1} - 1)(1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{t+1})} \\ N_t &= \sigma\tilde{R}_t^*N_{t-1}(1 + (\Delta_t - 1)\phi_{t-1}) + (1 - \sigma)\zeta. \end{aligned}$$

**Steady state.** The leverage ratio of banks' leverage ratio  $\phi_{ss}$  solve the following fixed-point equation (from (15) at the steady state):

$$\phi_{ss} [\Theta - (\Delta_{ss} - 1)(1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{ss})] = 1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{ss}.$$

The net worth is

$$N_{ss} = \frac{(1 - \sigma)\zeta}{1 - \sigma R_{ss}^*(1 + (\Delta_{ss} - 1)\phi_{ss})} \implies L_{ss} = \phi_{ss}N_{ss}.$$

Then, the exchange rate level is determined by the aggregate resource constraint

$$E_{ss}C^T(E_{ss}) - E_{ss}Y^T = (1 - R_{ss})L_{ss}.$$

Moreover, the net foreign asset position is  $\underline{NFA}_{ss} = N_{ss} - L_{ss}$  and the gross domestic product as  $GDP_{ss} = Y_{ss}^T + Q_{ss}^{-1}Y_{ss}^N$ .

**Linearized supply side.** Log-linearizing yields

$$\begin{aligned} \partial\phi_t - \frac{\tilde{\sigma}\Theta^2\phi_{ss}^2}{(1 - \tilde{\sigma} + \tilde{\sigma}\Theta\phi_{ss})^2}\partial\phi_{t+1} &= \phi_{ss}^2\partial\Delta_{t+1} \text{ for } t = 0, 1, \dots, T-1 \\ -\sigma R_{ss}^*(\Delta_{ss} - 1)N_{ss}\partial\phi_{t-1} + \partial N_t - \sigma R_{ss}^*[1 + (\Delta_{ss} - 1)\phi_{ss}]\partial N_{t-1} \\ &= \sigma((\Delta_{ss} - 1)L_{ss} + N_{ss})\partial\tilde{R}_t^* + \sigma R_{ss}^*L_{ss}\partial\Delta_t \text{ for } t = 0, 1, 2, \dots, T \end{aligned}$$

with  $\partial N_{-1} = 0$ ,  $\partial\phi_{-1} = 0$ ,  $\partial\phi_T = 0$ ,  $\partial\Delta_0 = -\frac{\Delta_{ss}}{E_{ss}}\partial E_0$ , and  $\partial\tilde{R}_0^* = \frac{R_{ss}^*}{E_{ss}}\partial E_0$ .

We have a  $2T + 1$  equations and  $2T + 1$  unknowns,  $\partial\phi = (\partial\phi_0, \partial\phi_1, \dots, \partial\phi_{T-1})^\top$  and  $\partial N = (\partial N_0, \partial N_1, \partial N_2, \dots, \partial N_T)^\top$ .

### C.3 Calibration: Finding parameters

We follow the same strategy for most of the models consider in this paper. The targeted moments are  $R_{ss}^*$ ,  $R_{ss}$ ,  $E_{ss}$ ,  $C_{ss}^T$ ,  $\frac{NFA_{ss}^*}{4GDP_{ss}}$ , and  $\frac{L_{ss}}{4GDP_{ss}}$ . We can find the right parameters as follows

1. Given  $R_{ss}$  and  $R_{ss}^*$ , we can compute  $\beta = 1/R_{ss}$ ,  $\beta^* = 1/R_{ss}^*$ , and  $\Delta_{ss} = \beta^*/\beta$ .
2. Given  $E_{ss}$  and  $C_{ss}^T$ , we can find  $Q_{ss}$  and  $Y_{ss}^N = \frac{1-\omega}{\omega}Q_{ss}^\eta C_{ss}^T$ .
3. Given  $\frac{L_{ss}}{4GDP_{ss}}$ ,  $Q_{ss}$ ,  $Y_{ss}^N$  and  $C_{ss}^T$ , we can compute  $Y_{ss}^T$  by using

$$\begin{aligned} \frac{L_{ss}}{4GDP_{ss}} \times 4(E_{ss}Y_{ss}^T + E_{ss}Q_{ss}^{-1}Y_{ss}^N) \times (1 - R_{ss}) &= E_{ss}Y_{ss}^T - E_{ss}C_{ss}^T \\ \implies Y_{ss}^T &= \frac{1}{1 - 4(R_{ss} - 1)\frac{L_{ss}}{4GDP_{ss}}} \left( 4(R_{ss} - 1) \times \frac{L_{ss}}{4GDP_{ss}} \times Q_{ss}^{-1}Y_{ss}^N + C_{ss}^T \right). \end{aligned}$$

4. We can compute  $L_{ss}$ ,  $\underline{NFA}_{ss}^*$ , and  $N_{ss}$  as

$$\begin{aligned} L_{ss} &= \frac{L_{ss}}{4GDP_{ss}} \times 4(E_{ss}Y_{ss}^T + E_{ss}Q_{ss}^{-1}Y_{ss}^N) \\ \underline{NFA}_{ss}^* &= \frac{NFA_{ss}^*}{4GDP} \times 4(E_{ss}Y_{ss}^T + E_{ss}Q_{ss}^{-1}Y_{ss}^N) \\ N_{ss} &= L_{ss} + \underline{NFA}_{ss}^*. \end{aligned}$$

5. Given  $\phi_{ss} = L_{ss}/N_{ss}$ , we can compute  $\zeta$  as

$$\zeta = \frac{1 - \sigma R_{ss}^* (1 + (\Delta_{ss} - 1)\phi_{ss})}{1 - \sigma} N_{ss}.$$

Moreover,  $\Theta$  is inferred from the steady state equation of  $\phi_{ss}$  in each possible model:

(a) Under the “short-run banks” setting this is

$$\Theta = \frac{\Delta_{ss} - 1}{L_{ss}}.$$

(b) Under the “long-run banks” setting this is

$$\Theta = \frac{(1 - \tilde{\sigma}) [1 + (\Delta_{ss} - 1)\phi_{ss}]}{\phi_{ss} [1 - \tilde{\sigma} (1 + (\Delta_{ss} - 1)\phi_{ss})]}.$$

# D Quantitative explorations

This appendix presents additional quantitative results that complement the analysis in the main text. The purpose is to illustrate the robustness of the model's predictions across alternative parameter values and horizon assumptions. In each case, we vary one parameter at a time while holding the rest of the environment fixed.

## D.1 Model without balance sheet

We begin with the model without balance sheet effects, which provides a useful benchmark for isolating the role of credit demand and credit supply dynamics in the determination of the UIP premium. We report how the responses change across alternative values of preference parameters, intermediation frictions, inherited debt positions, and model horizons. We present the corresponding exercises for economies with short-run and long-run banks, showing how the structure of financial intermediation shapes the transition dynamics in the absence of exchange-rate revaluation effects. Overall, the results reinforce the main conclusion of the paper that, without balance sheet effects of real exchange rate movements, dynamic intermediation does not change the qualitative prediction of the static model.

### D.1.1 Short-run banks

Figure D.1: Dynamic demand and short-run banks: Moving  $\Theta$

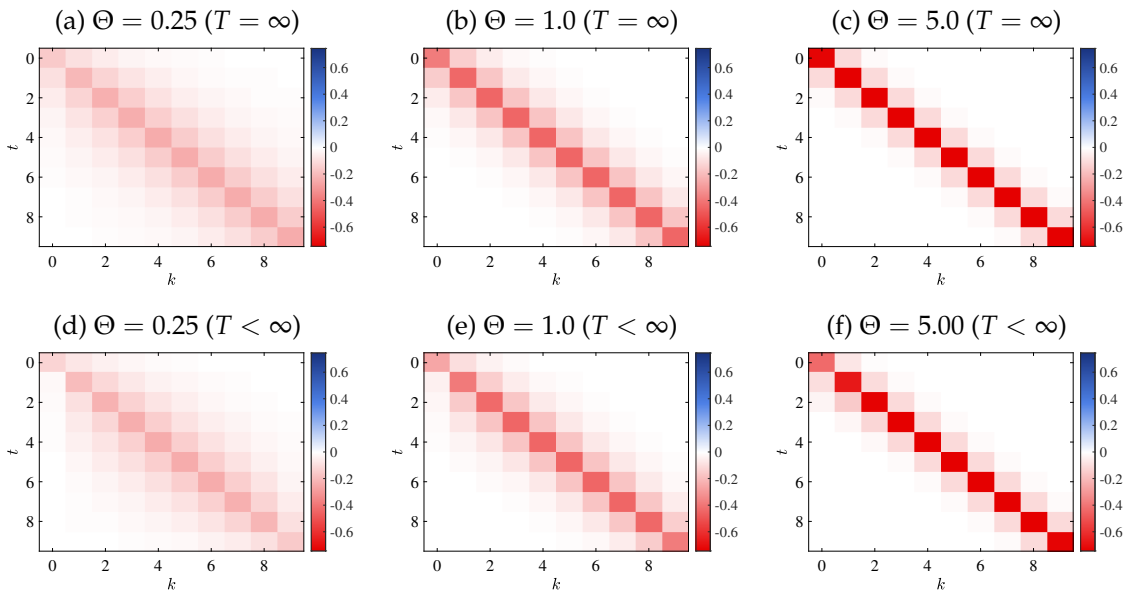


Figure D.2: Dynamic demand and short-run banks: Moving  $\gamma$

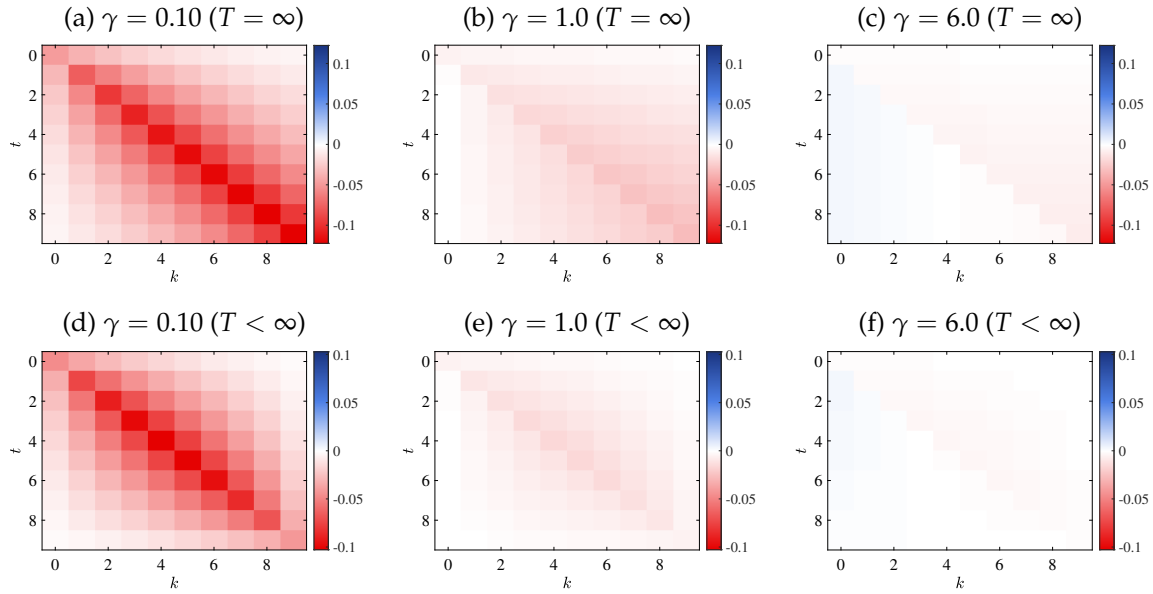
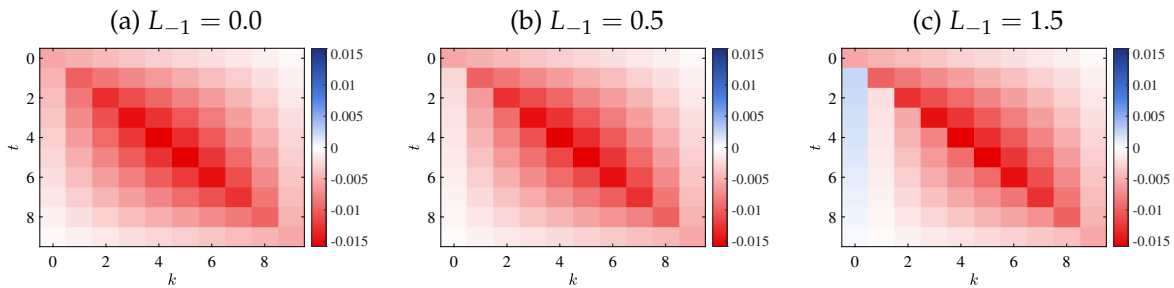


Figure D.3: Dynamic demand and short-run banks: Moving  $L_{-1}$



## D.1.2 Long-run banks

## D.2 Model with balance sheet

We next present additional quantitative results for the model with balance sheet effects. In this environment, exchange rate movements directly revalue intermediaries' foreign currency liabilities, altering net worth and shifting the supply of domestic credit. The figures show how the responses change across alternative values of the main financial parameters, including the tightness of intermediary constraints, the degree of forward looking behavior, the persistence of net worth, and the extent of inherited balance sheet exposure. Taken together, these exercises show that balance sheet effects are central for overturning the benchmark prediction of the model without revaluation effects and for generating the positive response of the UIP premium emphasized in the main text.

Figure D.4: Dynamic demand and “long run” banks: Moving  $\Theta$

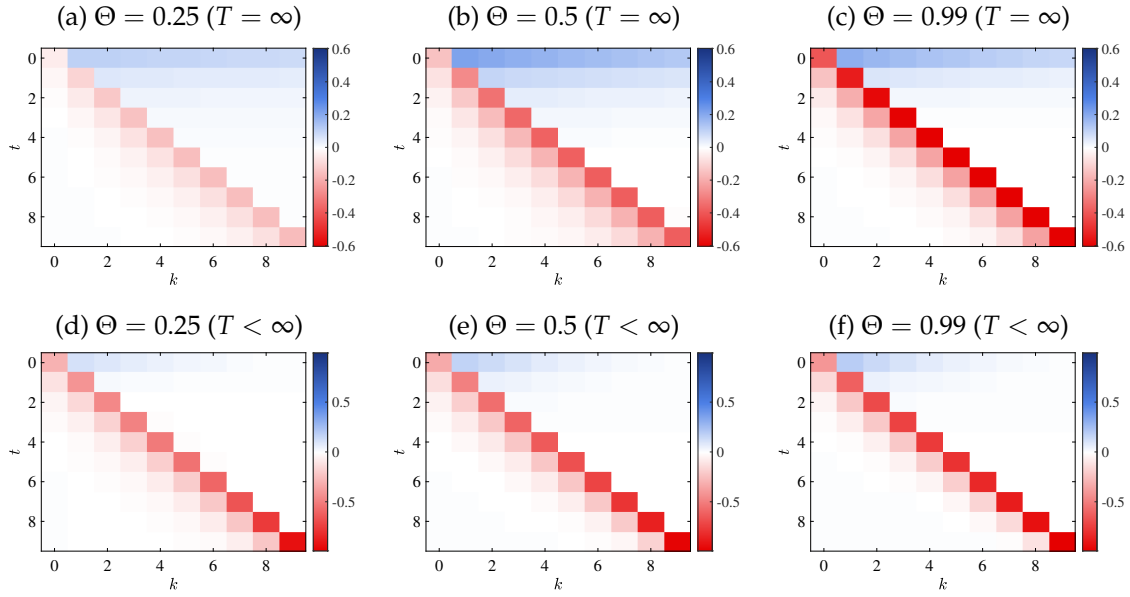


Figure D.5: Dynamic demand and “long run” banks: Moving  $\sigma$

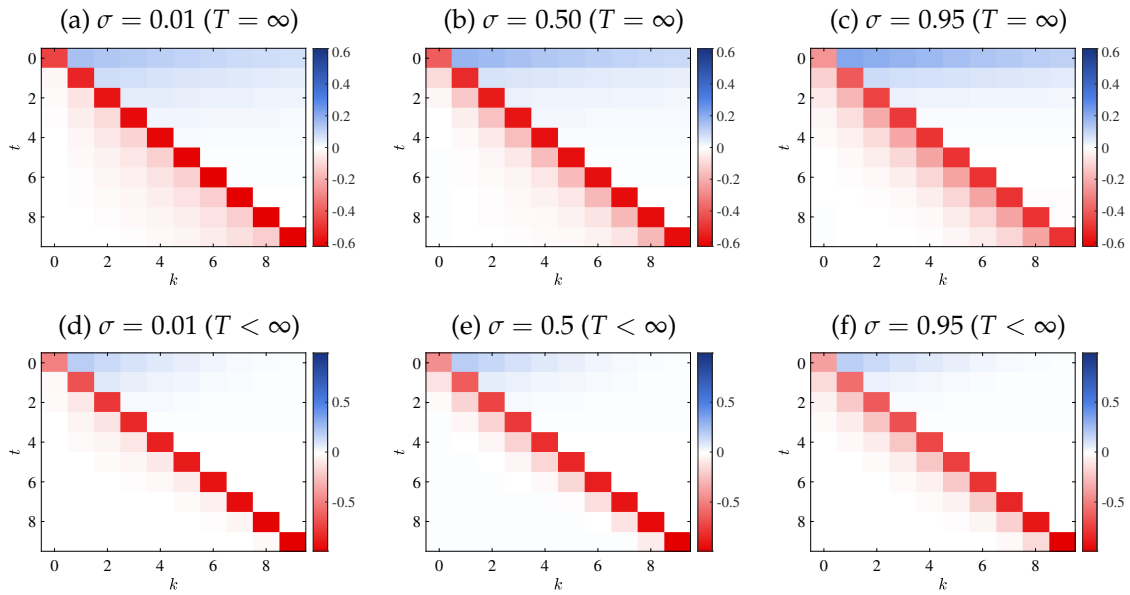


Figure D.6: Dynamic demand and “long run” banks: Moving  $\tilde{\sigma}$

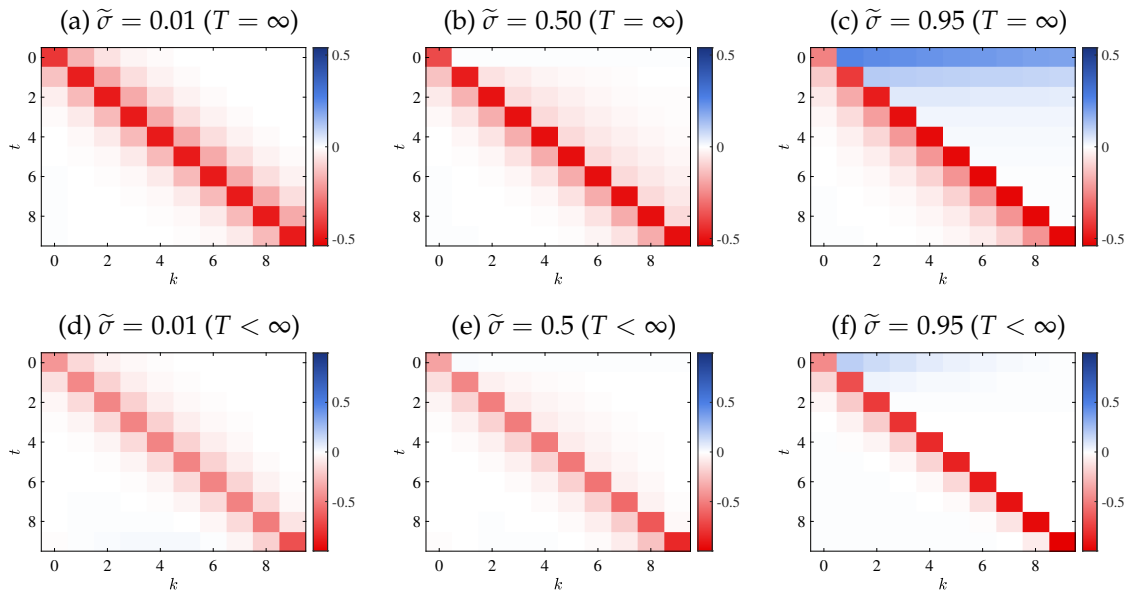


Figure D.7: Dynamic demand and “long run” banks: Moving  $L_{-1}$

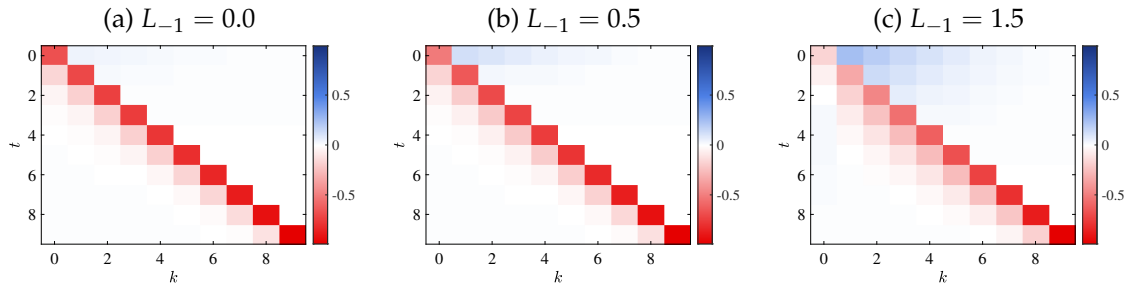


Figure D.8: Model with balance sheet: Moving  $\gamma$  and banks regime

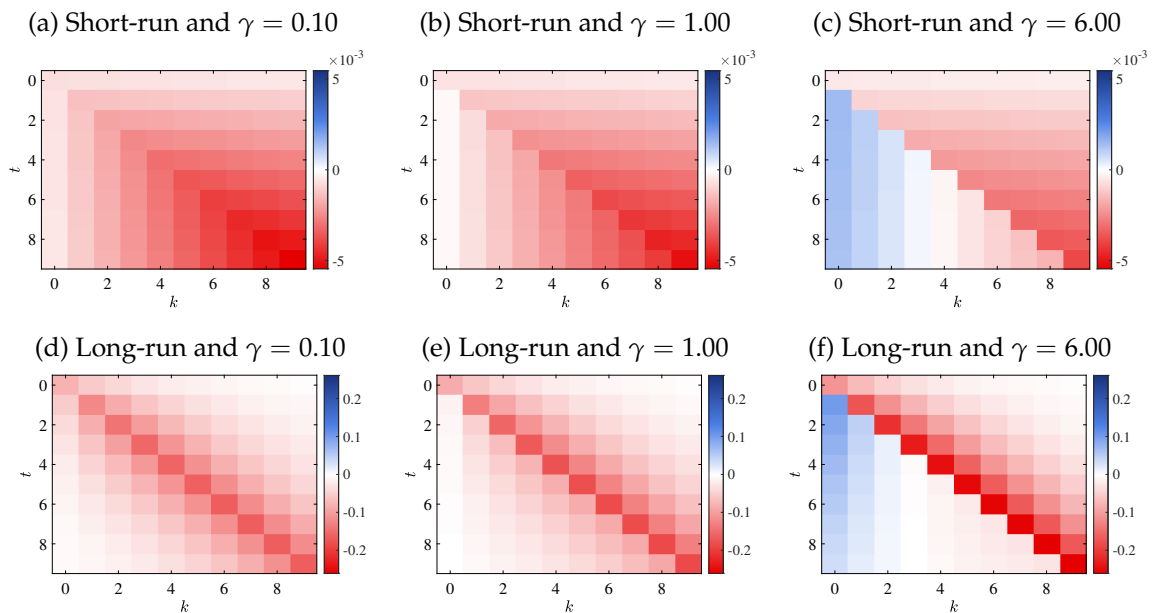


Figure D.9: Model with balance sheet: Moving  $\eta$  and banks

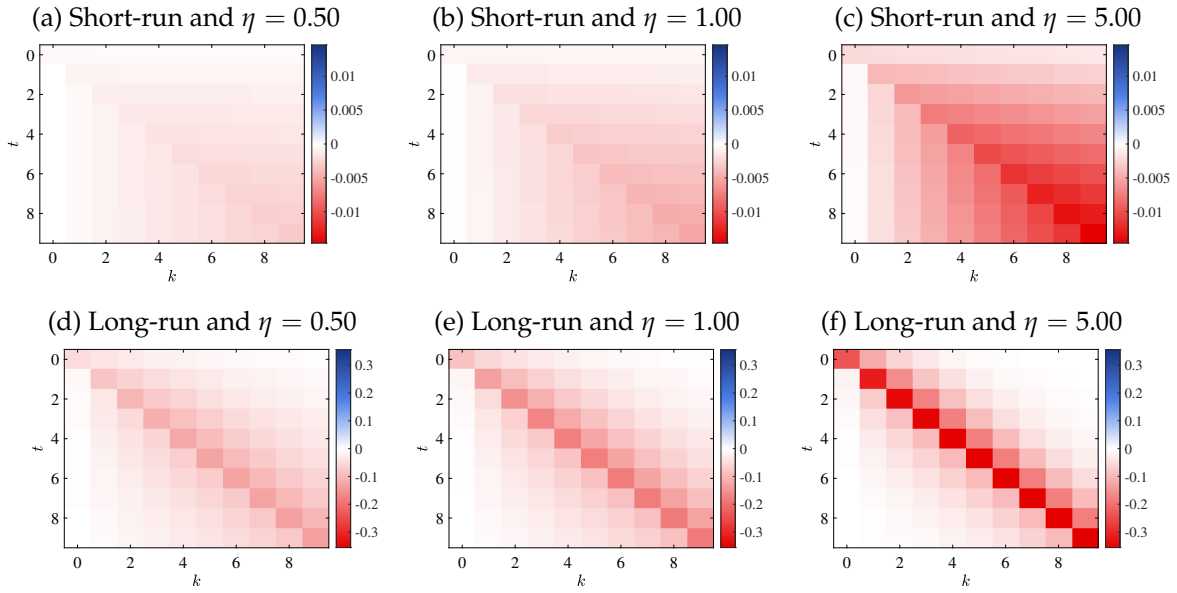


Figure D.10: Model with balance sheet: Moving financial block dynamics

