Abstract

Exchange rates and house prices can potentially amplify international financial shocks. We first document that during a capital flow boom real exchange rates and house prices appreciate, the current account deteriorates, consumption and GDP grow, and equity prices increase, while in a bust these dynamics reverse sharply. We document similar empirical findings in response to an identified change to the international supply of cross-border credit in a Panel VAR for 56 advanced and emerging countries. However, consumption and current account responses to such a shock are much larger in countries in which there is high level of foreign currency exposure, while this is not the case when we split the sample based on homeownership or mortgage debt to GDP. This suggests that the exchange rate is a potentially more important transmission mechanism. We then set up an open-economy model of housing consumption with international financial intermediation to interpret this evidence.

Keywords: Capital Flows, Global Liquidity, House Prices.

JEL codes: C32, E44, F44.
1 Introduction

This paper analyzes the relation between boom-bust cycles in international capital flows, the leverage of global financial intermediaries and house prices.

First, we document some novel stylized facts in a large sample of advanced and emerging markets using a novel dataset on historical house prices. We analyze the behavior of capital flows, house prices, and other macroeconomic and financial variables with an event study approach as in Mendoza and Terrones (2008), Fernandez, Rebucci, and Uribe (2015), and Benigno, Converse, and Fornaro (2015). Specifically, we identify boom-bust episodes in cross-border bank credit. We then observe the behavior of house prices and other macroeconomic and financial variables around the peak of those boom-bust cycles. Our exercise is novel in that is based on new historical data for house price in selected emerging markets. This unconditional analysis shows that, during a capital flows boom, the exchange rate appreciate, the current account balance goes into deficit, consumption and GDP grow, equity prices boom, while in a bust these dynamics reverse.

Second, we show that external factors are an important driver of boom-bust cycles in capital flows and house prices in all countries in our sample. We build an empirical model of house prices and capital flows in which we identify an exogenous change to a specific component of total gross flows, i.e. a global liquidity shock. Following Cesa-Bianchi, Cespedes, and Rebucci (2015), we identify a global liquidity shock in a panel Vector AutoRegression (VAR) model by aggregating cross-border credit flows across all sending and receiving countries in our sample, and by using the external instrumental variable approach of Stock and Watson (2012) and Mertens and Ravn (2013).

We show that our stylized facts are also present conditional on a “push shock” to capital flows. We also show that the amplitude of these cyclical variations are related to the currency denomination of the capital inflows: the larger the share of foreign currency capital flows, the larger is the amplitude of the boom-bust cycle. We do that by estimating the panel VAR on two groups of countries of equal size, where the country split is determined as before —i.e., based on the share of foreign currency cross-border credit over total cross-border credit. The
estimation results show that a global liquidity shock affects house prices and consumption in the group with a high share of foreign currency liabilities quantitatively more than in the group with a low share of foreign currency liabilities. We conjecture that this is due to an external financial friction that amplifies external shocks to capital flows, where the exchange rate amplifies the net worth of economic agents in the presence of foreign currency liabilities.

Third, in order to interpret this evidence, we explore the role of collateral valuation effects linked to house prices and financial intermediary balance sheet constraints in a simple open economy model with housing. Our framework recasts the recent work by Justiniano, Primiceri, and Tambalotti (2015) in an international context. In a two-country world, a relatively patient economy channels funds to a relatively impatient one via competitive financial intermediaries operating at the global level. The model features two types of financial frictions. First, impatient households in the domestic country are subject to a borrowing constraint as in Kiyotaki and Moore (1997). Second, financial intermediaries are subject to a balance sheet constraint (specified as a leverage ratio) as in Brunnermeier and Sannikov (2014) and He and Krishnamurthy (2013).

While in its basic specification the model is very tractable, the combination of the two financial frictions delivers a powerful mechanism that fits the evidence rather well. In particular, a relaxation of the leverage constraint in the foreign economy generates a global credit boom, which leads to a current account deficit and a consumption increase in the domestic economy. If the shock is sufficiently large, or the borrowing constraint in the domestic economy is already binding, the higher supply of credit reduces the real interest rate and fuels house prices. The model, therefore, provides a coherent framework to interpret the VAR evidence.

Our paper contributes to the recent literature on credit flows along two dimensions. On the empirical side, we extend the analysis in Cesa-Bianchi, Cespedes, and Rebucci (2015) to credit flows toward non-financial institutions with a longer sample, and provide a model-based interpretation of the results. On the theoretical side, the model goes beyond the typical assumption of frictionless international financial markets (e.g. Ferrero, 2015), and introduces
a role for global financial intermediation. To the best of our knowledge, the resulting product is the first model of housing and macroeconomic aggregates for emerging markets with both domestic and international financial frictions.¹

The rest of the paper is organized as follows. Section 2 reports some novel stylized facts on house prices and capital flows. Section 3 describes the empirical model and reports the estimation results. Section 4 sets up a DSGE model consistent with the facts in the previous sections. Section 5 describes the properties of the model in response to foreign credit supply shock. Section 6 concludes.

2 New stylized facts on cross-border credit and housing

In this Section we document a set of stylized facts on boom-bust cycles in international capital flows, house prices, and other macroeconomic and financial variables in a large sample of advanced and emerging markets using a novel dataset on historical house prices. We extend the data used in Cesa-Bianchi, Cespedes, and Rebucci (2015), an unbalanced panel of 57 quarterly time series on house prices, using novel historical house price series. This gives us a dataset with varying coverage from 1970:Q1 to 2012:Q4.

Our new data set on emerging economies uses information from the OECD house price database, the BIS property price data set, the Federal Reserve of Dallas international house price database, national central banks, national statistical offices, and academic and policy publications on housing markets.² Relative to its main building blocks —i.e., the OECD, the BIS, and the Federal Reserve of Dallas data sets— Cesa-Bianchi, Cespedes, and Rebucci (2015) extended the time coverage of 12 series and included 9 additional country indices.

In this paper, we further extend the time series coverage of 9 series, namely Argentina, Austria, Chile, Colombia, Greece, Hong Kong, Malaysia, Malta, and Uruguay. The coverage

¹Gabaix and Maggiori (2014) also develop a tractable model with a financial friction in international financial intermediation. Differently from ours, their work is primarily theoretical, focuses on exchange rate dynamics, and abstracts from housing.

²The Appendix provides details on the definitions and sources of both the house price data and the other macroeconomic and financial data used in the paper.
of existing indices is extended by extrapolating backward newer series with historical data. In addition to house prices we consider the following variables: GDP, private consumption, short-term market interest rates, equity prices, the real effective exchange rate, the exchange rate vis-a-vis the US Dollar, cross-border bank credit to the non-banking sector, and the current account as a share of GDP. All variables are expressed in real terms.

Armed with this new data set, we then analyze the behavior of macroeconomic and financial variables around boom-bust episodes in cross-border bank credit using an event study approach. To identify boom-bust episodes in cross-border bank credit we follow Fernandez, Rebucci, and Uribe (2015) and define a boom (bust) as a period longer than or equal to three years in which annual cross-border credit growth is positive (negative). The peak (trough) is defined as the last period within the episode where the annual growth rate of cross-border credit is positive (negative). We use data at annual frequency to reduce the noise related to quarterly movements in cross-border bank credit. We then define boom-bust episodes simply as boom episodes followed by a bust episode.

The procedure identifies 134 booms, 81 busts, and 50 boom-bust episodes. We then characterize the behavior of cross-border bank credit, house prices, and other macroeconomic and financial variables around the boom-bust episodes. Figure 1 reports the results from this event study: we report the mean, median and interquartile range (solid line, dotted line and shaded area, respectively) across all episodes, using a 9-year window going from three year before the peak to five years after the peak. In each of the charts of Figure 1, time zero marks the peak of the boom-bust cycle in cross-border bank credit (i.e., the last period of a boom where cross-border bank credit displays a positive growth rate), which is also depicted with a vertical line. All variables are expressed in percentage changes, with the exception of the real short-term interest rate and the current account over GDP which are expressed in percentage points changes.

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3This procedure is similar to the one commonly used in research on credit booms and periods of capital inflows (Gourinchas, Valdes, and Landerretche, 2001, Mendoza and Terrones, 2008, Cardarelli, Elekdag, and Kose, 2010, Caballero, 2014, Benigno, Converse, and Fornaro, 2015). These are typically defined as periods when credit (or capital inflows) rise more than one standard deviation above their trend. Our results are robust to using the above alternative procedures.

4The summary statistics of these episodes (such as duration and amplitude) are reported in the Appendix.
Figure 1 paints a clear picture of how macroeconomic and financial variables behave during a typical boom-bust episode. A boom in cross-border bank credit is associated with a boom in the real economy, as both GDP and consumption display positive growth rates. The boom is also accompanied by rising interest rates. Interestingly, both house prices and equity prices display strong growth in the boom phase, but they start to fall 1 period before the peak in cross-border bank credit. Turning to international variables, the exchange rate tends to appreciate during booms (even though the charts reveal a high degree of heterogeneity) and the current account tends to deteriorate.

During the bust, all these dynamics reverse and the economy experiences a sharp contraction, with both house prices and equity prices falling sharply, the exchange rate depreciating and the current account reverting abruptly into surplus. While both GDP and consumption recover relatively quickly, both house prices and cross-border bank credit remain depressed for most of the horizon considered in the event study.

3 The impact of global liquidity shocks

In this section, we investigate the causal link from capital flows to house prices and the broader macroeconomy, using a panel-vector autoregression model (PVAR) that embeds both “pull” and “push” factors, as usually assumed in the capital flows literature (e.g., Calvo, Leiderman, and Reinhart, 1996). We identify a shock to a particular push factor: an exogenous shift in the international supply of credit, i.e. a global liquidity shock. We then trace its impact on house prices, consumption, the exchange rate, and interest rates.

3.1 A PVAR model

The PVAR model that we specify includes two external variables and three domestic variables. In addition to cross-border credit to the non-banking sector, we include the real exchange rate vis-a-vis the US Dollar, a real (ex-post) short-term interest rate, real private consumption, and real house prices.\(^5\) Real private consumption is the measure of economic activity that

\(^5\)Differently from Cesa-Bianchi, Cespedes, and Rebucci (2015) we specify a smaller system that includes only the variables for which we have a direct counterpart in the model that we spell in Section 4. For the
we focus on. To keep the size of the VAR model as small as possible, we do not include inflation and nominal interest rate separately. Thus, the real ex-post short-term interest rate is meant to reflect the monetary policy stance. A stabilizing monetary policy response should manifests itself with a change in the real interest rate.

All variables considered enter the VAR in log-levels, except the interest rate, which enter in levels. The model is the same for all countries to avoid introducing differences in country responses due to different specifications, and because it would be difficult to find a perfectly data-congruent specification for all country in the sample. We specify the following VAR model (for each country $i$):

$$x_{it} = a_i + b_i t + c_i t^2 + F_{1i} x_{i,t-1} + u_{it},$$

(1)

where $x_{it}$ is a vector of endogenous variables; $a_i$ is a vector of constants; $t$ and $t^2$ are vectors of deterministic trends; $F_{1i}$ is a matrix of coefficients; and $u_{it}$ is a vector of residuals with variance-covariance matrix $\Sigma_{iu}$. We estimate the model using the mean group estimator of Pesaran and Smith (1995) and Pesaran, Smith, and Im (1996).\(^6\) In the estimation we drop all countries which have less than 40 observations and have unstable dynamics (i.e., with eigenvalues larger than 1). This leaves us with 48 of the original 57 countries.\(^7\)

While cross-border banking credit clearly is affected by both demand and supply factors, the shock that we want to identify is a shift in the international supply of credit. First, we attenuate the influence of country-specific factors by aggregating lending to all receiving countries. As long as countries are not too large, innovations to this variable should not be contaminated by domestic shocks. Second, to rule out that demand factors common among all countries in the sample, or that any particular country affects the aggregate measure, we also use the external instruments identification approach proposed by Stock and Watson same reason we use cross-border credit to the non-banking sector rather than cross-border credit to banks. As we show in the Appendix —where we report the results obtained with a larger model fully comparable with Cesa-Bianchi, Cespedes, and Rebucci (2015)— this also allows us to get more precise estimates and a better identification of the global liquidity shock.

\(^6\)This is because pooled estimators may be inconsistent in a dynamic panel data model with heterogeneous slope coefficient (i.e., slope coefficients that vary across countries).

\(^7\)Specifically, we drop the following countries from our original sample: Brazil, Germany, India, Korea, Mexico, Morocco, Spain, and Uruguay.
The candidate instruments that we consider are the US effective federal funds rate, the log of US M2, the log of US broker-dealers’ leverage, the slope of the US yield curve, the VIX index, and the TED spread. Note that, since our set of instruments is made up of US variables, it is hard to isolate the “foreign” component of the shock to the US system. We opt for excluding the US from the PVAR.

Equipped with the reduced-form residuals from the OLS country-by-country estimation of the VAR system (1), we can regress them on the instruments described above (i.e., the first stage regressions described by equation (A.6) in the Appendix). To improve the identification of the global liquidity shock we also drop all countries for which the $F$-statistic of the first stage regression is below 5, leaving us with 33 countries out of the 48 for which we estimated the VAR. For each country-specific VAR, both the $R^2$ and the $F$-statistic associated with the first stage regressions are reasonably high, averaging 0.73 and 8.7 across all countries, respectively.

### 3.2 Impulse response functions

We are now ready to discuss the impulse response functions to the identified global liquidity shock (i.e., an exogenous shift in the international supply of credit), where note that we normalized the size of the shock so that it corresponds to an increase in cross-border credit of 1 percent.

Figure 2 reports the mean group estimator computed across all countries in our sample.\(^8\)

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\(^8\)The Appendix reports the details of this identification strategy.

\(^9\)We enter the instruments both in levels and first differences. For each country, we select the instrument that maximizes the $F$-Statistic associated with the first stage regression.

\(^10\)To check the robustness of our results, in the Appendix we conduct two additional exercises. First we keep all countries in the mean group estimator irrespective of their $F$-statistic. Second, we drop all countries for which the $F$-statistic is smaller than 10 (as recommended by Stock, Wright, and Yogo (2002) to avoid problems related to weak instruments). The results from these exercises display little differences from our baseline.

\(^11\)Specifically, we drop the following countries: China, Czech Republic, Israel, Latvia, Lithuania, Luxembourg, Malta, Peru, Poland, Russia, Serbia, Slovenia, Slovakia and South Africa.

\(^12\)We use a simple average of the country-specific estimates to construct the mean group estimates. We also censor the responses included in this average at the 10 percent level (5 percent each side) to eliminate the possible influence of any outlier on the averages.
The dark and light shaded areas represent the one and two standard deviations confidence intervals, respectively. The dashed line is the uncensored impulse response function. The impulse responses reported in Figure 2 show that the global liquidity shock leads to a statistically significant increase in real consumption and real house prices. Specifically, consumption and house prices increase on impact by about 0.2% and 0.3% above their long-run levels, with the error bands pointing a relatively high degree of heterogeneity. The response of the short-term real interest rate is negative, even if the response is borderline statistically significant. It then increases slowly but steadily for some quarters, peaking at about 6 basis points above its long-run level. The real exchange vis-a-vis the US Dollar appreciates on impact by about 0.8 percent, arguably driven by the nominal exchange rate, and then reverts to its equilibrium level over time.

Cesa-Bianchi, Cespedes, and Rebucci (2015) conjecture that the global liquidity shock may be amplified by a relaxation of a borrowing constraint via an increase in the value of the collateral. To formalize their intuition, consider the following collateral constraint on borrowing:

\[ d_t \leq \theta (q_t h_t), \]

where \( d_t \) is borrowing, \( q_t h_t \) is the value of the house, and \( \theta \) represents the maximum admissible loan-to-value (LTV) ratio. Clearly, an increase in house prices leads to an increase in the borrowing capacity through increased value of collateral. But note that, if borrowing is in foreign currency, an appreciation of the domestic currency would play a similar role by increasing the foreign currency value of \( q_t h_t \). Cesa-Bianchi, Cespedes, and Rebucci (2015) show that the latter channel may play an important role. In what follows, therefore, we try to better understand the its importance with a simple exercise.

Using BIS confidential data, we rank all countries in our sample based on the share of cross-border bank credit in foreign currency over total cross-border bank credit. We then split our sample in two groups of equal size, depending on whether a country’s share of foreign currency liabilities is above or below the median. Finally, we compute the mean group estimator on the two groups separately. The impulse responses for each group are
The impact of the global liquidity shock in the typical ‘low share of foreign currency liabilities’ economy (panel (a) of Figure 3) is relatively similar to the impact that we obtain across all economies. Real consumption, house prices and the exchange rate increase in response to the shock, even though with a smaller magnitude than in Figure 2. Differently, the response of the short-term real interest rate is now initially mute and then positive.

The global liquidity shock has instead a much larger impact on the typical ‘high share of foreign currency liabilities’ economy (panel (b) of Figure 3). Consumption increases on impact by 0.35 percent and house price by 0.6 percent. These impacts are three times larger than in the low foreign currency liabilities economy. Differently, the response of the exchange rate is slightly smaller at 0.8 percent, with the wide error bands revealing large heterogeneity around the mean group estimate. This is consistent with the behavior of the short-term interest rate, which falls much more sharply than in panel (a) of Figure 3.

These results suggest that global liquidity shocks can significantly affect consumption, house prices, and the exchange rate. But they also suggest that the exchange rate plays an important amplification mechanism when the inflow of cross-border credit is in foreign currency. In the next Section we develop a model that embeds these mechanisms and that is consistent with this evidence.

4 Model

This section presents a two-country model with financial frictions to interpret the empirical evidence reported in the previous section. The model, which follows Justiniano, Primiceri, and Tambalotti (2015), is admittedly very simple, and abstracts from several realistic features such as aggregate uncertainty and endogenous production. The great benefit of this approach is that we can obtain clear analytical results.

Time is discrete and indexed by $t$. The world consists of two countries, denoted H (Home) and F (Foreign). There are respectively $n$ and $1 - n$ households in each of these countries,
who value consumption of non-durable goods and housing. Each country is endowed with one good \((c_{H_t} \text{ and } c_{F_t})\). The two countries only differ in the degree of patience of their representative households. In particular, the domestic representative household is relatively impatient. Housing purchases are subject to a standard collateral constraint. The foreign representative households saves via deposits and equity in a “global” financial intermediary. The financial intermediary channels funds internationally from lenders to borrowers and is subject to a leverage constraint (or, equivalently, a capital requirement).

### 4.1 Good markets

Households in each country consume a basket that comprises of both the home and the foreign good according to a Cobb-Douglas aggregator:

\[
c_t \equiv \left( \frac{c_{H_t}}{P_{H_t}} \right)^\alpha \left( \frac{c_{F_t}}{P_{F_t}} \right)^{1-\alpha} \left( \frac{1}{\alpha (1-\alpha)^{1-\alpha}} \right).
\]

For the H economy \(1 - \alpha\) is the weight of the imported goods in the home consumption basket. One could set \(1 - \alpha = (1 - n)\lambda\), i.e. the home consumers’ preferences for foreign goods, \(1 - \alpha\), is a function of the relative size of the foreign economy, \((1 - n)\), and of the degree of openness, \(\lambda \in (0, 1)\), which is assumed to be equal in both countries. This implies \(\alpha \in (n, 1]\) and generates home bias in consumption.\(^{13}\)

The demand equations of home consumers can be derived by noting that households choose their relative consumption demand such as to maximize utility for given expenditures. For the home consumers, the optimal allocation of \(c_H \) and \(c_F \) (and their price) is given by:

\[
c_{H_t} = \alpha \left( \frac{P_{H_t}}{P_t} \right)^{-1} c_t \quad \text{and} \quad c_{F_t} = (1 - \alpha) \left( \frac{P_{F_t}}{P_t} \right)^{-1} c_t, \quad (2)
\]

where \(P_{H_t}\) and \(P_{F_t}\) represent the price of a unit of home and foreign consumption respectively;\(^{13}\)

\(^{13}\)The size of the bias decreases with the degree of openness and disappears when \(\lambda = 1\) (see Sutherland, 2005). This specification encompass the SOE case when \(n \rightarrow 0\).
and $P_t$ is the price of a unit of the aggregate consumption basket:

$$P_t = P_{Ht}^\alpha P_{Ft}^{1-\alpha}.$$  

(3)

Analogous relations hold for agents in the foreign economy (denoted by an asterisk).

The terms of trade ($\tau_t$) are defined as the ratio between the price of imports and exports:

$$\tau_t = \frac{P_{Ft}}{E_t P_{Ht}^\alpha},$$  

(4)

thus an increase in $\tau_t$ is referred to as a terms of trade deterioration (depreciation) for home consumers. The real exchange rate ($s_t$) is defined as the price of the foreign consumption bundle in terms of the home consumption good:

$$s_t = \frac{E_t P_{Ht}^*}{P_t},$$  

(5)

where $E_t$ is the nominal exchange rate. An increase in $s_t$ corresponds to an increase in the price of the foreign basket relative to the home basket in home currency terms, and is thus referred to as a real exchange rate depreciation for home consumers.

We assume that the Law Of One Price (LOOP) holds. This implies:

$$\tau = (p_{Ft})^{\frac{1}{\alpha}} = (p_{Ht})^{\frac{1}{\alpha-1}},$$  

(6)

where $p_{Ht} \equiv P_{Ht}/P_t$ and $p_{Ft} \equiv P_{Ft}/P_t$. Also we can define the real exchange rate as a function of the terms of trade:

$$s_t \equiv \tau_{t}^{\alpha-\alpha^*}.$$  

(7)

4.2 Domestic Households (Impatient Borrowers)

The representative domestic household maximizes the present discounted value of an instantaneous felicity function defined over consumption of non-durable goods $c_t$ and housing
services, assumed to be proportional to the housing stock $h_t$:

$$
\max_{\{c_t, h_t, d_t\}} \mathbb{U}_t = \sum_{t=0}^{\infty} \beta^t [u(c_t) + v(h_t)],
$$

(8)

where $\beta \in (0, 1)$, and $u'$ and $v' > 0$.

Impatient households are subject to the following budget constraint:

$$
c_t + q_t h_t - s_t d_t = - s_t R_{t-1} d_{t-1} + p_{HT} y_t + q_t h_{t-1},
$$

(9)

where $s_t$ is the real exchange rate ($\uparrow$ is a depreciation of the local currency); $q_t$ is the price of houses in terms of the consumption good; $y_t$ is an exogenous endowment of H consumption goods; $p_{HT}$ is price of the home good relative to the consumption good; $d_t$ is the amount of one period debt (in units of foreign consumption goods) accumulated by the end of period $t$, and carried into period $t + 1$, with gross real interest rate $R_t$.

Following Kiyotaki and Moore (1997), a collateral constraint limits debt to a fraction $\theta \in (0, 1)$ of the value of the owned housing stock:

$$
s_t d_t \leq \theta q_t h_t.
$$

(10)

A common interpretation of this constraint is that the parameter $\theta$ represents the maximum admissible loan-to-value (LTV) ratio.

The problem for the domestic representative household is to maximize (8) subject to (9) and (10). Let $\mu_t u'(c_t)$ be the normalized Lagrange multiplier on the borrowing constraint. The first order condition for the optimal choice of debt is problem are:

$$
1 - \mu_t = \beta R_t E_t \left[ u'(c_{t+1}) \frac{s_{t+1}}{u'(c_t)} \right].
$$

(11)

Expression (11) is the consumption Euler equation relating the marginal benefit of higher consumption today to the marginal cost of lower consumption tomorrow. The equation shows how a tighter borrowing constraint (i.e., a higher $\mu$) reduces the marginal benefit of higher consumption.
consumption today. The first order condition for the optimal choice of housing services is:

\[(1 - \mu_t\theta)q_t = \frac{v'(h_t)}{u'(c_t)} + \beta E_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} q_{t+1} \right]. \quad (12)\]

Expression (12) is the asset pricing equation. This equation shows that house prices are higher when (i) the maximum loan-to-value ratio is higher and (ii) the borrowing constraint is tighter.

### 4.3 Foreign Households (Patient Lenders)

Representative foreign household derives utility from consumption \((c^*_t)\). The representative household maximizes the following utility function:

\[
\max_{\{c^*_t, d^*_t, e^*_t\}} U_t = \sum_{t=0}^{\infty} \beta^{t} u(c^*_t), \quad (13)
\]

where \(\beta^*\) is the foreign agents’ discount factor (which is larger than \(\beta\)).\(^{14}\)

Foreign households are subject to the following budget constraint:

\[
c^*_t + d^*_t + \psi(e_t) + e_t = p_{Ft} y^*_t + d^*_{t-1} R^d_{t-1} + e_{t-1} R^e_{t-1} + \pi_t, \quad (14)
\]

where \(d^*_{t-1}\) are deposits in a financial intermediary accumulated by the end of period \(t - 1\) and carried into period \(t\), which pay a gross interest rate \(R^d_{t-1}\); \(e_{t-1}\) represents equity capital in the financial intermediary, with gross rate of return \(R^e_{t-1}\); and \(y^*_t\) is an exogenous endowment of non-durable F consumption goods; and \(\psi(e_t)\) represents a convex cost of changing equity position. As in Jermann and Quadrini (2012), this cost is positive and creates a pecking order of liabilities whereby debt is always preferred to equity.

The problem for the foreign representative household is to maximize (13) subject to (14).

\(^{14}\)For simplicity, we abstract from housing purchases for the foreign representative household. Since the foreign household is assumed to be relatively patient, this assumption is innocuous. The only difference from explicitly incorporating foreign housing decisions would be to price housing in the lending country, something our empirical evidence has little to say.
The first order conditions for the optimal choice of deposits and equity are:

\[ 1 = \beta^* R^d_t \mathbb{E}_t \left[ \frac{u'(c^*_t+1)}{u'(c^*_t)} \right], \]

(15)

and:

\[ 1 + \psi'(e_t) = \beta^* R^e_t \mathbb{E}_t \left[ \frac{u'(c^*_t+1)}{u'(c^*_t)} \right]. \]

(16)

4.4 Global Financial Intermediary

A representative global financial intermediary finance loans to impatient domestic households with a mix of equity and deposits collected from the patient foreign savers. The balance sheet of the global financial intermediary at time \( t \) (after borrowers and lenders decisions) is:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans, ( nd_t )</td>
<td>Deposits, ((1-n)d^*_t)</td>
</tr>
<tr>
<td>Equity, ((1-n)e_t)</td>
<td></td>
</tr>
</tbody>
</table>

The financial intermediary maximizes (next period) profits:

\[ \max_{\{d_t, d^*_t, e_t\}} \Pi_{t+1} = R_t nd_t - R^d_t (1-n) d^*_t - R^e_t (1-n) e_t. \]

(17)

The financial intermediary is subject to a leverage constraint:

\[ nd_t \leq \chi (1-n) e_t, \]

(18)

where \( \chi \in (0, 1) \) captures the maximum leverage ratio either markets or regulatory authorities are willing to tolerate.\(^{15}\)

\(^{15}\)Gabaix and Maggiori (2014) obtain a similar constraint assuming financiers can divert part of the funds intermediated through their activity.
The problem for the representative global financial intermediary is to maximize (17) subject to the following balance sheet constraint:

\[ nd_t = (1 - n)d^*_t + (1 - n)e_t, \]  

(19)

and leverage constraint (19). Let \( \phi_t \) be Lagrange multiplier on the leverage constraint. The first order conditions for the optimal choice of loans (after substituting for \( d^*_t \) in the profit function from the balance sheet constraint) is:

\[ \phi_t = R_t - R^{d}_t. \]  

(20)

The first order condition for the optimal choice of equity is:

\[ R^{e}_t - R^{d}_t = \phi_t \chi. \]  

(21)

Replacing \( \phi_t \) from (20) into (21) we get:

\[ R_t = \left(1 - \frac{1}{\chi}\right) R^{d}_t + \frac{1}{\chi} R^{e}_t. \]

The above equation shows that the interest rate on loans to impatient households is a weighted average of the cost of funding these loans with a combination of equity and deposits.

4.5 Assumptions, functional forms, and equilibrium

In equilibrium, the assumption of a relative impatient domestic household implies that the Home country borrows from the Foreign country at the prevailing market interest rate. Therefore, borrowers can use their endowment, together with loans, to buy non-durable consumption goods and new houses, and to repay old loans with interest.

Moreover, we make the following assumptions: (i) the supply of housing is fixed and equal to 1, so that \( h_t = h = 1 \); (ii) the utility function for both home and foreign consumers has a
standard CRRA form:
\[ u(c_t) = \frac{c_t^{1-v} - 1}{1 - v}, \]
where \( v \) is the CRRA coefficient; and (iii) we parametrize the equity adjustment costs as follows:
\[ \psi(e_t) = \bar{e} \eta \left( \frac{e_t}{\bar{e}} \right)^\gamma, \]
where \( \bar{e} \) is steady state equity, \( \eta > 0 \), and \( \gamma > 1 \). Note that this implies that
\[ \psi'(e_t) = \gamma \eta \left( \frac{e_t}{\bar{e}} \right)^{\gamma - 1}. \]
That is, \( \psi(e_t) \) is a positive, increasing and convex function of \( e_t \). Also, in steady state
\[ \psi'(e_t) = \gamma \eta. \]

We solve for the equilibrium where both the collateral constraint and the leverage constraint are binding. The equilibrium is a set of stationary processes \( \{ q_t, \mu_t, R_t, R_t^d, R_t^e, d_t, \tau_t, s_t, c_t, c^*_t, c^*_H_t, c^*_F_t \} \) for \( t \geq 0 \) subject to the equilibrium equations below.

**Domestic households optimality conditions:**

\[
\begin{align*}
1 - \mu_t &= \beta R_t \mathbb{E}_t \left[ \frac{u'(c_{t+1}) s_{t+1}}{u'(c_t) s_t} \right], \\
(1 - \mu_t \theta) q_t &= \frac{v'(h)}{u'(c_t)} + \beta \mathbb{E}_t \left[ \frac{u'(c_{t+1}) q_{t+1}}{u'(c_t)} \right], \\
s_t d_t &\leq \theta q_t,
\end{align*}
\]
with \( \mu_t \geq 0 \). Foreign households:

\[
\begin{align*}
1 &= \beta^* R_t^d \mathbb{E}_t \left[ \frac{u'(c^*_t+1)}{u'(c^*_t)} \right], \\
1 + \psi'(e_t) &= \beta^* R_t^e \mathbb{E}_t \left[ \frac{u'(c^*_t+1)}{u'(c^*_t)} \right].
\end{align*}
\]

**Financial intermediaries:**

\[ R_t = \left( 1 - \frac{1}{\chi} \right) R_t^d + \frac{1}{\chi} R_t^e. \]
and their leverage constraint:

\[ nd_t \leq \chi(1 - n)c_t. \]

Goods market equilibrium:

\[ ny_t = nc_{Ht} + (1 - n)c^*_t \quad (1 - n)y^*_t = nc_{Ft} + (1 - n)c^*_t. \]

Consumption demands:

\[ c_{Ht} = \alpha \tau^{1-\alpha} c_t \quad \text{and} \quad c_{Ft} = (1 - \alpha) \tau^{-\alpha} c_t, \]

and

\[ c^*_{Ht} = \alpha^* \tau^{1-\alpha^*} c^* t \quad \text{and} \quad c^*_{Ft} = (1 - \alpha^*) \tau^{-\alpha^*} c^* t, \]

where note that the relative prices are expressed using the terms of trade as in equation (6).

Exchange rate:

\[ s_t = \tau_t^{\alpha - \alpha^*}, \]

and borrower’s budget constraint:

\[ c_t = \tau_t^{\alpha - 1} y_t + s_t(d_t - R_{t-1}d_{t-1}). \]

with \( \mu_t \geq 0. \)

5 A Foreign Credit Supply Shock

This Section studies the response of the domestic economy to a foreign shock that is consistent with the “global liquidity shock” identified in the empirical analysis of Section 3. Specifically, we consider a foreign credit supply shock caused by the relaxation of the financial intermediary’s leverage constraint (\( \chi \)). We focus on this shock because, according to the instrument selection procedure described in Section 3, US broker dealers’ leverage turns out to be the most relevant instrument to identify global liquidity shocks. Specifically, leverage is chosen as external instrument in 42 out of 48 cases.
We first present the results from a simplified version of the model to build intuition on how the foreign credit supply shock transmits to the domestic economy. We then consider the full version model to conduct a quantitative exercise.

5.1 Analytical results

We consider a simplified version of the model that allows us to characterize the equilibrium of the economy analytically. To do that we make three auxiliary assumptions: (i) there is a single good in the economy (i.e., \( s_t = \tau_t = 1 \)); (ii) utility is linear in consumption (i.e., \( u'(c_t) = \bar{u} \) for both home and foreign consumers); and (iii) the two countries have equal size (i.e., \( n = 0.5 \)). As a result, the marginal rate of substitution between housing services and consumption is constant:

\[
mrs = \frac{v'(1)}{\bar{u}},
\]

and the equilibrium is fully static (the Appendix reports the full derivation).

Under these assumptions we can derive the credit demand and the credit supply schedules in this simple economy and characterize its equilibrium. Equation (22) constitutes the supply of funds:

\[
R = \frac{1}{\beta^*} \left( 1 + \Theta \left( \frac{d}{\chi} \right)^{\gamma-1} \right).
\]  (22)

where \( \Theta = \gamma \eta \bar{e}^{1-\gamma} \). In the space \( \{d, R\} \), the supply is an increasing and convex function (as long as \( \gamma > 1 \)), which crosses the vertical axis at \( 1/\beta^* \). Equation (23) constitutes the demand of funds:

\[
R = \begin{cases} 
1/\beta & \text{if } d < \theta p \\
\frac{\theta-(1-\beta)}{\beta^*} - \frac{mrs}{\beta d} & \text{if } d = \theta p 
\end{cases} \]  (23)

The demand of funds is a piecewise function in the space \( \{d, R\} \). The first portion is flat: when debt is low the collateral constraint is not binding and, hence the shadow price of the collateral constraint is zero. The second part of the demand schedule is downward-sloping. The borrowing constraint at equality pins down the kink of the demand function.

Finally, we can derive an expression for house prices that depends on whether the collateral

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constraint is binding or not:

\[ q = \frac{mrs}{1 - \mu \theta - \beta}, \] (24)

while consumption is defined by the home household budget constraint:

\[ c = y - d(R - 1). \] (25)

The intersection of demand and supply of funds determines an equilibrium quantity of credit \( d \) that flows from the foreign to the domestic economy, and an associated interest rate \( R \). As Figure 4 shows, depending on the parameter values, two equilibria may arise. If the borrowing constraint does not bind (point A in Figure 4), the interest rate is equal to the inverse of the home households’ discount factor \( (R = 1/\beta) \), house prices equal the present discounted value of the marginal rate of substitution \( (q = mrs/(1 - \beta)) \), and credit is low. Vice versa, if the borrowing constraint is binding (point B in Figure 4), the interest rate is “low”, and lies somewhere in between the inverse of the two individual discount factors \( (1/\beta^* \leq R < 1/\beta) \), while credit and house prices are high. Given the value of credit and the interest rate, equity equals credit divided by the leverage constraint parameter \( \chi \). Finally, the budget constraints determine consumption of the two representative households.

Consider now an increase in \( \chi \) that leads to an increase in the leverage of financial intermediaries. Since equity is sticky, the shock shifts the supply of credit, which leads to increased cross-border bank lending \( (d \uparrow) \). In response to the shock, consumption increases. Depending on the starting point and the size of the shock, the interest rate and house prices respond differently.

**Case 1: Small Shock in a Low Credit Economy**

The first case corresponds to an economy that starts in the equilibrium with low credit and high interest rate (as in point A depicted in Figure 4). If the shock is small, the supply schedule shifts right (dashed line in Figure 5), but not enough to cross the downward sloping portion of the demand schedule (point \( A' \)). The increase in credit availability is not enough to make agents in the domestic economy willing to increase their housing purchases. Instead, the additional funds are fully spent on consumption of non-durable goods. As a result, the
shock has no effect on interest rates and house prices.

Case 2: High Credit Economy

The second case sees the domestic economy starting in an equilibrium in which credit supply is relatively high and the interest rate relatively low (as in point $B$ depicted in Figure 4). As in the previous case, the shock shifts the supply schedule to the right (dashed line in Figure 6). But now the additional availability of credit pushes down on the interest rate and induces domestic households to further purchase housing (point $B'$). As the interest rate falls, the shadow value of housing increases and magnifies the effect on house prices.

Case 3: Large Shock in a Low Credit Economy

The most interesting case occurs when a large credit shock hits an economy that starts with low credit and a high interest rate (as in point $A$ depicted in Figure 4). In this case, the supply schedule shifts enough to cross the downward sloping portion of the demand schedule (dashed line in Figure 7), pushing the economy to the new equilibrium denoted by $A'$. As a result, the adjustment is similar to the previous case, but all the effects are obviously larger. In particular, this scenario shows how a relaxation of the collateral constraint via increased house prices can amplify the foreign-ignited domestic boom caused by the foreign credit supply shock. This is in line with the conjecture (which similar to the global liquidity shock identified in Section 3) can lead to a that is line with the VAR evidence, especially for the those countries that have a large share of foreign currency liabilities.

The results from the credit supply shock in the model are qualitatively in line with the VAR evidence and with the conjectured transmission mechanism. As cross-border credit increases, so do consumption and house prices. If borrowing is limited by a collateral constraint, the foreign credit supply shock relaxes the tightness of the constraint by increasing the value of the collateral.

Moreover, as we have seen in the impulse responses in Figure 3, the increase in house prices and consumption is much larger in the group of countries that have a large share of foreign currency liabilities. However, the simple model we analyzed in this Section abstracts from relative price movements. This discussion therefore pushes us toward a model that
can fully address these issues. In the next section, we enrich our baseline economy with multiple goods and home bias in consumption so that we can define the real exchange rate and characterize its evolution. The cost of introducing these additional elements is the loss of tractability, as in addition we also depart from the assumption of risk neutrality and perfect foresight.

5.2 Quantitative results

We are now ready to analyze the results from the full model presented in Section 4. we provide a short description of its parametrization below, while the complete list of equations (together with the derivation of the steady state) are reported in the Appendix.

Table 1 summarizes the parameter values. Household preferences are given by a CRRA utility function. As is commonly done in the literature, we set the coefficient of risk aversion in the utility function $\nu$ to 1.5. We set the discount factor in the foreign economy $\beta^*$ to 0.992, consistent with an annualized interest rate on deposits ($R^d_t$) of 3.25 percent. We then parametrize the equity adjustment cost function so as to fix the return on equity ($R^e_t$) to about 6.4 percent. To do that we set $\eta = 0.005$ and $\gamma = 1.5$. We set steady state leverage ($\chi$) to 5. This implies that the interest on borrowing for home consumers is equal to about 4 percent. The discount factor for home consumers ($\beta$) is set to 0.985, arbitrarily smaller than $\beta^*$. The maximum allowed LTV ratio ($\theta$) is set to 0.75.

In line with the empirical exercise above, we assume that the domestic economy is smaller than the foreign economy. We therefore set $n = 0.01$. We also assume a substantial degree of home bias in consumption, and we set $\alpha = 0.6$ (the home bias in consumption for the foreign economy is set symmetrically).

As in the previous sections, we consider a foreign credit supply shock caused by the relaxation of the financial intermediary’s leverage constraint ($\chi$). We therefore specify the

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16 We then set the (constant) marginal utility of housing services to an arbitrarily low number.
following exogenous process for the leverage constraint:

\[ \chi_t = \chi_t^{(1-\rho_\chi)} \chi_{t-1}^{\rho_\chi} \exp (\varepsilon_{\chi,t}) , \]

where \( \rho_\chi \) is the persistence of \( \chi_t \) and \( \varepsilon_{\chi,t} \) is an exogenous innovation that we assume being normally distributed, with zero mean and variance equal to \( \sigma^2_\chi \).

We solve and log-linearize the model around its non-stochastic steady state using Dynare. In doing that, we assume that the collateral constraint on borrowing is always binding. This corresponds to “Case 2” analyzed above.

Figure 8 reports the impulse responses to a shock to \( \varepsilon_{\chi,t} \). To facilitate the comparison with the impulse responses from the VAR in Section 3, we normalize the shock so that it leads to an increase of home consumers borrowing by 1 percent. As in the simple model described above, the shock corresponds to an outward shifts of the credit supply schedule. The additional availability of credit pushes down on the interest rate and induces domestic households to further purchase housing and to consume more. As the interest rate falls, the shadow value of housing increases and magnifies the effect on house prices. Moreover, given the home bias in consumption, the relative price of the home and foreign consumption baskets change. As a result, the exchange rate appreciates, therefore increasing the dollar value of the collateral and further relaxing the borrowing constraint.

6 Conclusions

To Be Added
## Table 1 Model’s Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Weight of H good in H consumption</td>
<td>0.6</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Size of H economy</td>
<td>0.01</td>
</tr>
<tr>
<td>$\alpha^*$</td>
<td>Weight of H good in F consumption</td>
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<td>$\nu$</td>
<td>Relative risk aversion</td>
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<td>$\psi_h$</td>
<td>Marginal utility of housing</td>
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<tr>
<td>$\beta$</td>
<td>H discount factor</td>
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<tr>
<td>$\beta^*$</td>
<td>F discount factor</td>
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<tr>
<td>$\theta$</td>
<td>LTV ratio</td>
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</tr>
<tr>
<td>$y$</td>
<td>H endowment</td>
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</tr>
<tr>
<td>$y^*$</td>
<td>F endowment</td>
<td>1</td>
</tr>
<tr>
<td>$\rho_\chi$</td>
<td>Persistence of leverage shock</td>
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<tr>
<td>$\chi$</td>
<td>Steady state leverage</td>
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</tr>
<tr>
<td>$\gamma$</td>
<td>Equity adj. cost (1)</td>
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</tr>
<tr>
<td>$\eta$</td>
<td>Equity adj. cost (2)</td>
<td>0.005</td>
</tr>
</tbody>
</table>

*Note.* Parameter values in the baseline calibration.
Figure 1 Event Study on Cross-border Bank Credit. Note.
Figure 2 IRFs to a global liquidity shock - All Countries. Censored impulse responses to a shock to global liquidity that raises cross-border credit by 1 percent. The dark and light shaded areas are the one and two standard deviation confidence intervals. The dashed line reports the uncensored impulse responses.
Figure 3 Impulse Responses To A Global Liquidity Shock – Low And High Share Of Foreign Currency Debt. Censored impulse responses to a shock to global liquidity that raises cross-border credit by 1 percent in “high” and “low” foreign currency liabilities countries. The dark and light shaded areas are the one and two standard deviation confidence intervals. The dashed line reports the uncensored impulse responses.
**Figure 4** Graphical Representation Of The Equilibrium. Equilibrium in the credit market of the simplified model.

**Figure 5** Relaxation Of The Leverage Constraint (Small Shock) In An Economy Starting With Low Credit And High Interest Rate. Comparative statics in the simplified model. The shock corresponds to an increase in $\chi$, i.e. an increase in the financial intermediary’s leverage.
Figure 6 Relaxation of the leverage constraint (small shock) in an economy starting with high credit and low interest rate. Comparative statics in the simplified model. The shock corresponds to an increase in $\chi$, i.e. an increase in the financial intermediary’s leverage.

Figure 7 Relaxation of the leverage constraint (large shock) in an economy starting with low credit and high interest rate. Comparative statics in the simplified model. The shock corresponds to an increase in $\chi$, i.e. an increase in the financial intermediary’s leverage.
Figure 8: Relaxation of the Leverage Constraint. Impulse responses obtained from the full model. The shock corresponds to an increase in \( \chi \), i.e. an increase in the financial intermediary’s leverage, that leads to an increase of home consumers borrowing by 1 percent.
References


A Appendix. Identification

Consider the following reduced form VAR (with only one lag and no constant or trend for simplicity):

\[ x_t = Fx_{t-1} + u_t, \]  
(A.1)

where \( x_t \) is a \((m \times 1)\) vector of endogenous variables; \( F \) is a \((m \times m)\) matrix of coefficients; and \( u_t \) is a \((m \times 1)\) vector of residuals with variance-covariance matrix \( \Sigma_u \). The objective is to recover the structural form of the above VAR, i.e.:

\[ Ax_t = Bx_{t-1} + \varepsilon_t, \]  
(A.2)

where \( A \) and \( B \) are \((m \times m)\) matrices of coefficients; and \( \varepsilon_t \) is an \((m \times 1)\) vector of structural residuals with variance-covariance matrix \( \Sigma_\varepsilon = I \). Note that the reduced form residuals are a linear combination of the structural residuals. Specifically, letting \( \tilde{A} = A^{-1} \), we have that \( u_t = \tilde{A}\varepsilon_t \).

If we partition the vector of endogenous variables \( x_t \) as \((GL_t, x_{p,t})'\) —where \( GL_t \) is global liquidity and \( x_{p,t} \) is the \((m-1 \times 1)\) vector of remaining endogenous variables— we can re-write the reduced-form VAR as:

\[
\begin{bmatrix}
GL_t \\
x_{p,t}
\end{bmatrix}
= \begin{bmatrix}
f_{11} & f_{12} \\
f_{21} & f_{22}
\end{bmatrix}
\begin{bmatrix}
GL_{t-1} \\
x_{p,t-1}
\end{bmatrix}
+ \begin{bmatrix}
\tilde{a}_{11} & \tilde{a}_{12} \\
\tilde{a}_{21} & \tilde{a}_{22}
\end{bmatrix}
\begin{bmatrix}
\varepsilon_t^{GL} \\
\varepsilon_t^{x_p}
\end{bmatrix},
\]  
(A.3)

where \( f_{11} \) and \( \tilde{a}_{11} \) are scalars; \( f_{12} \) and \( \tilde{a}_{12} \) are \((1 \times m - 1)\) vectors; \( f_{21} \) and \( \tilde{a}_{21} \) are \((m - 1 \times 1)\) vectors; \( f_{22} \) and \( \tilde{a}_{22} \) are \((m - 1 \times m - 1)\) matrices; and \( \varepsilon_t^{GL} \) and \( \varepsilon_t^{x_p} \) are the structural residuals associated to global liquidity and the remaining endogenous variables, respectively.

For the sake of argument, let’s assume that the structural matrix \( \tilde{A} \) is known. Then, we would be able to compute the impulse response to a global liquidity shock. Specifically, the contemporaneous responses of \( GL \) and \( x_p \) to a unit shock to \( \varepsilon_t^{GL} \) would be given by:

\[
\begin{bmatrix}
\mathcal{IRF}^{GL}_0 \\
\mathcal{IRF}^{x_p}_0
\end{bmatrix}
= \begin{bmatrix}
\tilde{a}_{11} \\
\tilde{a}_{21}
\end{bmatrix},
\]

which, since the model is linear, can be normalized to:

\[
\begin{bmatrix}
\mathcal{IRF}^{GL}_0 \\
\mathcal{IRF}^{x_p}_0
\end{bmatrix}
= \begin{bmatrix}
1 \\
\tilde{a}_{21}/\tilde{a}_{11}
\end{bmatrix}.
\]  
(A.4)

Finally, the impulse response functions at longer horizons can be computed as:

\[ \mathcal{IRF}_n = F^{n-1} \cdot \mathcal{IRF}_{n-1} \quad \text{for} \quad n = 2, ..., N. \]  
(A.5)

Note that if we are interested in computing the impulse responses to the global liquidity
shock only we do not need to know all the coefficients of $\tilde{A}$, but rather only the elements of the first column of $\tilde{A}$, namely $\tilde{a}^1$.

We now consider the case of $\tilde{A}$ unknown. To achieve identification, we follow the external instrument identification approach pioneered by Stock and Watson (2012) and Mertens and Ravn (2013). Let $u^{GL}$ and $u^{x_p}$ be the OLS estimates of the reduced form residuals in (A.1). Also, let $Z_t$ be a $(z \times 1)$ vector of instrumental variables that satisfy:

$$
E[\varepsilon^{GL} Z'_t] = \phi,
E[\varepsilon^{x_p} Z'_t] = 0,
$$

i.e., the instruments are correlated with the global liquidity shock ($\varepsilon^{GL}$) but are orthogonal to all the other domestic shocks (the elements of $\varepsilon^{x_p}$). We can obtain consistent estimates of $\tilde{a}^1$ from the two-stage least squares regression of $u^{x_p}$ on $u^{GL}$ using $Z_t$ as instruments. In other words, since the reduced form residuals of the global liquidity equation ($u^{GL}_t$) are an imperfect measure of true structural shock ($\varepsilon^{GL}$), in the first stage we regress them on the set of instruments ($Z_t$):

$$
u^{GL}_t = \beta Z_t + \xi_t, \tag{A.6}$$

to construct the fitted values $\hat{u}^{GL}_t$. Then we regress the reduced form residuals of the domestic equations ($u^{x_p}_t$) on the fitted values ($\hat{u}^{GL}_t$) to get a consistent estimate of the ratio $\tilde{a}_{21}/\tilde{a}_{11}$:

$$
u^{x_p}_t = \frac{\tilde{a}_{21}}{\tilde{a}_{11}} \hat{u}^{GL}_t + \zeta_t, \tag{A.7}$$

where note that $\hat{u}^{GL}_t$ is orthogonal to $\zeta_t$ under the assumption that $E[\varepsilon^{x_p} Z'_t] = 0$.

Finally, we can use the OLS estimates of the matrix $F$ to compute the impulse response functions of all variables to a global liquidity shock using the formula in (A.5).

B Appendix. Steady state of the full model

First substitute consumption demands and definition of exchange rate into goods market equilibrium:

$$
ny_t = \tau^{-1-\alpha}_t [\alpha n c_t + s_t \alpha^*(1-n)c^*_t] \quad (1-n)y^*_t = \tau^{-\alpha}_t [(1-\alpha)nc_t + s_t(1-\alpha^*)(1-n)c^*_t].
$$
The equilibrium simplifies to a set of stationary processes \( \{ q_t, \mu_t, R_t, R^d_t, R^e_t, d_t, c_t, s_t, c_t^*, \tau_t, s_t^*, c_t^* \} \) for \( t \geq 0 \) subject to the equilibrium equations below:

\[
\begin{align*}
(1) \quad & 1 - \mu_t = \beta R_t E_t \left[ \frac{u'(c_{t+1})}{u(c_t)} \right] s_{t+1} \\
(2) \quad & (1 - \mu_t \theta) q_t = \frac{v'(h)}{u'(c_t)} + \beta E_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} q_{t+1} \right] \\
(3) \quad & s_t d_t = \theta q_t \\
(4) \quad & 1 = \beta^* R^d_t E_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} \right] \\
(5) \quad & 1 + \psi'(e_t) = \beta^* R^e_t E_t \left[ \frac{u'(c_{t+1})}{u'(c_t)} \right] \\
(6) \quad & R_t = \left( 1 - \frac{1}{\chi} \right) R^d_t + \frac{1}{\chi} R^e_t \\
(7) \quad & nd_t \leq \chi (1 - n) e_t \\
(8) \quad & s_t = \tau^{\alpha - \alpha^*}_t \\
(9) \quad & n y_t = \tau^{1 - \alpha}_t [\alpha n c_t + s_t \alpha^*(1 - n)c_t^*] \\
(10) \quad & (1 - n) y^*_t = \tau^{\alpha}_t [(1 - \alpha)n c_t + s_t (1 - \alpha^*)(1 - n)c_t^*] \\
(11) \quad & c_t = \tau^{\alpha - 1}_t y_t + s_t (d_t - R_{t-1} d_{t-1})
\end{align*}
\]

with \( \mu_t \geq 0 \). Remove time subscripts and plug in assumed functional forms:

\[
\begin{align*}
(1) \quad & 1 - \mu = \beta R, \\
(2) \quad & (1 - \theta \mu) q = v^h c^v + \beta q \quad \Rightarrow \quad q = \frac{v^h c^v}{1 - \mu - \beta} \\
(3) \quad & s d = \theta q, \\
(4) \quad & 1 = \beta^* R^d \\
(5) \quad & 1 + \gamma \eta = \beta^* R^e \\
(6) \quad & R = \left( 1 - \frac{1}{\chi} \right) R^d + \frac{1}{\chi} R^e \\
(7) \quad & nd \leq \chi (1 - n) e \\
(8) \quad & s = \tau^{\alpha - \alpha^*}_t \\
(9) \quad & n y = \tau^{1 - \alpha}_t [\alpha n c + s \alpha^*(1 - n)c^*] \\
(10) \quad & (1 - n) y^*_t = \tau^{\alpha}_t [(1 - \alpha)n c + s (1 - \alpha^*)(1 - n)c^*] \\
(11) \quad & c = \tau^{\alpha - 1}_t y + s (d - R_{t-1} d_{t-1})
\end{align*}
\]

From (4):

\[ R^d = \frac{1}{\beta^*}. \]

From (5):

\[ R^e = \frac{1 + \gamma \eta}{\beta^*}. \]

From (6):

\[ R = \left( 1 - \frac{1}{\chi} \right) R^d + \frac{1}{\chi} R^e. \]

From (1)

\[ \mu = 1 - \beta R. \]
Substitute $s$ from (8) everywhere

\begin{align*}
(2) \quad (1 - \theta \mu) q &= v^h c^v + \beta q \quad \implies \quad q = \frac{v^h c^v}{1 - \theta \mu - \beta} \\
(3) \quad \tau^{\alpha - \alpha^*} d &= \theta q, \\
(7) \quad n d &\leq \chi (1 - n) e \\
(9) \quad n y &= \tau^{1 - \alpha} [\alpha n c + \tau^{\alpha - \alpha^*} \alpha^* (1 - n) c^*] \\
(10) \quad (1 - n)y^* &= \tau^{\alpha^*} [(1 - \alpha) n c + \tau^{\alpha - \alpha^*} (1 - \alpha^*) (1 - n) c^*] \\
(11) \quad c &= \tau^{\alpha - 1} y + \tau^{\alpha - \alpha^*} d (1 - R)
\end{align*}

Substitute $q$ from (2) into (3):

\begin{align*}
(3) \quad \tau^{\alpha - \alpha^*} d &= \theta \frac{v^h c^v}{1 - \theta \mu - \beta}, \\
(7) \quad n d &\leq \chi (1 - n) e \\
(9) \quad n y &= \tau^{1 - \alpha} [\alpha n c + \tau^{\alpha - \alpha^*} \alpha^* (1 - n) c^*] \\
(10) \quad (1 - n)y^* &= \tau^{\alpha^*} [(1 - \alpha) n c + \tau^{\alpha - \alpha^*} (1 - \alpha^*) (1 - n) c^*] \\
(11) \quad c &= \tau^{\alpha - 1} y + \tau^{\alpha - \alpha^*} d (1 - R)
\end{align*}

Now forget about (7) for the moment and note that if we substitute $d$ from (3) into (11), we get a system of 3 equations (9)-(10)-(11) in three unknowns $c$, $c^*$, and $\tau$:

\begin{align*}
(9) \quad n y &= \tau^{1 - \alpha} [\alpha n c + \tau^{\alpha - \alpha^*} \alpha^* (1 - n) c^*] \\
(10) \quad (1 - n)y^* &= \tau^{\alpha^*} [(1 - \alpha) n c + \tau^{\alpha - \alpha^*} (1 - \alpha^*) (1 - n) c^*] \\
(11) \quad c &= \tau^{\alpha - 1} y + \theta \frac{v^h c^v}{1 - \theta \mu - \beta} (1 - R)
\end{align*}

We can solve this system in Matlab. Now we can use (2) to recover $q$

\[
q = \frac{v^h c^v}{1 - \theta \mu - \beta},
\]

and (3) to recover $d$:

\[
d = \theta q \tau^{-\alpha + \alpha^*}.
\]

Finally we can find a value for $e$ from (5):

\[
e_t = \frac{nd_t}{\chi (1 - n)},
\]

and a value for $s$ from (3)

\[
s = \tau^{\alpha - \alpha^*}.
\]

C Appendix. The simplified model

We consider a simplified version of the model that allows us to characterize the equilibrium of the economy analytically. To do that we make three auxiliary assumptions: (i) there is
a single good in the economy (i.e., \( s_t = \tau_t = 1 \)); (ii) utility is linear in consumption (i.e., \( u'(c_t) = \bar{u} \) for both H and F consumers); and (iii) the two countries have equal size (i.e., \( n = 0.5 \)).

The equilibrium conditions of the simplified model are very similar to the ones of the full model. The exchange rate \( (s_t) \) drops out from the budget and collateral constraints of the impatient household. The problem of the patient household is not affected. Given the assumption of countries of equal sizes (i.e., \( n = 0.5 \)), the problem of the global financial intermediary also simplifies and \( n \) disappears from balance sheet and leverage constraints. An implication of imposing that utility is linear in consumption and that the supply of housing is fixed and equal to 1 \( (h_t = h = 1) \), is that the marginal rate of substitution between housing services and consumption is constant:

\[
\text{mrs} = \frac{u'(1)}{\bar{u}}.
\]

This also implies that the equilibrium is fully static. Therefore, in what follows, we drop the time indexes. The equilibrium of this simple economy can be characterized by the following system of equations:

\[
\begin{align*}
(1) & \quad 1 - \mu = \beta R \\
(2) & \quad (1 - \mu \theta)q = \text{mrs} + \beta q \\
(3) & \quad d = \theta q \\
(4) & \quad 1 = \beta^* R^d \\
(5) & \quad 1 + \psi'(e) = \beta^* R^e \\
(6) & \quad R = \left(1 - \frac{1}{\chi}\right) R^d + \frac{1}{\chi} R^e \\
(7) & \quad d \leq \chi e \\
(9) & \quad c = y + (d - Rd)
\end{align*}
\]

C.1 Analytical derivation of the equilibrium in the credit market

Risk neutrality gives that the return on deposits is equal to the inverse of the individual discount factor of the foreign representative household:

\[
R^d = \frac{1}{\beta^*},
\]

while the return on equity is:

\[
R^e = \frac{1 + \psi'(e)}{\beta^*},
\]

which implies that that the return on equity is larger than the return on deposits. We can now rewrite the optimality condition for the global financial intermediary as:

\[
R = \frac{1}{\beta^*} \left(1 + \frac{\psi'(e)}{\chi}\right).
\]
Finally, note that
\[ \psi'(e) = \Theta e^{\gamma-1}, \]
where \( \Theta = \gamma \eta e^{1-\gamma} \). Finally, we assume that the leverage binds with equality to obtain:
\[ R = \frac{1}{\beta^*} \left( 1 + \Theta \left( \frac{d}{\chi} \right)^{\gamma-1} \right). \tag{C.1} \]

Equation (C.1) constitutes the supply of funds. In the space \( \{d, R\} \), the supply is an increasing and convex function (as long as \( \gamma > 1 \)), which crosses the vertical axis at \( 1/\beta^* \).

To obtain an expression for the demand of funds, we can use the domestic representative household optimality condition
\[ R = \frac{1 - \mu}{\beta}. \]
The demand of funds is a piecewise function in the space \( \{d, R\} \). The first portion is flat: when debt is low the collateral constraint is not binding and, hence the shadow price of the collateral constraint is zero. The second part of the demand schedule is downward-sloping. The borrowing constraint at equality pins down the kink of the demand function. To obtain the expression for demand in this case, we can recover an expression for the Lagrange multiplier from the first order condition for house prices (i.e., \( (1 - \mu \theta) q = \text{mrs} + \beta q \)) assuming that the collateral constraint holds with equality (i.e., \( d = \theta q \)). We can finally write:
\[ R = \begin{cases} 
1/\beta & \text{if } d < \theta p \\
\frac{\theta - (1-\beta)}{\beta \theta} - \frac{\text{mrs}}{\beta d} & \text{if } d = \theta p 
\end{cases} \tag{C.2} \]

The intersection of demand and supply of funds determines an equilibrium quantity of credit \( d \) that flows from the foreign to the domestic economy, and an associated interest rate \( R \).

### D Appendix. Data Sources

This appendix provides a description of the data used in the empirical analysis and on their sources. We consider 57 countries in our empirical analysis: 24 advanced economies (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, and US) and 33 emerging economies (Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Czech Republic, Estonia, Hong Kong, Hungary, India, Indonesia, Israel, Korea, Latvia, Lithuania, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Taiwan, Thailand, Ukraine, and Uruguay).
We collect data over the 1990:Q1 – 2012:Q4 (subject to data availability) for the following variables:

- **House prices.** Nominal house prices deflated by consumer price inflation. Source: OECD house price database, BIS Residential property price statistics, Dallas FED International House Price Database, National Central Banks, National Statistical Offices, academic and policy publications. More details on the definitions and the sources are reported in Table D.1.

- **Total cross-border banking flows.** Foreign claims (all instruments, in all currencies) of all BIS reporting banks vis-à-vis all sectors deflated by US consumer price inflation. Source: BIS.

- **Global liquidity.** Foreign claims (loans and deposits, in all currencies) of all BIS reporting banks vis-à-vis the banking sector deflated by US consumer price inflation. Source: BIS.

- **GDP.** Real index. Source: OECD, IMF IFS, Bloomberg.

- **Consumption.** Real private final consumption index. Source: OECD, IMF, IFS, Bloomberg.

- **Consumer prices.** Consumer price index. Source: OECD, IMF IFS, Bloomberg.

- **Short-term interest rates.** Short-term nominal market rates. A real ex-post interest rate is obtained by subtracting consumer price inflation. Source: OECD, IMF, IFS, Bloomberg.

- **Equity prices.** Equity price index deflated by consumer price inflation. Source: OECD, IMF IFS, Bloomberg.

- **Exchange rate vis-à-vis US dollar.** US dollars per unit of domestic currency. A real exchange rate is obtained with US and domestic consumer price inflation. Source: Datastream.

- **Real effective exchange rate.** Index (such that a decline of the index is a depreciation). Source: IMF IFS, BIS, Bloomberg.

- **Current account to GDP ratio.** Current account balance divided by nominal GDP. Source: OECD, IMF IFS, Bloomberg.
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**Note.** See the extended appendix on the sources of house price series extended with historical data.