Domestic Financial Participation and External Vulnerability in Emerging Economies*

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Abstract

The Global Financial Crisis (GFC) of 2008-2009 highlighted the role of the banking system as an important propagation mechanism of U.S. financial shocks to emerging economies (EMEs). Recent evidence shows that compared to advanced economies (AEs), emerging economies (EMEs) exhibit considerably lower levels of firm participation in the domestic banking system, leading several EMEs to promote greater firm domestic financial participation. What are the implications of this greater firm participation in the banking system for the response to external financial shocks, such as those experienced by EMEs during the GFC? We build a two-country RBC model with banking frictions, endogenous firm entry, and limited domestic financial participation by firms. Using the model, we show that greater firm financial participation in EMEs limits the effect of adverse external financial shocks on EME financial and macro aggregates, with endogenous firm entry playing a critical role in the volatility-reducing effects of greater firm financial participation in EMEs. We provide empirical evidence for EMEs that broadly supports our model findings.

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1 Introduction

The Global Financial Crisis (GFC) of 2008-2009 highlighted the strong linkages between financial markets and real economic activity within and across economies. As a result of the crisis, both advanced economies (AEs) and emerging economies (EMEs) have modified their financial regulatory frameworks to address credit and aggregate fluctuations. Importantly, in EMEs, these policy discussions have taken place amid sustained efforts to bolster greater firm participation in the domestic banking system on the extensive margin—more succinctly, *firm financial participation*—whose current levels are strikingly low in EMEs relative to those in AEs. Indeed, focusing on the extensive margin of participation, while more than 70 percent of firms in AEs have access to and use bank credit, only 20 percent of firms do so in EMEs. Firm financial participation rates across economies are also strongly positively associated with these economies' average bank credit-GDP ratios, with AEs having average bank credit-GDP ratios of 96 percent and EMEs having corresponding average ratios of only 56 percent (details on these facts are presented and discussed in Section **??**). Despite the growing body of work on the transmission of external financial shocks in the aftermath of the GFC and the role of the banking system, surprisingly little is known about the extent to which the degree of domestic financial development and its association with the extensive margin of firm financial participation in the domestic banking system in EMEs plays a role in the sensitivity to external financial shocks transmitted via the banking system in these economies. Our paper attempts to fill this gap by using a two-country RBC framework with banking frictions and endogenous firm entry that incorporates the differences between AEs and EMEs highlighted above. Our main result is that the degree of firm financial participation in EMEs is negatively associated with the size of the domestic propagation of adverse foreign financial shocks emanating from AEs and transmitted via the banking system. Moreover, using data for a representative sample of EMEs, we show that our model findings are broadly supported by empirical evidence.

Our two-country (AE and EME) framework features endogenous firm entry for two categories of firms, where firms in each category differ fundamentally in the way they finance their physical capital expenditures. Firms that purchase capital with internal resources are considered financially-excluded (e), whereas firms that use bank credit from domestic banks to obtain capital are considered financially-included (i). Importantly, endogenous entry introduces an explicit notion of the extensive margin of firm financial participation which, as noted above, has been at the center of financial inclusion efforts in EMEs. Following the literature on banking frictions ((Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gertler, Kiyotaki and Queralto, 2012)), banks in each economy face a financial constraint on raising resources via deposits from domestic households. We calibrate the model so that the AE represents the U.S. and the EME replicates the average level of firm financial participation based a representative sample of EMEs. Similar to Cuadra and Nuguer (2018), banks in the AE have a larger net worth (relative to the size of their economy) relative to EME banks and consequently lend to EME banks using cross-border bank flows (that is, non-core bank liabilities). Using the calibrated model, we reduce the sunk entry cost of financially-included firms in the EME, which generates an endogenous increase in the share of EME firms that participate in the domestic banking system. A key result is that greater firm financial participation in the EME reduces the adverse financial and aggregate effects in EMEs after an adverse external financial shock originating in the AE and transmitted via cross-border bank flows, with endogenous firm entry playing a critical role for this result. This finding is broadly consistent with evidence we document on the relationship between U.S. banks' net charge-offs, economic activity in EMEs, and the degree of EME domestic financial participation and development.

The intuition behind our model findings is as follows. In an environment with endogenous firm entry, households effectively consider firms as assets. As such, a reduction in financially-included firms' cost of entry in the EME (which, incidentally, generates an endogenous increase in the share of firm financial participation) amid a financial shock originating in the AE acts as a stabilizing force across asset classes—firms, capital, household deposits—which results in smoother fluctuations in all asset prices. Smoother asset-price fluctuations are ultimately reflected in smoother fluctuations in banks' net worth, bank credit, consumption, investment, and output in the EME. Importantly, we show that this stabilizing mechanism is absent in a model that abstracts from endogenous firm entry. As such, an otherwise-identical model without endogenous entry generates a counterfactual link between greater firm financial participation in the EME and the response of the EME to adverse external financial shocks originating in the AE. Thus, our findings stress the role of firm entry and exit for a better understanding of the transmission of financial shocks from AEs to EMEs when the two country groups differ non-trivially in their degree of domestic financial participation. More broadly, our findings suggest that cyclical financial policies aimed at stabilizing credit market fluctuations may need to adapt to the average degree of domestic financial participation.

Our work contributes to the theoretical literature on financial frictions, which has primarily focused in AEs in the aftermath of the GFC (Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gertler *et al.*, 2012), to recent studies that have extended models of banking frictions to EME contexts (Cuadra and Nuguer, 2018; Aoki, Benigno and Kiyotaki, 2015), and to the literature on endogenous firm entry and macroeconomic fluctuations rooted in the seminal work of Bilbiie, Ghironi and Melitz (2012) (henceforth BGM; examples of the BGM framework applied to a two-country environment, which is a feature at the heart of our framework, include Ghironi and Melitz (2005); Cacciatore, Ghironi and Stebunovs (2015); Cacciatore, Fiori and Ghironi (2016b); Cacciatore, Duval, Fiori and Ghironi (2016a)). Closest to our work is Epstein and Finkelstein Shapiro (2019), who study the extent to which differences in firms' and households' domestic financial participation in EMEs relative to AEs shed light on the differences in labor market dynamics and business cycle fluctuations between EMEs and AEs, and Rossi (2015); La Croce and Rossi (2018), who combine endogenous firm entry and a monopolistically-competitive banking system to show that endogenous firm entry acts as an amplification mechanism of shocks. A key difference between our work and Epstein and Finkelstein Shapiro (2019) is our explicit inclusion of banking frictions and our focus on the consequences for EMEs of external financial shocks originating in AEs and transmitted via the banking system. In turn, a key difference in our work relative to Rossi (2015); La Croce and Rossi (2018) is our interest in the limited participation of firms in the domestic banking system, which is not only a defining characteristic of firms in EMEs, but also a feature that has generally received little attention in the EME business cycle literature.

The rest of the paper is structured as follows. Section 2 summarizes key facts on firm financial participation and domestic financial development across countries that motivate our work. Section 3 describes the model. Section 4 presents our quantitative analysis and discusses our main findings, including empirical evidence that provides ample support to our results. Section 5 concludes.

2 Firm Financial Participation and Domestic Financial Development in the Data

In what follows, we use data for a representative sample of economies with available data on the fraction of firms that have bank credit which, by definition, is the extensive margin of firm financial participation, to highlight the stark differences in domestic financial development between AEs and EMEs. In addition, we document a positive and significant relationship between the breadth of firm financial participation and the average bank credit-GDP ratio (a proxy for the level of domestic financial development) across a comprehensive group of EMEs.

Data Details: Firm Financial Participation We use annual data on the percent of firms that have a bank loan or line of credit as a measure of firms' participation in the domestic banking system—a measure of the *extensive* margin of firm financial participation—for emerging economies with available data from the World Bank Enterprise Survey (WBES).[1] Our focus on bank credit as opposed to other sources of formal credit stems from the fact that bank credit generally represents the primary source of formal external financing for most firms that use the latter (IFC Enterprise Finance Gap Database 2010) Of note, the data on firm financial participation pertains only to registered (or formal) firms (existing evidence from the IFC Enterprise Finance Gap Database 2010 confirms that the bulk of unregistered (or informal) firms does not have formal external financing). The WBES data on firm financial participation generally includes more than one observation per country, with the earliest available year in the survey being 2006 and the most recent year being 2018, and the availability of observations for each year varying across countries. One limitation of the data on firm financial participation is its restricted time-series availability

[1] The WBES focuses primarily on developing and emerging economies and only includes a very select number of AEs.

on a consistent basis. As such, we construct an average measure of domestic financial participation by firms for each EME in the sample.

Data Details: Bank Credit to the Non-Financial Private Sector We use the share of bank credit to private non-financial sector in GDP—more succinctly, the bank credit-GDP ratio—from the Bank for International Settlements (BIS) as a measure of domestic financial development. This measure is available at a *quarterly* frequency, on average, for 45 years for a sample of 40 economies that includes AEs and EMEs.[2]

Key Facts Table 1 shows the ratio of average bank credit to the private non-financial sector to GDP for a select sample of AEs and EMEs for the period 1996Q1-2018Q2: the average bank credit-GDP ratio for AEs is 95.82 percent while the corresponding ratio for EMEs is 55.61 percent.

In turn, Figure 1 shows the relationship between our extensive-margin measure of firm financial participation and the average bank credit-GDP ratio for a comprehensive sample of EMEs with available data on both measures. The plot confirms a strong, positive relationship between the two variables, suggesting that greater domestic financial development is strongly associated with greater extensive-margin participation of firms in the domestic banking system. Our theoretical framework is able to capture these important characteristics of EMEs.

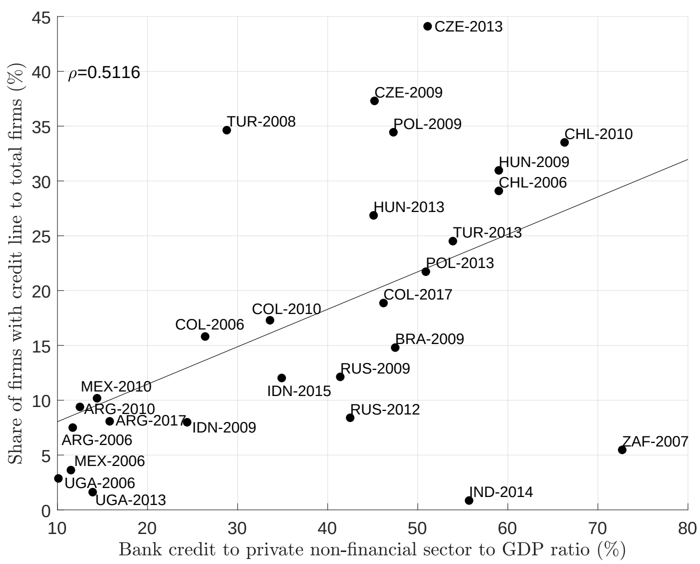
[2] The data on domestic bank credit does not differentiate between bank credit to firms and to households. However, existing evidence suggests that the bulk of bank credit in EMEs is allocated to firms (see, for example Beck, Büyükkarabacak, Rioja and Valev, 2012).

Tab. 1. Average Bank credit to private non-financial sector to GDP ratio for AEs and EMEs

Bank credit to private non-financial sector to GDP ratio			
Emerging Economies		Advanced Economies	
Argentina	14.75	Australia	108.56
Brazil	43.64	Austria	86.88
Chile	66.27	Belgium	62.11
Colombia	32.05	Canada	80.66
Czech Republic	41.9	Denmark	155.00
Hungary	38.97	Finland	70.87
India	43.84	France	81.77
Indonesia	30.13	Germany	88.93
Israel	68.13	Greece	78.69
Malaysia	128.9	Ireland	95.30
Mexico	15.05	Italy	72.84
Poland	37.01	Japan	104.58
Russia	30.67	Luxembourg	83.13
Saudi Arabia	37.44	Netherlands	109.16
Singapore	101.47	New Zealand	128.67
South Africa	61.87	Norway	73.09
South Korea	120.9	Portugal	117.14
Thailand	112.41	Sweden	107.58
Turkey	31.2	Switzerland	147.02
		United Kingdom	89.65
		United States	50.33
Average EME	55.61	Average AE	95.82

Source: Authors' calculations using data from the Bank for International Settlements (BIS).
Notes: The data spans the period 1996Q1-2018Q2. We follow BIS classification criteria of AEs and EMEs. The average for EMEs excludes China and Hong Kong.

Fig. 1. Percent of Firms with a Bank Loan or Line of Credit and Ratio of Bank Credit to private non-financial sector to GDP: Selected EMEs



Source: Authors' calculations using data from the BIS and the WBES.

3 Model

We extend a standard two-country RBC model with banking frictions in the spirit of Cuadra and Nuguer (2018) to incorporate endogenous firm entry and firm heterogeneity in participation in the domestic banking system.

There are two economies, AE and EME. The AE is of size $0 < m < 1$ and the EME, whose variables are denoted with a *, is of size $1 - m$. Each economy is comprised of households, final goods firms, domestic monopolistically-competitive wholesale-goods firms whose entry is endogenous, domestic perfectly-competitive intermediate-goods firms who produce using capital and labor and supply their output to wholesale-goods firms, capital producers, and banks. Following Cuadra and Nuguer (2018), asymmetric information problems give rise to banking frictions as in Gertler and Kiyotaki (2010). A key difference relative to existing models is the presence of two categories of domestic firms in each country: financially-excluded (e) firms, who do not participate in the banking system and have a less capital-intensive production technology, and financially-included (i) firms, who use bank credit to purchase capital and have a more capital-intensive production technology. This assumption gives rise to i firms having endogenously-higher labor productivity relative to e firms (this model feature is broadly consistent with existing evidence on the positive link between bank-credit usage and firm productivity). Moreover, amid endogenous firm entry, the measures of e and i firms in each economy are endogenous. Additionally, in line with existing empirical evidence, AE banks lend to EME banks through cross-border bank flows. The calibration we adopt is such that the AE has higher steady-state shares of firm financial participation and bank credit-GDP ratios, while the EME has lower steady-state shares of firm financial participation and bank credit-GDP ratios.

Of note, in what follows, we present the model from the perspective of the AE—or home economy, H, for ease of notation—with analogous conditions for the EME—or foreign economy, F, for ease of notation—unless otherwise noted.

3.1 Final Goods Production

Final goods firms in economy H use total domestically-produced output and imported output from economy F to produce final output using the CES technology

$$Y_t = \left[\alpha_a^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a-1}{\phi_a}} + (1-\alpha_a)^{\frac{1}{\phi_a}} Y_{F,t}^{\frac{\phi_a-1}{\phi_a}}\right]^{\frac{\phi_a}{\phi_a-1}}. \tag{1}$$

The corresponding price index in H is

$$P_t = \left[\alpha_a P_{H,t}^{1-\phi_a} + (1-\alpha_a) P_{F,t}^{1-\phi_a}\right]^{\frac{1}{1-\phi_a}}, \tag{2}$$

where $0 < \alpha_a < 1$ corresponds to the home bias and $\phi_a > 1$ is the CES parameter. First-order conditions yield relative demands for domestically-produced total output and imports from F:

$$Y_{H,t} = \alpha_a \left(\rho_{H,t}\right)^{-\phi_a} Y_t, \tag{3}$$

and

$$Y_{F,t} = (1 - \alpha_a) \left(\rho_{F,t}\right)^{-\phi_a} Y_t, \tag{4}$$

respectively. The real prices faced by H, $\rho_{H,t} = P_{H,t}/P_t$ and $\rho_{F,t} = P_{F,t}/P_t$, are defined with respect to the price of the final good in H. Following the literature and assuming that the law of one price (LOP) holds for each good $Y_{F,t}$, we have $P_{H,t} = \text{NER}_t P^*_{H,t}$ and $P_{F,t} = \text{NER}_t P^*_{F,t}$, where NER_t is the nominal exchange rate.

3.2 Domestic Production Structure

There are *two broad categories of domestic firms* in each economy H and F, financially-excluded (e) and financially-included (i) firms. To make our environment as comparable as possible to standard models with banking frictions, each firm category e and i is comprised of two subtypes of firms. First, perfectly-competitive intermediate-goods firms of measure 1. Second, monopolistically-competitive wholesale firms whose entry and measure are endogenous.

Intermediate-goods firms in each category $j \in \{i, e\}$ use labor and capital to produce output, which is sold to their monopolistically-competitive wholesale counterparts as an input for wholesale-firm production. Critically, while intermediate-goods e firms use internal resources to purchase capital from capital producers and do not participate in the banking system, intermediate-goods i firms borrow funds from banks to purchase capital from the same capital producers. In turn, total *domestic* production is a combination of total output from e and i wholesale firms. Of note, we separate intermediate-goods firms from wholesale firms for expositional clarity and for ease of comparison of our model with standard models of banking frictions and standard models of endogenous firm entry, respectively (a completely valid way of interpreting the domestic production structure is to think about downstream and upstream producers within a given firm category, e or i).

3.2.1 Intermediate-Goods Firms

There is a measure 1 of perfectly-competitive intermediate-goods firms in each firm category $j \in \{i, e\}$. These firms use labor, $L_{j,t}$, and capital, $k_{j,t}$, to produce output sold to their monopolistically-competitive wholesale counterparts at price $mc_{j,t}$. A key difference between e and i firms is that i firms rely on bank credit to purchase capital from capital producers. In contrast, e firms rely on internal resources to purchase capital from the same capital producers.

Formally, e firms choose $L_{e,t}$ and $k_{e,t+1}$ to maximize the expected discounted value of profits

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \Xi_{t|0} \left\{ mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e} (L_{e,t})^{1-\alpha_e} - w_{e,t} L_{e,t} - Q_{e,t} \left[k_{e,t+1} - (1-\delta) k_{e,t} \right] \right\},$$

where $\Xi_{t|0}$ is the household's stochastic discount factor (defined in the household's problem further below), $0 < \alpha_e < 1$ is the share of capital in the production function, and $Q_{e,t}$ is the price of new capital. The first-order conditions yield standard labor demand and capital demand conditions

$$w_{e,t} = (1-\alpha_e) mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e} (L_{e,t})^{-\alpha_e}, \tag{5}$$

and

$$Q_{e,t} = \mathbb{E}_t \Xi_{t+1|t} \left[r_{e,t+1} + Q_{e,t+1} (1-\delta) \right], \tag{6}$$

where $r_{e,t} = \alpha_e mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e - 1} (L_{e,t})^{1-\alpha_e}$. Intuitively, firms equate the marginal cost of labor to the marginal benefit, and the marginal cost of one unit of capital to the expected marginal benefit.

Turning to i firms, these firms choose $L_{i,t}$, $k_{i,t+1}$, as well as bank credit from financial intermediaries $s_{i,t}$ to maximize the expected present discounted value of profits

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \Xi_{t|0} \Big\{ mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i} (L_{i,t})^{1-\alpha_i} - w_{i,t} L_{i,t} - Q_{i,t} \left[k_{i,t+1} - (1-\delta) k_{i,t} \right] + Q_{i,t} s_{i,t} - R_{k_i,t} Q_{i,t-1} s_{i,t-1} \Big\},$$

where $\alpha_i > \alpha_e$ and $R_{k_i,t}$ denotes the cost of bank credit (that is, the gross lending rate). The optimal demand for labor is given by

$$w_{i,t} = (1-\alpha_i) mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i} (L_{i,t})^{-\alpha_i}. \tag{7}$$

Combining the optimality conditions for physical capital demand and bank-credit demand, we can write

$$R_{k_i,t+1} = \Psi_{t+1} \frac{\left[r_{i,t+1} + Q_{i,t+1} (1-\delta) \right]}{Q_{i,t}}, \tag{8}$$

where $r_{i,t} = \alpha_i mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i - 1} (L_{i,t})^{1-\alpha_i}$ and $s_{i,t} = k_{i,t+1}/\Psi_{t+1}$. As in Gertler and Kiyotaki (2010), Ψ_{t+1} is a shock to the quality of capital (in this case, to capital for i firms). This last condition is standard in models with banking frictions.

3.2.2 Monopolistically-Competitive Wholesale Firms

There is an unbounded number of potential wholesale entrants into each domestic wholesale firm category $j \in \{e, i\}$. Following BGM, let Ω_j denote the potential mass of firms in firm category j. We first focus on incumbent firms and describe firm-creation decisions as part of the household's problem below.

Each incumbent firm produces a single differentiated good ω_j, so that ω_j denotes both the good produced and the firm. Then, total output from each domestic wholesale firm category $j \in \{e, i\}$ is given by $Y_{j,t} = \left[\int_{\omega_j \in \Omega_j} y_{j,t}(\omega_j)^{\frac{\varepsilon-1}{\varepsilon}} d\omega_j\right]^{\frac{\varepsilon}{\varepsilon-1}}$ where $y_{j,t}(\omega_j)$ represents output of firm ω_j and $\varepsilon > 1$ is the elasticity of substitution between firms' output. The firm-category price index is given by $P_{j,t} = \left[\int_{\omega_j \in \Omega_j} p_{j,t}(\omega_j)^{1-\varepsilon} d\omega_j\right]^{\frac{1}{1-\varepsilon}}$, where $p_{j,t}(\omega_j)$ is the nominal price of firm $\omega_j's$ output.

Each incumbent firm ω_j purchases inputs from their intermediate-goods counterparts at price $mc_{j,t}$, with the real price of their output given by $\rho_{j,t}(\omega_j) = p_{j,t}(\omega_j)/P_t$. Then, individual profits for firm ω_j are given by $d_{j,t}(\omega_j) = (\rho_{j,t}(\omega_j) - mc_{j,t})y_{j,t}(\omega_j)$ and the optimal pricing condition for firm ω_j is $\rho_{j,t}(\omega_j) = [\varepsilon/(\varepsilon - 1)]\, mc_{j,t}$ for $j \in \{e, i\}$.

3.2.3 Total Domestic Production

Total domestic production $Y_{P,t}$ is comprised of total output from financially-excluded (e) wholesale firms, $Y_{e,t}$, and total output from financially-included (i) wholesale firms, $Y_{i,t}$. Formally, a representative perfectly-competitive domestic output aggregator chooses $Y_{e,t}$ and $Y_{i,t}$ to maximize profits

$$P_{P,t}Y_{P,t} - P_{i,t}Y_{i,t} - P_{e,t}Y_{e,t}, \tag{9}$$

subject to

$$Y_{P,t} = \left[(1-\alpha_y)^{\frac{1}{\phi_y}} Y_{i,t}^{\frac{\phi_y - 1}{\phi_y}} + (\alpha_y)^{\frac{1}{\phi_y}} Y_{e,t}^{\frac{\phi_y - 1}{\phi_y}}\right]^{\frac{\phi_y}{\phi_y - 1}}, \tag{10}$$

where the price of total domestic output is given by $P_{P,t} = \left[(1-\alpha_y)P_{i,t}^{1-\phi_y} + (\alpha_y)P_{e,t}^{1-\phi_y}\right]^{\frac{1}{1-\phi_y}}$, $0 < \alpha_y < 1$, and $\phi_y > 1$. The first-order conditions yield standard demand functions $Y_{e,t} = \alpha_y \left(P_{e,t}/P_{P,t}\right)^{-\phi_y} Y_{P,t}$ and $Y_{i,t} = (1-\alpha_y)\left(P_{i,t}/P_{P,t}\right)^{-\phi_y} Y_{P,t}$.

3.3 Capital Producers

Capital producers choose investment $i_{e,t}$ and $i_{i,t}$ to maximize their expected discounted profits $\mathbb{E}_t \sum_{s=t}^{\infty} \Xi_{t|s} \left\{Q_{e,s}i_{e,s} - i_{e,s}\left[1 + \Phi\left(i_{e,s}/i_{e,s-1}\right)\right] + Q_{i,s}i_{i,s} - i_{i,s}\left[1 + \Phi\left(i_{i,s}/i_{i,s-1}\right)\right]\right\}$ subject to

$$i_{e,s} = k_{e,s} - (1-\delta)k_{e,s-1}, \tag{11}$$

and

$$i_{i,s} = s_{i,s} - (1-\delta)k_{i,s-1}, \tag{12}$$

where following the literature on banking frictions, $k_{i,s} = \Psi_t s_{i,s}$ and Ψ_t embodies a banking-sector shock in the form of a shock to the quality of capital of i firms. The first order conditions yield the price of capital goods $Q_{j,t}$ for each firm category $j \in \{e, i\}$:

$$Q_{j,t} = 1 + \Phi\left(\frac{i_{j,t}}{i_{j,t-1}}\right) i_{j,t} + i_{j,t-1}\Phi'\left(\frac{i_{j,t}}{i_{j,t-1}}\right) - \mathbb{E}_t \Xi_{t+1|t}\left(\frac{i_{j,t+1}}{i_{j,t}}\right)^2 \Phi\left(\frac{i_{j,t+1}}{i_{j,t}}\right). \qquad (13)$$

3.4 Banks

The structure of financial intermediaries (or banks) follows Cuadra and Nuguer (2018), who build on Gertler and Kiyotaki (2010) and related papers. Households in each economy are the ultimate owners of banks in their own economy. These banks use retained earnings from previous periods, nw_t, and funds obtained from domestic households, $b_{d,t}$, to lend to domestic intermediate-goods i firms. We further assume that banks in F also obtain funds from H banks, which are denoted by b^*. Following the literature on banking frictions, banks in both economies are constrained by how much they borrow from their respective domestic households. In order to limit the bankers' ability to save enough to overcome their financial constraints, we allow for turnover between bankers and workers inside the households in each economy. In particular, we assume that with i.i.d. probability σ a banker survives into the next period, while with probability $1 - \sigma$ the banker exits the banking sector. If the banker exits, all retained earnings are transferred back to the household and the banker becomes a worker. We assume that each period a fraction of workers become bankers to keep the total number of workers and bankers constant. Given that a bank needs positive funds to operate, every new banker receives start-up funds, which represent a fraction $0 < \xi < 1$ of total assets of the bank.

Cross-border bank flows arise because H (or AE) banks are larger relative to the size of their economy, and F (or EME) banks are smaller relatively to the size of their economy, so H (or AE) banks lend to F (or EME) banks. We denote these flows non-core liabilities, which differ from deposits (which are core liabilities).

After obtaining their liabilities and combining them with their net worth, domestic banks decide how much to lend to domestic intermediate-goods i firms. Since there are no frictions when transferring resources to intermediate-goods i firms, these firms offer banks a perfect state-contingent security. The price of the security (or loan) is $Q_{i,t}$, which is also the price of bank assets. In other words, $Q_{i,t}$ is the market price of the bank's claims on the future returns on one unit of capital in intermediate-goods i firms at the end of period t, which is in process for period $t + 1$. Given that F (or EME) banks borrow from H (or AE) banks, in what follows we separate the description of banks in each economy.

3.4.1 H Banks

The balance sheet of an individual bank in H is such that the value of the loans to domestic intermediate-goods i firms funded in that period, $Q_{i,t}s_{i,t}$, plus any cross-border bank flows,

$Q_{b,t}b_t$, has to equal the sum of the bank's net worth and domestic deposits

$$Q_{i,t}s_{i,t} + Q_{b,t}b_t = nw_t + b_{d,t},$$

where $Q_{b,t}$ represents the price of cross-border bank flows. Let $R_{b,t}$ be the rate of return from period $t-1$ to period t on cross-border bank flows that F banks pay to H banks. Then, the net worth of an individual bank in H in period t is the payoff from assets funded in $t-1$ net of borrowing costs

$$nw_t = [r_{i,t} + (1-\delta)Q_{i,t}]\, s_{i,t-1}\Psi_t + R_{b,t-1}Q_{b,t-1}b_{t-1} - R_{t-1}b_{d,t-1},$$

where $r_{i,t}$ is the dividend payment at t on loans funded in the previous period and defined as part of the intermediate-goods firms problem in Section 3.2.1.

At the end of period t, the bank maximizes the present value of future dividends taking into account the probability of continuing to be a banker next period. The value of the bank is then defined as

$$V_t = \mathbb{E}_t \sum_{s=1}^{\infty} (1-\sigma)\sigma^{s-1}\Xi_{t+s|t}nw_{t+s}.$$

Following the literature on banking frictions, we introduce a simple agency problem to motivate the limited ability of the bank to obtain funds. After the bank obtains domestic deposits, the bank may transfer a fraction $0 < \theta < 1$ of assets back to its own household. Given this friction, domestic households limit the funds supplied to domestic banks.

If a bank diverts assets, it defaults on its debt and shuts down. Its creditors can reclaim the remaining fraction $1-\theta$ of assets. Let $V(s_{i,t}, b_t, b_{d,t})$ be the maximized value of V_t, given an asset and liability configuration at the end of period t. Then, the following incentive constraint must hold for each bank individually to ensure that the bank does not divert funds:

$$V\left(s_{i,t}, b_t, b_{d,t}\right) \geq \theta\left(Q_{i,t}s_{i,t} + Q_{b,t}b_t\right). \tag{14}$$

This borrowing constraint establishes that for households to be willing to supply funds to a bank, the value of the bank (the left-hand-side of (14)) must be at least as large as the benefit from diverting funds (the right-hand-side of (14)).

At the end of period $t-1$, the value of the bank satisfies the following Bellman equation

$$V\left(s_{i,t-1}, b_{t-1}, b_{d,t-1}\right) = \mathbb{E}_{t-1}\Xi_{t|t-1}\left\{(1-\sigma)nw_t + \sigma\left[\max_{s_{i,t},b_t,b_{d,t}} V\left(s_{i,t}, b_t, b_{d,t}\right)\right]\right\}. \tag{15}$$

The problem of the bank is then to maximize (15) subject to constraint (14). We guess and verify that the form of the value function of the Bellman equation is linear in assets and liabilities:

$$V\left(s_{i,t}, b_t, b_{d,t}\right) = \vartheta_{s,t}s_{i,t} + \vartheta_{b,t}b_t - \vartheta_{d,t}b_{d,t}, \tag{16}$$

where $\vartheta_{s,t}$ is the marginal value of assets at the end of period t, $\vartheta_{b,t}$ is the marginal value of lending to banks in F, and $\vartheta_{d,t}$ is the marginal cost of domestic deposits. Solving for the problem of the bank, and assuming that λ_t is the multiplier associated with the borrowing constraint, the first-order conditions are

$$\begin{aligned}
s_{i,t}: & \quad \vartheta_{s,t} - \lambda_t(\vartheta_{s,t} - \theta Q_{i,t}) = 0, \\
b_t: & \quad \vartheta_{b,t} - \lambda_t(\vartheta_{b,t} - \theta) = 0, \\
b_{d,t}: & \quad \vartheta_{d,t} - \lambda_t \vartheta_{d,t} = 0, \\
\lambda_t: & \quad \theta(Q_{i,t}s_{i,t} + Q_{b,t}b_t) - (\vartheta_{s,t}s_{i,t} + \vartheta_{b,t}b_t - \vartheta_{d,t}b_{d,t}) = 0.
\end{aligned}$$

We define μ_t as the excess value of a unit of assets relative to domestic deposits

$$\mu_t \equiv \vartheta_{s,t}/Q_{i,t} - \vartheta_{d,t}. \tag{17}$$

The last first-order condition can be rewritten as

$$Q_{i,t}s_{i,t} + Q_{b,t}b_t = \phi_t nw_t \tag{18}$$

$$\text{where} \quad \phi_t \equiv \frac{\vartheta_{d,t}}{\theta - \mu_t}. \tag{19}$$

The last two equations establish how tightly the constraint is binding. Leverage, ϕ_t, shows that when banks are more borrowing-constrained (reflected in a higher θ), the ratio between assets and net worth falls due to banks having fewer resources available. When the value of an extra unit of assets increases relative to the cost of holding domestic deposits (a higher μ), leverage also falls as a result of the greater accumulation of assets.

Let Λ_{t+1} be the marginal value of the net worth of the bank at date $t+1$. Then, after combining the guess for the value function with the Bellman equation, we can verify that the value function is linear in $(s_{i,t}, b_t, b_{d,t})$ if μ_t and $\vartheta_{d,t}$ satisfy

$$\vartheta_{d,t} = \mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1} R_t, \tag{20}$$

$$\mu_t = \mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1}(R_{k_i,t+1} - R_t), \tag{21}$$

$$\Lambda_t = (1-\sigma) + \sigma(\vartheta_{d,t} + \phi_t \mu_t). \tag{22}$$

The last equation provides information about the shadow value of the bank's net worth. In particular, the first term denotes the probability of exiting the banking sector. The second term represents the marginal benefit of continuing to be a banker: the marginal value of an extra unit of domestic deposits, $\vartheta_{d,t}$, plus the payoff of holding assets (that is, the leverage ratio times the excess value of loans, $\phi_t \mu_t$).

The first order conditions specified above yield that the marginal value of cross-border bank lending equals the marginal value of assets

$$\frac{\vartheta_{s,t}}{Q_{i,t}} = \frac{\vartheta_{b,t}}{Q_{b,t}},$$

which implies that the discounted rate of return on domestic assets in H equals the discounted rate of return on cross-border bank flows

$$\mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1} R_{k_i,t+1} = \mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1} R_{b,t+1}. \tag{23}$$

H banks are indifferent between providing funds to intermediate goods domestic firms and to F banks because the expected return on both assets is equalized in equilibrium.

3.4.2 F Banks

The problem of F (or EME) banks is similar to the one of H (or AE) banks, expect for one feature: cross-border bank flows, b_t^*, are a liability fo F banks. Therefore, the balance sheet of a bank in F reads:

$$Q_{i,t}^* s_{i,t}^* = nw_t^* + b_{d,t}^* + Q_{b,t}^* b_t^*.$$

The net worth of a bank is the payoff from assets funded in period $t-1$, net of borrowing costs which in this case include cross-border bank loans:

$$nw_t^* = \left[r_{i,t}^* + (1-\delta) Q_{i,t}^* \right] s_{i,t-1}^* \Psi_t^* - R_{b,t-1}^* Q_{b,t-1}^* b_{t-1}^* - R_{t-1}^* b_{d,t-1}^*.$$

The interpretation of the variables is equivalent to the case of H banks. Moreover, as was the case for H banks, the borrowing constraint for F banks must hold for each bank individually to ensure that a bank does not divert funds:

$$V^* \left(s_{i,t}^*, b_t^*, b_{d,t}^* \right) \geq \theta^* \left(Q_{i,t}^* s_{i,t}^* - Q_{b,t}^* b_t^* \right). \tag{24}$$

This equation establishes that F banks cannot divert funds from H banks. We also guess that the value function is a linear combination of the asset and liability configuration. Then, following the same notation, we can show that the shadow value of domestic-foreign assets is equal to the shadow cost of cross-border bank flows

$$\frac{\vartheta_{s,t}^*}{Q_{i,t}^*} = \frac{\vartheta_{b,t}^*}{Q_{b,t}^*}. \tag{25}$$

In terms of returns, the last equation reads:

$$\mathbb{E}_t \Xi_{t+1|t}^* \Lambda_{t+1}^* R_{k_i,t+1}^* = \mathbb{E}_t \Xi_{t+1|t}^* \Lambda_{t+1}^* R_{b,t+1}^*. \tag{26}$$

In this framework, the cross-border bank flows' return transmits a shock in economy H economy to economy F through the impact on the return on domestic assets. Additionally, the expected discounted rate of return on the cross-border bank asset is equal to the one on loans to intermediate-goods i firms in H. In turn, H and F loan markets behave in a similar way.

3.4.3 Aggregate Banking Conditions

Using equation (18) and aggregating across H banks, we have

$$Q_{i,t}S_{i,t} + Q_{b,t}B_t = \phi_t NW_t, \tag{27}$$

where capital letters indicate aggregate variables in the banking sector. The law of motion of economy H's aggregate bank net worth is given by

$$NW_t = (\sigma + \xi)\left(R_{ki,t}Q_{i,t-1}S_{i,t-1} + R_{b,t}Q_{b,t-1}B_{t-1}\right) - \sigma R_{t-1}B_{d,t-1}. \tag{28}$$

For F banks, the corresponding aggregate conditions look similar:

$$Q^*_{i,t}S^*_{i,t} - Q^*_{b,t}B^*_t = \phi^*_t NW^*_t \tag{29}$$
$$NW^*_t = (\sigma^* + \xi^*)R^*_{ki,t}Q^*_{i,t-1}S^*_{i,t-1} - \sigma^* R^*_{b,t}Q^*_{b,t-1}B^*_{t-1} - \sigma^* R^*_{t-1}B^*_{d,t-1}. \tag{30}$$

In equilibrium, H banks lend to F banks because economy H has excess resources in comparison to what H needs; this translates into the agency problem of each banking system that results in a stronger borrowing constraint in economy F. F is relatively small and we assume that F banks need to pay a premium on borrowing from H banks. Following Schmitt-Grohé and Uribe (2003), the interest rate paid by F banks on their international debt is debt elastic. Then, equation (23) becomes

$$\mathbb{E}_t\Xi_{t+1|t}\Lambda_{t+1}R_{k_i,t+1} = \mathbb{E}_t\Xi_{t+1|t}\Lambda_{t+1}R_{b,t+1} + \Phi\left[\exp(B_t - B) - 1\right]. \tag{31}$$

The last term is the risk premium associated with lending to economy F, where parameter Φ dictates the elasticity of steady-state deviations in cross-border bank flows and, following Schmitt-Grohé and Uribe (2003), the risk premium in steady-state is zero.
Turning to the interest rate on cross-border bank flows, the return on loans to F banks made by H banks is $\mathbb{E}_t(R_{b,t+1}) = \mathbb{E}_t(R^*_{b,t+1})\frac{\text{RER}_{t+1}}{\text{RER}_t}$. We assume that F banks bear all the risk from exchange-rate fluctuations. This particular channel plays a central role in the transmission of shocks. When the currency in F depreciates, the collateral in F expressed in foreign currency falls. This implies that H banks lend less to F banks because the risk of F banks running away with resources from H banks is higher. In equilibrium, H banks are indifferent between lending to F banks or intermediate-goods i firms in H. Moreover, F banks do not have excess returns from borrowing from H banks, so the return on loans to F banks is equal to the interest rate charged by H banks. Thus, there is perfect asset-market integration.

3.5 Households and Firm Creation

The representative households in each economy are identical, and we focus on the household's problem in H without loss of generality.

Formally, the household in H chooses consumption, c_t, labor supply to each domestic intermediate-goods firm category, $L_{e,t}$ and $L_{i,t}$, real domestic deposits, $B_{d,t}$, the desired number of wholesale financially-excluded (e) and financially-included (i) firms next period, $N_{e,t+1}$ and $N_{i,t+1}$, and the measure of new wholesale e and i firms needed to hit those firm targets, $N^e_{E,t}$ and $N^i_{E,t}$, to maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, L_{e,t}, L_{i,t})$ subject to

$$
\begin{aligned}
& c_t + \psi_e N^e_{E,t} + \psi_i N^i_{E,t} + B_{d,t} = \\
& \qquad w_{e,t}L_{e,t} + w_{i,t}L_{i,t} + R_{t-1}B_{d,t-1} + d_{e,t}N_{e,t} + d_{i,t}N_{i,t} + \Pi_{e,t} + \Pi_{i,t} + \Pi_{k,t} + \Pi_{b,t}, \quad (32)
\end{aligned}
$$

and the evolution of each category of wholesale firms $j \in \{e, i\}$

$$N_{j,t+1} = (1-\delta)\left(N_{j,t} + N^j_{E,t}\right), \quad (33)$$

where R_{t-1} is the gross real interest rate on domestic deposits, and $w_{j,t}$ and $d_{j,t}$ denote the real wage and real individual-firm profits in firm category $j \in \{e, i\}$. $\Pi_{e,t}$ and $\Pi_{i,t}$ denote profits from intermediate-goods e and i firms, profits from capital producers are given by $\Pi_{k,t}$, and $\Pi_{b,t}$ denotes total bank profits. Following the macro literature on endogenous firm entry, $0 < \delta < 1$ is the exogenous exit probability of firms.[3]

Optimal labor supply to each domestic intermediate-goods firm category $j \in \{e, i\}$ is given by

$$-u_{L_j,t} = w_{j,t}u_{c_j,t}. \quad (34)$$

In turn, the Euler equation over domestic deposits is standard and given by

$$1 = \mathbb{E}_t \Xi_{t+1|t} R_t, \quad (35)$$

where the stochastic discount factor is defined as $\Xi_{t+1|t} = \beta u_{c_j,t+1}/u_{c_j,t}$. Finally, the firm creation conditions for each domestic wholesale firm category are given by

$$\psi_j = (1-\delta)\mathbb{E}_t \Xi_{t+1|t}\left(d_{j,t+1} + \psi_j\right), \quad (36)$$

for $j \in \{e, i\}$. We assume that $\psi_i > \psi_e$ and, as we discuss below, i firms have access to bank credit and a more capital-intensive production technology that delivers endogenously-higher labor productivity. The expressions for labor supply and the Euler equation for deposits are standard. The firm creation condition equates the marginal cost of creating one more firm in category j to the expected marginal benefit, which is given by the expected presented discounted value of individual-firm profits and the continuation value if the firm survives into the next period with probability $(1-\delta)$.

[3] Assuming that the depreciation rate of physical capital and the exogenous probability of firm exit differ does not change our main conclusions.

3.6 Market Clearing

Total demand for output produced in H must be equal to what is produced, so that

$$Y_{H,t} + \left(\frac{1-m}{m}\right) Y^*_{H,t} = Y_{P,t}, \tag{37}$$

where $Y_{P,t}$ denotes total domestic production in H. Market clearing in each domestic firm category implies that

$$N_{e,t} y_{e,t} = z_{e,t} (k_{e,t})^{1-\alpha_e} (L_{e,t})^{\alpha_e}, \tag{38}$$

and

$$N_{i,t} y_{i,t} = z_{i,t} (k_{i,t})^{1-\alpha_i} (L_{i,t})^{\alpha_i}. \tag{39}$$

The resource constraint in H is given by

$$Y_t = c_t + i_{i,t} + i_{e,t} + \psi_i N^i_{E,t} + \psi_e N^e_{E,t}. \tag{40}$$

Finally, the current account can be written as

$$\text{RER}_t Q_{b,t} B_t - \text{RER}_t R_{b,t} Q_{b,t-1} B_{t-1} = \left(\frac{1-m}{m}\right) Y^*_{H,t} \frac{P_{H,t}}{P_t} - Y_{F,t} \text{ToT}_t \frac{P_{H,t}}{P_t}, \tag{41}$$

where $\text{RER}_t = \text{NER}_t P^*_t / P_t$ denotes the real exchange rate and ToT_t the terms-of-trade. Finally, cross-border bank flows are in zero net supply $B_t = B^*_t \frac{1-m}{m}$. The Appendix presents the complete list of endogenous variables and corresponding equilibrium conditions.

4 Quantitative Analysis

To explore the quantitative implications of greater firm financial participation in EMEs amid external financial shocks, we consider the H economy as the U.S. and the F economy as an average EME in the firm-financial-participation sense.

4.1 Calibration

The calibration of the H economy follows (Cuadra and Nuguer, 2018). We adopt the following functional form for household utility in both H and F:

$$u(c_t, L_{e,t}, L_{i,t}) = \frac{\left[c_t - \frac{\kappa}{1+\chi} (L_{e,t} + L_{i,t})^{1+\chi}\right]^{1-\sigma_c}}{1-\sigma_c}.$$

The investment adjustment cost function for $j \in \{e, i\}$ is $\Phi\left(\frac{i_{j,t}}{i_{j,t-1}}\right) = \left(\frac{\phi_k}{2}\right)\left(\frac{i_{j,t}}{i_{j,t-1}} - 1\right)^2$ where $\phi_k > 0$.

Parameters from Literature Following the international RBC literature, we set $\sigma_c = 2$, $\alpha_i = 0.32$, $\beta = 0.985$, $\chi = 1$, and $\delta = 0.025$ in both economies H and F (all standard values in the literature). As noted in Section 3, we assume that financially-excluded (e) firms in both economies have less capital-intensive production technologies so that $\alpha_e = 0.20$, which gives rise to endogenously-higher labor productivity in i firms (this assumption is consistent with existing evidence on bank-credit usage and firm productivity; alternative values for α_e do not change our main conclusions). Following the literature, we analyze the response of both economies to a shock to the quality of capital in H, Ψ, and set exogenous sectoral productivity in each category of intermediate-goods firms such that $z_i = z_e = z_i^* = z_e^* = 1$. Following the literature on endogenous firm entry, the elasticity of substitution of wholesale-firm output for each domestic firm category $j \in \{e, i\}$ in each economy is $\epsilon = 6$. As a baseline, we assume a relatively high degree of substitutability between domestic e-firm-category *total* output $Y_{e,t}$ and i-firm-category *total* output $Y_{i,t}$ and set $\phi_y = 5$.

In terms of the trade structure between H and F, we set the country size for H, $0 < m < 1$, to 0.90. In turn, the degree of home bias in H, α_a, is influenced by the economy's degree of openness λ, so that $\alpha_a = 1 - (1 - m)\lambda$ (see (Cuadra and Nuguer, 2018)). Analogously, the degree of home bias in F, α_a^*, is given by $\alpha_a^* = 1 - m\lambda$. In both economies, the degree of substitution between total domestic output and imported output is $\phi_a = \phi_a^* = 1.5566$, which is in line with the international RBC literature.

Turning to the banking-sector parameters, we follow (Cuadra and Nuguer, 2018) and set $\sigma = 0.972$ and $\xi = 0.002$. In addition, following the literature on banking frictions, we assume an i.i.d. shock to capital quality, $\ln(\Psi_t) = \varepsilon_t$, where $\varepsilon_t \sim N(0, \sigma_\Psi)$ and $\sigma_\Psi = 0.05$. Finally, we follow related literature and set $\phi_k = 1$ and the foreign-debt elasticity parameter $\eta_b = 0.01$.

Calibrated Parameters We calibrate the remaining parameters κ, κ^*, ψ_i, ψ_e, ψ_i^*, ψ_e^*, α_y, α_y^*, θ, and θ^* to match the following targets based on commonly adopted targets in the international RBC literature, U.S. data to calibrate economy H (the AE), and data using averages for the EME sample used in Section **??** to calibrate economy F (the EME). The targets we use are: a share of total hours worked in both economies (H and F) of 0.33; a cost of creating i firms in H of 1 percent of output per capita (consistent with the cost of starting a business in the U.S. per World Bank Doing Business data); an output-per-capita cost of creating i firms in F of 10 percent of output per capita (consistent with the average cost of starting a business in our EME sample, per World Bank Doing Business data); a share of i firms in H of $N_i/N = 0.80$; a share of i firms in F of $N_i^*/N^* = 0.20$; a share of output from i firms in total output in H of $P_iY_i/PY = 0.80$; a share of output from i firms in total output in F of $P_i^*Y_i^*/P^*Y^* = 0.70$; and average annual interest-rate premia of 110 basis points in both economies. The resulting parameter values are: $\kappa = 16.2155$, $\kappa^* = 9.8087$, $\psi_i = 0.0305$, $\psi_e = 0.0111$, $\psi_i^* = 0.2525$, $\psi_e^* = 0.0322$, $\alpha_y = 0.6438$, $\alpha_y^* = 0.4326$, $\theta = 0.5042$, and $\theta^* = 0.8952$. Note that our calibration plausibly delivers $\theta^* > \theta$, which is consistent with EME banks facing tighter banking constraints compared to AEs, and $\psi_i^* > \psi_i$, which is also consistent with EMEs having greater firm-entry costs.

4.2 Greater Domestic Financial Participation in EMEs

We analyze the aggregate implications of increasing firms' participation in the domestic banking system in EMEs by reducing the sunk entry cost of i firms in the representative EME, ψ_i^* from its baseline level, which delivers a steady-state endogenous share of i firms in our representative EME of 0.20, to a level that generates a steady-state share of i firms of 0.80, which is consistent with the level of firm domestic financial participation in our representative AE. Importantly, we lower ψ_i^* holding all other parameters at their original values, including ψ_i (that is, the sunk entry cost for i firms in the AE). Of note, even after reducing ψ_i^*, it is still the case that $\psi_i^* > \psi_i$.

4.2.1 Steady State

Table 2 shows how the steady state of key variables of interest in the representative baseline EME changes when we reduce the sunk entry cost of i firms ψ_i^* in that economy. Recall that EME (or economy F) variables in the model are denoted by a *.

The reduction in ψ_i^* increases firm participation in the domestic banking system (firm financial participation, or FFP) in that same economy, and leads to greater total output, consumption, and equilibrium bank credit; to greater labor in i firms and lower labor in e firms; to higher wages and bank net worth; and to greater (endogenous) labor productivity across firm categories in the representative EME.

Intuitively, a lower ψ_i^* reduces the marginal cost of creating i firms in the EME. Greater i-firm creation leads to greater demand for labor and capital by these firms, and to lower demand for labor and capital by e firms, resulting in greater i-firm-category equilibrium labor and capital, and lower e-firm-category equilibrium labor and capital. Interestingly, the sharp reduction in labor in e firms increases labor productivity in this firm category despite an unambiguous fall in capital usage. In contrast, given the rise in both capital and labor among i firms stemming from greater i-firm entry, labor productivity in this firm category increases. Turning to the banking sector, since i firms use bank resources to finance their capital purchases, greater i-firm entry translates into greater equilibrium bank credit (recall that steady-state EME bank credit is $s_i^* = k_i^*/\Psi$, where steady-state $\Psi = 1$, so steady-state EME bank credit is simply given by k_i^*). The expansion in loans to EME i firms by domestic banks ultimately contributes to increasing EME banks' net worth. Finally, EME banks finance greater bank credit to i firms via greater household deposits and greater borrowing from AE banks, but the ratio of household deposits to total external funds (that is, the sum of household deposits and foreign borrowing) remains unchanged, with household deposits being the dominant source used to finance bank credit to firms. This last result is consistent with existing cross-country evidence on banks' heavy reliance

Tab. 2. Steady State Equilibria: EME baseline, with 50, and 80 percent of firm financial participation (FFP)

Variable	Baseline	50 Percent FFP	80 Percent FFP
Output Y^*	1.69	2.292	2.836
Consumption c^*	1.082	1.440	1.773
Foreign claims B^*	0.066	0.117	0.155
Deposits B_d^*	0.438	0.780	1.033
Included f. capital k_i^*	7.319	13.02	17.24
Excluded f. capital k_e^*	2.497	1.349	0.895
Included f. labor L_i^*	0.206	0.320	0.383
Excluded f. labor L_e^*	0.124	0.058	0.035
Wages w*	3.249	3.726	4.119
Net worth NW^*	1.550	2.758	3.652
Included firms N_i^*	19.173	57.59	104.8
Excluded firms N_e^*	95.86	113.96	150.7
Labor Prod_i^*	5.733	6.575	7.269
Labor Prod_e^*	4.873	5.589	6.179
ψ_i^*/Y^*	0.150	0.0218	0.007

on domestic deposits to extend bank credit.

4.2.2 Response to an Adverse Shock to the Quality of Capital in the AE

Figure 2 shows the impulse response functions (IRFs) to an adverse quality shock to i-firm capital in AEs in two calibrated versions of the benchmark model. The first version is the model under the baseline calibration (that is, the AE with a steady-state share of firm financial participation of 80 percent and the baseline EME with a steady-state share of firm financial participation of 20 percent). The second model is the benchmark with a lower ψ_i^* such that the EME has a new steady-state share of firm financial participation of 80 percent (versus the original 20 percent), holding all other parameters at their baseline values (as noted earlier, this implies that the baseline value for the sunk entry cost for i firms in the AE remains at its original value as well).

Figure 2 shows that a greater share of steady-state firm participation in the domestic banking system in the EME contributes to a smoother response in EME banks' net worth and asset prices in the short term, and a smoother response in EME bank credit, investment, and consumption in the medium term. Moreover, note that the response of the real exchange rate is very similar under the baseline model and the model with a high level of EME firm financial participation. The most notable change is in EMEs' foreign debt, which drops dramatically on impact relative to the baseline model, but recovers swiftly after the shock. Thus, our quantitative results suggest that conditional on a shock to capital quality in the AE, greater domestic financial participation by EME firms limits the adverse effect of the shock in the EME.

To understand these results, first note that the larger response of EME foreign debt B^* traces back to the fact that greater steady-state firm financial participation in the EME expands EME banks' steady-state borrowing from AE banks, which makes the response of EME foreign borrowing more sensitive to the financial shock originating from the AE. However, since EME banks' steady-state net worth is greater under greater firm financial participation (recall Table 2), EME banks' net worth becomes more resilient to shocks. Importantly, this last fact makes bank credit to i firms in the EME less sensitive to AE capital-quality shocks, resulting in smoother EME asset-price dynamics, a smaller medium- and long-term contraction in EME investment, and a smaller contraction in both the number of EME i-firms and in EME consumption. All told, even though greater firm financial participation in the EME makes EME foreign borrowing more sensitive to external shocks, the positive impact on EME banks' steady-state net worth from having a larger steady-state share of EME firms using domestic bank credit makes the EME more resilient to financial shocks originating from the AE.

4.3 The Role of Endogenous Firm Entry

To highlight the critical ole of the *extensive* margin of firm financial participation for our results, consider a simplified version of our benchmark model without endogenous firm entry (and therefore without an *extensive* margin of firm financial participation). In this simpler framework, firm financial participation is effectively reflected in the contribution of i firms to total output, only (this stands in contrast with having an endogenous share of i-category firms in our benchmark model).

To perform IRF experiments comparable to those we conducted in Figure 2 using the model *without endogenous firm entry*, we change parameter α_y in the domestic-output aggregator to obtain the same (endogenous) share of i-firm-category output in total output that results from having a share of EME i-firms of 80 percent in our benchmark model. Figure 3 shows the results of this experiment based on the model *without endogenous firm entry*. The differences with respect to our benchmark results in Figure 2 are clear: *absent endogenous firm entry, greater EME firm financial participation leads to negligible changes in the sensitivity of EME banks' net worth and EME asset prices to a financial shock originating in the AE, and to a more sensitive response of EME investment and consumption.* These dynamic results are *qualitatively* different from the ones in our benchmark model (where greater domestic financial participation by EME firms leads to smoother responses in EME macro aggregates), but occur in a context where the qualitative changes in steady-state firm-financial-participation equilibria in the two models are broadly similar.

Intuitively, as is well-known from BGM, the presence of endogenous firm entry and firm sunk entry costs implies that households effectively consider firms as assets (in addition to capital and deposits). As such, a reduction in the cost of creating i firms amid shocks to the quality of capital in the AE acts as a stabilizing force across asset classes—firms, capital, household deposits—which results in smoother fluctuations across all asset prices in equilibrium. In turn, these smoother fluctuations feed into the rest of the economy, thereby delivering a smaller response in macro aggregates. This mechanism is naturally absent in a model that abstracts from endogenous firm entry since firms do not represent an asset in a context without endogenous firm entry.

4.4 Empirical Validation of Main Results

Our baseline model findings suggest a clear relationship between the degree of firm financial participation, domestic financial development, and the response of EMEs to adverse external financial shocks emanating from AEs and transmitted via the banking system. In what follows, we explore the extent to which our model findings are corroborated by the data. Specifically, we use data for a representative sample of EMEs to characterize the link between the response of these economies to external shocks and the average degree of participation of firms in the domestic banking system in these economies.

Of note, our measure of the extensive margin of firm financial participation in the data faces non-trivial limitations in its country and time-series coverage, thereby limiting its usefulness in empirical analyses. However, recall that Figure 1 in Section 2 shows a strong and positive relationship between the share of firms with bank credit and the bank credit-GDP ratio across economies. Given this fact, we can use the bank credit-GDP ratio as a rough proxy for firm financial participation in order to overcome the coverage limitations of firm financial participation data. We can then empirically explore how the extensive margin of firm financial participation in EMEs is associated with the impact of external financial shocks on select macro aggregates of interest in these economies. For the purposes of our empirical analysis and the mapping of the model to the data, we follow Cuadra and Nuguer (2018); Lambertini and Uysal (2013) and use U.S. commercial banks' net charge-offs—which represent the value of loans that banks know will not be repaid—as a proxy for external financial conditions to EMEs that affect these same economies. In turn, changes in U.S. commercial banks' net charge-offs are transmitted to EMEs through cross-border bank flows. This is broadly similar to the transmission of financial shocks that originate in the AE and affect the EME in our model.

4.4.1 Data

U.S. Commercial Banks' Net Charge-Offs We follow Cuadra and Nuguer (2018); Lambertini and Uysal (2013) and consider a shock to the U.S. commercial banks' net charge-offs on all loans and leases. This variable corresponds to the value of those loans that commercial banks assume will not be paid. Similar to related studies, in our model, this shock is associated with a fall in the value of banks' assets that corresponds to a quality-of-capital shock in the AE. The data we use to construct this shock comes from the St. Louis Fed

FRED database and covers the period 1985-2018 at a quarterly frequency.

Cross-Border Bank Flows Cuadra and Nuguer (2018) show that financial shocks in the U.S. were transmitted to EMEs via cross-border bank flows. Given this fact, we use foreign claims of U.S. banks for specific economies, obtained from the BIS' Consolidated Banking Statistics dataset.[4] The data is available for 18 EMEs and 21 AEs and has unbalanced coverage from 2000Q1 to 2018Q3.

Real Exchange Rate The real exchange rate data comes from Stein, Fernández, Rosenow and Zuluaga (2018). Given our focus on how changes in external financial conditions affect EMEs, we focus on real exchange rate data with respect to the U.S. for each country in our sample.

4.4.2 Empirical Validation of Model Results

Using a comprehensive sample of EMEs dictated by data availability on the measures described above, we characterize the effect of U.S. net charge-offs, NCO_t, on the ratio of foreign claims of U.S. reporting banks (reflected in cross-border bank flows in our theoretical framework) to GDP, $\frac{B_{it}}{\text{GDP}_{it}}$, and explore how the impact on EMEs may be different given differences in bank credit-GDP ratios, $\frac{\text{Cr}_i}{\text{GDP}_i}$, which, as noted above, we use as a rough proxy of (the extensive margin of) firm financial participation. As a baseline, we focus on the period 2000Q1-2018Q3. This allows us to maximize the amount of data available while also trying to keep a consistent financial framework without major changes across time. We consider three different measures of the bank credit-to-GDP ratio: the first one corresponds to the average ratio over the sample 2000Q1-2018Q3, the second one to the ratio in 2000Q1, and the third one corresponds to the average between 1990Q1 and 2000Q1. The results for the last two measures are in Appendix C.1. Variables NCO_t and $\frac{B_{it}}{\text{GDP}_{it}}$ are logged and HP-filtered using a smoothing parameter of 1600.[5]

First, we estimate the following panel regression, where we include an interaction term between the bank credit-GDP ratio with U.S. net charge-offs (which we consider as the external financial shock for EMEs):

$$\frac{B_{it}}{\text{GDP}_{it}} = \beta_0 + \beta_1 \text{NCO}_t \times \left(\frac{\bar{\text{Cr}}_i}{\text{GDP}_i} \right) + \varepsilon_i + \iota_t + u_{it}, \tag{42}$$

where country i fixed-effects are captured by ε_i and time t fixed-effects are captured by ι_t.

Columns (1)-(3) in Table 3 summarize our main findings for the first measure of the bank credit-GDP ratio, we show the other two in the Appendix. Specifically, column (1)

[4] Specifically, we use data from Table 9B in the BIS Consolidated Banking Statistics for all-maturities total claims on U.S. banks, excluding domestic positions.

[5] We note that using linear detrending techniques shows that the variables are not stationary but the results deliver similar results to those using the HP-filter.

presents the results for a regression that includes the controls variables of the interaction term but no time- or country-fixed effects. Column (2) presents similar results with country-fixed-effects but no time-; and the third column presents the results of regression 42.

The fact that the interaction term between U.S. net charge-offs and the bank credit-GDP ratio in Table 3 is negative implies that the marginal effect of U.S. net charge-offs on foreign claims is negative, and that this effect is stronger the higher is the bank credit-to-GDP ratio. In other words, EME countries with greater firm financial participation exhibit a larger fall in foreign claims as a result of positive movements in U.S. net charge-offs. The regressions also show that the effect of net charge-offs when the bank credit-to-GDP ratio is very low is not statistically different from zero. The results are also economically significant: a 1 percent decrease in the baseline level of the bank credit-to-GDP ratio brings about a 15 percent increase in the effect of how foreign claims to GDP react to U.S. net charge-offs.

Tab. 3. Fixed-Effects Estimations with Country-Specific Cross-Border Bank Flows and Private Real Consumption as Dependent Variables

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{\text{GDP}_{it}}$			Consumption C_{it}		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs NCO_t	0.102	0.102				
	(0.070)	(0.070)				
Credit to $\text{GDP}_{i,1990:1-2018:3}$	0.001**			0.004***		
	(0.001)			(0.090)		
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{NCO}_t$	-0.149**	-0.149**	-0.149*			
	(0.068)	(0.068)	(0.071)			
Real Exchange Rate RER_{it}				-0.230***	-0.192**	-0.192**
				(0.074)	(0.078)	(0.077)
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{RER}_{it}$				0.198**	0.279**	0.279**
				(0.090)	(0.122)	(0.122)
Constant	-0.001	-0.000	-0.006	-0.002	- 0.005	0.002
	(0.001)	(0.000)	(0.014)	(0.001)	(0.007)	(0.014)
Country FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	Yes	No	No	Yes
Observations	1,022	1,022	1,022	873	873	873
R-squared	0.012	0.013	0.176			0.283
Number of countries	14	14	14	14	14	14

Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q3. NCO_t, RER_{it}, C_{it} and $\frac{B_{it}}{\text{GDP}_{it}}$ are real, logged and detrended using the Hodrick-Prescott filter. Credit to $\text{GDP}_{1990:1-2018:3}$ is the average bank credit to GDP for the period 1990:1-2018:3. Foreign claims to GDP correspond to foreign claims of each country on U.S. banks to GDP ratio. The sample of EMEs used is comprised of: Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Korea, Malaysia, Mexico, Russia, South Africa, Thailand, and Turkey.

Second, we consider a similar estimation to (42), now with a focus on how real exchange rate movements, RER_{it}, may be associated with movements in real private consumption,

C_{it}, and whether the bank credit-GDP ratio measures explain the extent of the response in real private consumption. Formally, the estimation equation with country and time fixed-effects is given by:

$$C_{it} = \delta_0 + \delta_1 \text{RER}_{it} \times \left(\frac{\bar{\text{Cr}}_i}{\text{GDP}_i} \right) + \varepsilon_i + \iota_t + z_{it}. \tag{43}$$

The results for this specification are shown in columns (3)-(5) of Table 3, in a similar fashion to the regression (42): column (3) does not include fixed effects and includes both control variables of the interaction term; column (4) includes country-fixed effects and column (5) shows the results for regression (43) The parameter estimated on the interaction term has the expected sign. An increase in the bank credit-GDP ratio is associated with an increase in real private consumption relative to trend. With respect to the real exchange rate parameter, a depreciation in the real exchange rate (an increase) is associated with a decline in real private consumption relative to trend, no matter the bank credit-GDP ratio. In other words,the interaction term is telling us that the transmission channel that operates through the real exchange rate depends on the economy's degree of domestic financial participation.

Put differently, consumption and the foreign claims with respect to GDP do react differently depending on the initial bank credit-GDP ratio. The facts in 3 are consistent with the results from our benchmark model, thereby stressing the importance of endogenous firm entry and, more broadly, the relevance of the extensive margin of firm financial participation.

Robustness Results Appendix C presents a series of robustness checks using alternative specifications, which confirm our main empirical findings. First, we show that other measures of bank credit-GDP ratio provide the same results as in Table 3. We do that in Table **??** in Appendix **??**. Second, we use the deposits-GDP ratio as an alternative measure of domestic financial participation (this measure is also positively correlated with the share of firms that have bank credit or bank loans; we consider the deposits-GDP ratio counterparts of the bank credit-GDP ratios described above). Results for this specification are presented in Table C.2. Third, we run the regressions (43) using the lag of the real exchange rate as a dependent variable (see Table C.3). These two robustness checks corroborate our baseline findings. Fourth, for completeness and to highlight our focus on EMEs, we run the baseline regressions above for AEs (see Table C.4). The results from this fourth exercise suggest that our findings for EMEs do not necessarily hold for AEs. In particular, the marginal effect of U.S. net charge-offs on the foreign claims-to-GDP ratio is positive; additionally, consumption does not seem to react in any significant way to movements in the real exchange rate. Table C.5 presents similar results for AEs using the deposits-GDP ratio.

Fig. 2. Impulse Response to an Adverse Shock to the Quality of Capital in the AE: Baseline EME and EME with Greater Firm Financial Participation

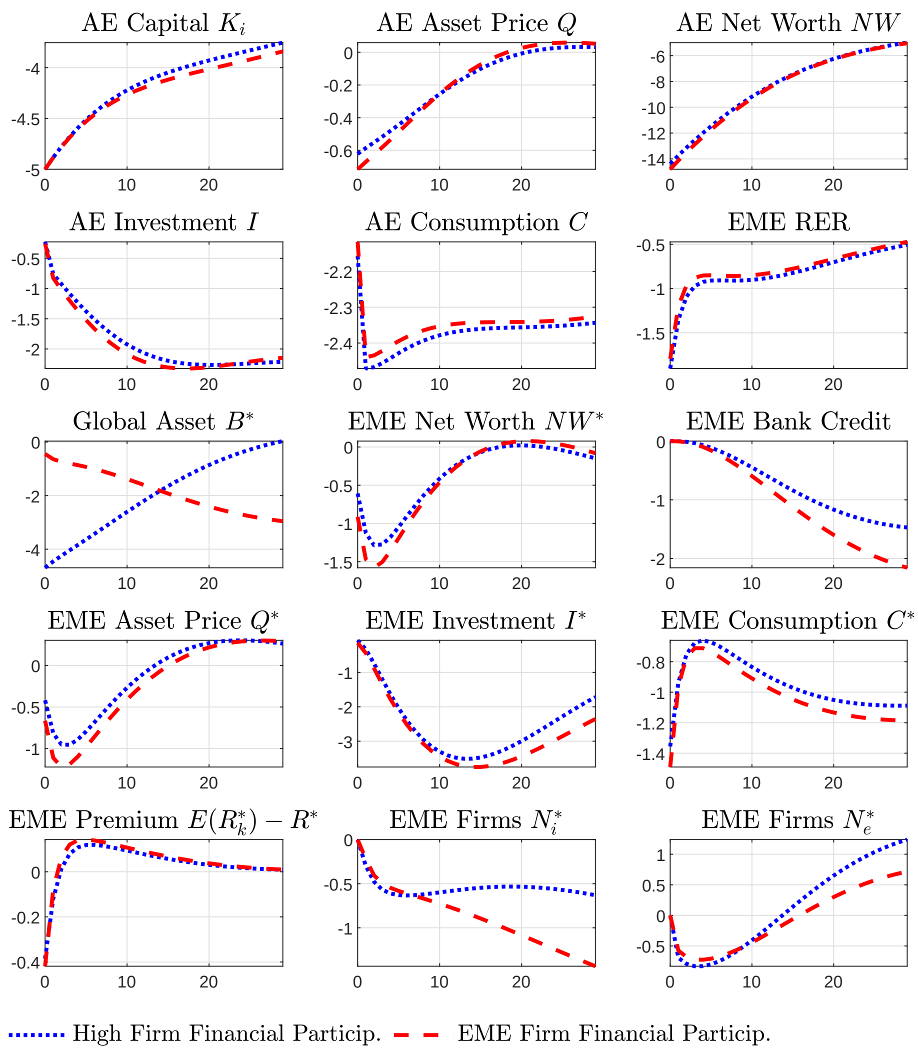
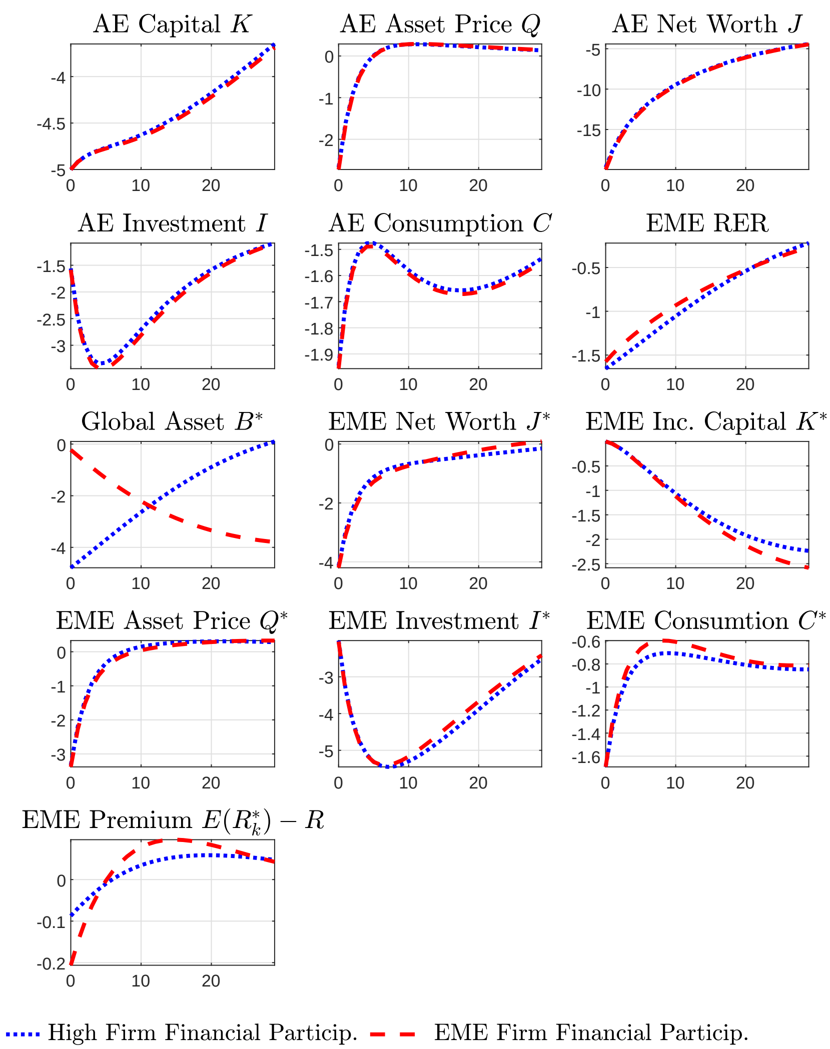


Fig. 3. Impulse Response to an Adverse Shock to the Quality of Capital in the AE: No Endogenous Entry



5 Conclusion

The Global Financial Crisis (GFC) of 2008-2009 highlighted the role of the banking system as an important propagation mechanism of U.S. financial shocks to emerging economies (EMEs). Recent evidence shows that compared to advanced economies (AEs), emerging economies (EMEs) exhibit considerably lower levels of firm participation in the domestic banking system, with several EMEs promoting greater firm financial participation in recent years. What are the implications of this greater firm participation in the banking system for the response to external financial shocks, such as those experienced by EMEs during the GFC? We build a two-country RBC model with banking frictions, endogenous firm entry, and limited domestic financial participation by firms. Using the model, we show that greater firm financial participation in EMEs limits the effect of adverse external financial shocks on EME financial and macro aggregates, with endogenous firm entry playing a critical role in the volatility-reducing effects of greater firm financial participation in EMEs. We provide empirical evidence for EMEs that broadly supports our model findings and mechanisms. More broadly, our findings suggest that cyclical financial policies aimed at stabilizing credit market fluctuations may need to be considered within a larger context where the economy's average degree of domestic firm financial participation.

A Additional Model Derivations and Details

In what follows, we present additional relevant details pertaining to the benchmark model's derivations.

A.1 Final Goods

A.1.1 Final Goods Firms in Home (H) Economy

Total output in the home (H) economy is given by

$$Y_t = \left[\alpha_a^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a - 1}{\phi_a}} + (1-\alpha_a)^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a - 1}{\phi_a}}\right]^{\frac{\phi_a}{\phi_a - 1}},$$

where the price index

$$P_t = \left[\alpha_a P_{H,t}^{1-\phi_a} + (1-\alpha_a) P_{F,t}^{1-\phi_a}\right]^{\frac{1}{1-\phi_a}}.$$

The first-order conditions yield relative demands for domestic goods and imported goods:

$$Y_{H,t} = \alpha_a \left(\frac{P_{H,t}}{P_t}\right)^{-\phi_a} Y_t = \alpha_a \left(\rho_{H,t}\right)^{-\phi_a} Y_t,$$

and

$$Y_{F,t} = (1-\alpha_a) \left(\frac{P_{F,t}}{P_t}\right)^{-\phi_a} Y_t = (1-\alpha_a) \left(\rho_{F,t}\right)^{-\phi_a} Y_t,$$

where $\rho_{H,t} = \frac{P_{H,t}}{P_t}$ and $\rho_{F,t} = \frac{P_{F,t}}{P_t}$. Defining the terms-of-trade (ToT) as the ratio of the price of imports to the price of exports, $ToT_t = P_{F,t}/P_{H,t}$, we can write

$$\frac{P_t}{P_{H,t}} = \left[\alpha_a + (1-\alpha_a)\left(ToT_t\right)^{1-\phi_a}\right]^{\frac{1}{1-\phi_a}},$$

and

$$\frac{P_t}{P_{F,t}} = \frac{P_t}{P_{H,t}} \frac{1}{ToT_t} = \frac{\left[\alpha_a + (1-\alpha_a) ToT_t^{1-\phi_a}\right]^{\frac{1}{1-\phi_a}}}{ToT_t}.$$

Then, the relative demands above can be expressed using the ToT:

$$Y_{H,t} = \alpha_a \left(\left[\alpha_a + (1-\alpha_a) ToT_t^{1-\phi_a}\right]^{\frac{\phi_a}{1-\phi_a}}\right) Y_t,$$

and

$$Y_{F,t} = \alpha_a \left(ToT_t^{-\phi_a} \left[\alpha_a + (1-\alpha_a) ToT_t^{1-\phi_a}\right]^{\frac{\phi_a}{1-\phi_a}}\right) Y_t.$$

A.1.2 Final Goods Firms in Foreign (F) Economy

Total output in the foreign (F) economy is given by

$$Y_t^* = \left[(\alpha_a^*)^{\frac{1}{\phi_a^*}} \left(Y_{F,t}^* \right)^{\frac{\phi_a^*-1}{\phi_a^*}} + (1-\alpha_a^*)^{\frac{1}{\phi_a^*}} \left(Y_{H,t}^* \right)^{\frac{\phi_a^*-1}{\phi_a^*}} \right]^{\frac{\phi_a^*}{\phi_a^*-1}},$$

where the price index

$$P_t^* = \left[(\alpha_a^*) \left(P_{F,t}^* \right)^{1-\phi_a^*} + (1-\alpha_a^*) \left(P_{H,t}^* \right)^{1-\phi_a^*} \right]^{\frac{1}{1-\phi_a^*}}.$$

The first-order conditions yield relative demands for domestic goods and imported goods:

$$Y_{F,t}^* = \alpha_a^* \left(\frac{P_{F,t}^*}{P_t^*} \right)^{-\phi_a^*} Y_t^* = \alpha_a^* \left(\rho_{F,t}^* \right)^{-\phi_a^*} Y_t^*,$$

and

$$Y_{H,t}^* = (1-\alpha_a^*) \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\phi_a^*} Y_t^* = (1-\alpha_a^*) \left(\rho_{H,t}^* \right)^{-\phi_a^*} Y_t^*,$$

where $\rho_{H,t}^* = \frac{P_{H,t}^*}{P_t^*}$ and $\rho_{F,t}^* = \frac{P_{F,t}^*}{P_t^*}$.

Assuming that the Law of One Price (LOP) holds, we have $P_{H,t} = NER_t P_{H,t}^*$ and $P_{F,t} = NER_t P_{F,t}^*$. Then, recalling that the ToT are given by $ToT_t = P_{F,t}/P_{H,t}$, we can write

$$ToT_t = \frac{P_{F,t}}{P_{H,t}} = \frac{NER_t P_{F,t}^*}{NER_t P_{H,t}^*} = \frac{P_{F,t}^*}{P_{H,t}^*}.$$

Then, noting that

$$\frac{P_t^*}{P_{F,t}^*} = \left[(\alpha_a^*) + (1-\alpha_a^*) \left(ToT_t \right)^{\phi_a^*-1} \right]^{\frac{1}{1-\phi_a^*}},$$

and

$$\frac{P_t^*}{P_{H,t}^*} = \frac{P_t^*}{P_{F,t}^*} ToT_t = ToT_t \left[(\alpha_a^*) + (1-\alpha_a^*) \left(ToT_t \right)^{\phi_a^*-1} \right]^{\frac{1}{1-\phi_a^*}},$$

we can write

$$Y_{F,t}^* = \alpha_a^* \left(\left[(\alpha_a^*) + (1-\alpha_a^*) \left(ToT_t \right)^{\phi_a^*-1} \right]^{\frac{\phi_a^*}{1-\phi_a^*}} \right) Y_t^*,$$

and

$$Y_{H,t}^* = (1-\alpha_a^*) \left(ToT_t^{\phi_a^*} \left[(\alpha_a^*) + (1-\alpha_a^*) \left(ToT_t \right)^{\phi_a^*-1} \right]^{\frac{\phi_a^*}{1-\phi_a^*}} \right) Y_t^*.$$

A.2 Real Exchange Rate

Define the real exchange rate (RER) as $RER_t = NER_t P_t^*/P_t$. Then, by the LOP, we have

$$P_{H,t} = NER_t P_{H,t}^*,$$

or

$$NER_t = \frac{P_{H,t}}{P_{H,t}^*}.$$

We can then write

$$RER_t = \frac{NER_t P_t^*}{P_t},$$

$$RER_t = \frac{P_{H,t}}{P_{H,t}^*}\frac{P_t^*}{P_t},$$

$$RER_t = \frac{P_{H,t}}{P_t}\frac{P_t^*}{P_{H,t}^*},$$

or

$$RER_t = \frac{\left[(\alpha_a^*)\left(ToT_t\right)^{1-\phi_a^*} + (1-\alpha_a^*)\right]^{\frac{1}{1-\phi_a^*}}}{\left[\alpha_a + (1-\alpha_a)\left(ToT_t\right)^{1-\phi_a}\right]^{\frac{1}{1-\phi_a}}}.$$

A.3 Domestic Production

A.3.1 Domestic Output Aggregators

Domestic output in H is given by

$$Y_{P,t} = \left[(1-\alpha_y)^{\frac{1}{\phi_y}} Y_{i,t}^{\frac{\phi_y-1}{\phi_y}} + (\alpha_y)^{\frac{1}{\phi_y}} Y_{e,t}^{\frac{\phi_y-1}{\phi_y}}\right]^{\frac{\phi_y}{\phi_y-1}}, \tag{A.1}$$

where

$$P_{P,t} = \left[(1-\alpha_y)P_{i,t}^{1-\phi_y} + (\alpha_y)P_{e,t}^{1-\phi_y}\right]^{\frac{1}{1-\phi_y}}.$$

Then, domestic output aggregators choose $Y_{e,t}$ and $Y_{i,t}$ to maximize

$$\left[\frac{P_{P,t}}{P_t}Y_{P,t} - \frac{P_{i,t}}{P_t}Y_{i,t} - \frac{P_{e,t}}{P_t}Y_{e,t}\right]$$

subject to

$$Y_{P,t} = \left[(1-\alpha_y)^{\frac{1}{\phi_y}} Y_{i,t}^{\frac{\phi_y - 1}{\phi_y}} + (\alpha_y)^{\frac{1}{\phi_y}} Y_{e,t}^{\frac{\phi_y - 1}{\phi_y}} \right]^{\frac{\phi_y}{\phi_y - 1}}$$

The first-order conditions yield

$$Y_{i,t} = (1-\alpha_y) \left(\frac{P_{i,t}}{P_t} \frac{P_t}{P_{P,t}} \right)^{-\phi_y} Y_{P,t}$$

and

$$Y_{e,t} = \alpha_y \left(\frac{P_{e,t}}{P_t} \frac{P_t}{P_{P,t}} \right)^{-\phi_y} Y_{P,t}$$

Recalling the definition of the ToT and $\frac{P_{P,t}}{P_t} = \left[\alpha_a + (1-\alpha_a) (ToT_t)^{1-\phi_a} \right]^{\frac{-1}{1-\phi_a}}$, we can write

$$Y_{i,t} = (1-\alpha_y) \left(\frac{P_{i,t}}{P_t} \left[\alpha_a + (1-\alpha_a) (ToT_t)^{1-\phi_a} \right]^{\frac{1}{1-\phi_a}} \right)^{-\phi_y} Y_{P,t},$$

and

$$Y_{e,t} = \alpha_y \left(\frac{P_{e,t}}{P_t} \left[\alpha_a + (1-\alpha_a) (ToT_t)^{1-\phi_a} \right]^{\frac{1}{1-\phi_a}} \right)^{-\phi_y} Y_{P,t}.$$

Similarly, domestic output in F is given by

$$Y_{P,t}^* = \left[(1-\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{i,t}^{\frac{\phi_y^* - 1}{\phi_y^*}} + (\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{e,t}^{\frac{\phi_y^* - 1}{\phi_y^*}} \right]^{\frac{\phi_y^*}{\phi_y^* - 1}},$$

where

$$P_{P,t}^* = \left[(1-\alpha_y^*) \left(P_{i,t}^* \right)^{1-\phi_y^*} + (\alpha_y^*) \left(P_{e,t}^* \right)^{1-\phi_y^*} \right]^{\frac{1}{1-\phi_y^*}}.$$

Then, domestic output aggregators choose $Y_{e,t}^*$ and $Y_{i,t}^*$ to maximize

$$\left[\frac{P_{P,t}^*}{P_t^*} Y_{P,t}^* - \frac{P_{i,t}^*}{P_t^*} Y_{i,t}^* - \frac{P_{e,t}^*}{P_t^*} Y_{e,t}^* \right],$$

subject to

$$Y_{P,t}^* = \left[(1-\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{i,t}^{\frac{\phi_y^* - 1}{\phi_y^*}} + (\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{e,t}^{\frac{\phi_y^* - 1}{\phi_y^*}} \right]^{\frac{\phi_y^*}{\phi_y^* - 1}}.$$

The first-order conditions yield

$$Y_{i,t}^{*}=(1-\alpha_y^{*})\left(\frac{P_{i,t}^{*}}{P_t^{*}}\frac{P_t^{*}}{P_{P,t}^{*}}\right)^{-\phi_y^{*}}Y_{P,t}^{*},$$

and

$$Y_{e,t}^{*}=\alpha_y^{*}\left(\frac{P_{e,t}^{*}}{P_t^{*}}\frac{P_t^{*}}{P_{P,t}^{*}}\right)^{-\phi_y}Y_{P,t}^{*}.$$

Recalling that $\frac{P_{P,t}^{*}}{P_t^{*}}=\left[(\alpha_a^{*})+(1-\alpha_a^{*})\left(ToT_t\right)^{\phi_a^{*}-1}\right]^{\frac{-1}{1-\phi_a^{*}}}$, we have

$$Y_{i,t}^{*}=(1-\alpha_y^{*})\left(\frac{P_{i,t}^{*}}{P_t^{*}}\left[(\alpha_a^{*})+(1-\alpha_a^{*})\left(ToT_t\right)^{\phi_a^{*}-1}\right]^{\frac{1}{1-\phi_a^{*}}}\right)^{-\phi_y^{*}}Y_{P,t}^{*},$$

and

$$Y_{e,t}^{*}=\alpha_y^{*}\left(\frac{P_{e,t}^{*}}{P_t^{*}}\left[(\alpha_a^{*})+(1-\alpha_a^{*})\left(ToT_t\right)^{\phi_a^{*}-1}\right]^{\frac{1}{1-\phi_a^{*}}}\right)^{-\phi_y}Y_{P,t}^{*}.$$

A.3.2 Aggregation of Domestic Wholesale Output

Recall that total domestic wholesale output in firm category $j\in\{e,i\}$ is given by

$$Y_{j,t}=\left(\int_{\omega_j\in\Omega_j}y_{j,t}(\omega_j)^{\frac{\varepsilon-1}{\varepsilon}}d\omega_j\right)^{\frac{\varepsilon}{\varepsilon-1}},$$

and the associated price index is

$$P_{j,t}=\left(\int_{\omega_j\in\Omega_j}p_{j,t}(\omega_j)^{1-\varepsilon}d\omega_j\right)^{\frac{1}{1-\varepsilon}}.$$

In a symmetric equilibrium, we have

$$Y_{j,t}=y_{j,t}N_{j,t}^{\frac{\varepsilon}{\varepsilon-1}}.$$

We can write the real price of wholesale output in firm category $j\in\{e,i\}$ as

$$\frac{P_{j,t}}{P_t}=\rho_{j,t}N_{j,t}^{\frac{1}{1-\varepsilon}},$$

where $\rho_{j,t}=\left(\varepsilon/(\varepsilon-1)\right)mc_{j,t}$.

A.4 Market Clearing

A.4.1 Total Domestic Output

From economy H's perspective, total demand for output produced in H must be equal to what is produced, so that

$$Y_{H,t} + \left(\frac{1-m}{m}\right) Y^*_{H,t} = Y_{P,t},$$

where $Y_{P,t}$ denotes total production in H. Analogously, economy F faces a similar market clearing condition, so that

$$\left(\frac{m}{1-m}\right) Y_{F,t} + Y^*_{F,t} = Y^*_{P,t}.$$

Formally, domestic aggregators in H choose $Y_{H,t}$ and $Y^*_{H,t}$ to maximize

$$\left[\frac{P_{H,t}}{P_t} Y_{H,t} + \frac{NER_t P^*_{H,t}}{P_t}\left(\frac{1-m}{m}\right) Y^*_{H,t} - \frac{P_{P,t}}{P_t} Y_{P,t}\right],$$

subject to

$$Y_{H,t} + \left(\frac{1-m}{m}\right) Y^*_{H,t} = Y_{P,t},$$

where NER_t denotes the nominal exchange rate.

The first-order conditions yield

$$\frac{P_{H,t}}{P_t} = \frac{P_{P,t}}{P_t},$$

or

$$\frac{P_{P,t}}{P_t} = \left[\alpha_a + (1-\alpha_a)\left(ToT_t\right)^{1-\phi_a}\right]^{\frac{-1}{1-\phi_a}},$$

and

$$\frac{NER_t P^*_{H,t}}{P_t} = \frac{P_{P,t}}{P_t},$$

which we can rewrite as

$$\frac{P^*_t NER_t}{P_t}\frac{P^*_{H,t}}{P^*_t} = \frac{P_{P,t}}{P_t},$$

or

$$\frac{P^*_{H,t}}{P^*_t} = \frac{P_{P,t}}{P_t}\frac{1}{RER_t}.$$

Similarly, domestic aggregators in F choose $Y_{F,t}$ and $Y^*_{F,t}$ to maximize

$$\left[\frac{P^*_{F,t}}{P^*_t}Y^*_{F,t} + \frac{P_{F,t}}{P^*_t NER_t}\left(\frac{m}{1-m}\right)Y^*_{F,t} - \frac{P^*_{P,t}}{P^*_t}Y^*_{P,t}\right],$$

subject to

$$\left(\frac{m}{1-m}\right)Y_{F,t} + Y^*_{F,t} = Y^*_{P,t},$$

The first-order conditions yield

$$\frac{P^*_{F,t}}{P^*_t} = \frac{P^*_{P,t}}{P^*_t},$$

or

$$\frac{P^*_{P,t}}{P^*_t} = \left[(\alpha^*_a) + (1-\alpha^*_a)\left(ToT_t\right)^{\phi^*_a - 1}\right]^{\frac{-1}{1-\phi^*_a}},$$

and

$$\frac{P_{F,t}}{P^*_t NER_t} = \frac{P^*_{P,t}}{P^*_t},$$

which we can rewrite as

$$\frac{P_{F,t}}{P_t}\frac{P_t}{P^*_t NER_t} = \frac{P^*_{P,t}}{P^*_t},$$

or

$$\frac{P_{F,t}}{P_t} = \frac{P^*_{P,t}}{P^*_t}RER_t.$$

Market clearing in each firm category in H is given by

$$N_{e,t}y_{e,t} = z_{e,t}(k_{e,t})^{1-\alpha_e}(L_{e,t})^{\alpha_e},$$

and

$$N_{i,t}y_{i,t} = z_{i,t}(k_{i,t})^{1-\alpha_i}(L_{i,t})^{\alpha_i}.$$

Market clearing in each firm category in F is given by

$$N^*_{e,t} y^*_{e,t} = z^*_{e,t} (k^*_{e,t})^{1-\alpha^*_e} (L^*_{e,t})^{\alpha^*_e},$$

and

$$N^*_{i,t} y^*_{i,t} = z^*_{i,t} (k^*_{i,t})^{1-\alpha^*_i} (L^*_{i,t})^{\alpha^*_i}.$$

B Equilibrium Conditions

The endogenous variables
$\left\{Y_{i,t}, \rho_{i,t}, mc_{i,t}, Y_{e,t}, \rho_{e,t}, mc_{e,t}, \frac{P^*_{i,t}}{P^*_t}, \frac{P^*_{e,t}}{P^*_t}, Y_{P,t}, \frac{P_{P,t}}{P_t}, Y^*_{H,t}, ToT_t, Y_{H,t}, Y_t, \frac{P_{H,t}}{P_t}, N_{i,t}, N_{e,t}\right\}$
$\left\{d_{i,t}, d_{e,t}, N^i_{E,t}, N^e_{E,t}, y_{i,t}, y_{e,t}, c_t, RER_t, L_{i,t}, L_{e,t}, i_{i,t}, i_{e,t}, w_{i,t}, w_{e,t}, r_{i,t}, r_{e,t}, R_t, k_{e,t}, k_{i,t}\right\}$
$\left\{Y^*_{i,t}, \rho^*_{i,t}, mc^*_{i,t}, Y^*_{e,t}, \rho^*_{e,t}, mc^*_{e,t}, \frac{P^*_{i,t}}{P^*_t}, \frac{P^*_{e,t}}{P^*_t}, Y^*_{P,t}, \frac{P^*_{P,t}}{P^*_t}, Y_{F,t}, Y^*_{F,t}, Y^*_t, \frac{P^*_{F,t}}{P^*_t}, N^*_{i,t}, N^*_{e,t}, d^*_{i,t}, d^*_{e,t}\right\}$
$\left\{N^{i*}_{E,t}, N^{e*}_{E,t}, y^*_{i,t}, y^*_{e,t}, c^*_t, L^*_{i,t}, L^*_{e,t}, i^*_{i,t}, i^*_{e,t}, w^*_{i,t}, w^*_{e,t}, r^*_{i,t}, r^*_{e,t}, R^*_t, k^*_{e,t}, k^*_{i,t}, B^*_t, s_{i,t}, s^*_{i,t}, \phi_t\right\}$
$\left\{\vartheta_t, \mu_t, \Lambda_t, NW_t, B_{d,t}, R_{k_i,t}, \phi^*_t, \vartheta^*_t, \mu^*_t, \Lambda^*_t, NW^*_t, B^*_{d,t}, R^*_{k_i,t}, \mu^*_{b,t}, \phi^*_{b,t}, R^*_{b,t}, Q^*_{b,t}, B_t\right\}$ satisfy the following equations:

$$Y_{i,t} = y_{i,t} N_{i,t}^{\frac{\varepsilon}{\varepsilon-1}}, \tag{B.1}$$

$$\frac{P_{i,t}}{P_t} = \rho_{i,t} N_{i,t}^{\frac{1}{1-\varepsilon}}, \tag{B.2}$$

$$\rho_{i,t} = \frac{\varepsilon}{\varepsilon - 1} mc_{i,t}, \tag{B.3}$$

$$Y_{e,t} = y_{e,t} N_{e,t}^{\frac{\varepsilon}{\varepsilon-1}}, \tag{B.4}$$

$$\frac{P_{e,t}}{P_t} = \rho_{e,t} N_{e,t}^{\frac{1}{1-\varepsilon}}, \tag{B.5}$$

$$\rho_{e,t} = \frac{\varepsilon}{\varepsilon - 1} mc_{e,t}, \tag{B.6}$$

$$Y_{e,t} = \alpha_y \left(\frac{P_{e,t}}{P_t} \left[\alpha_a + (1-\alpha_a)(ToT_t)^{1-\phi_a} \right]^{\frac{1}{1-\phi_a}} \right)^{-\phi_y} Y_{P,t}, \tag{B.7}$$

$$Y^*_{P,t} = \left[(1-\alpha^*_y)^{\frac{1}{\phi^*_y}} Y_{i,t}^{\frac{\phi^*_y - 1}{\phi^*_y}} + (\alpha^*_y)^{\frac{1}{\phi^*_y}} Y_{e,t}^{\frac{\phi^*_y - 1}{\phi^*_y}} \right]^{\frac{\phi^*_y}{\phi^*_y - 1}}, \tag{B.8}$$

$$Y_{P,t} = \left[(1-\alpha_y)^{\frac{1}{\phi_y}} Y_{i,t}^{\frac{\phi_y-1}{\phi_y}} + (\alpha_y)^{\frac{1}{\phi_y}} Y_{e,t}^{\frac{\phi_y-1}{\phi_y}} \right]^{\frac{\phi_y}{\phi_y-1}}, \tag{B.9}$$

$$\frac{P_{P,t}}{P_t} = \left[\alpha_a + (1-\alpha_a)(ToT_t)^{1-\phi_a} \right]^{\frac{-1}{1-\phi_a}}, \tag{B.10}$$

$$Y_{H,t} + \left(\frac{1-m}{m} \right) Y_{H,t}^{*} = Y_{P,t}, \tag{B.11}$$

$$RER_t = \frac{\left[(\alpha_a^{*})(ToT_t)^{1-\phi_a^{*}} + (1-\alpha_a^{*}) \right]^{\frac{1}{1-\phi_a^{*}}}}{\left[\alpha_a + (1-\alpha_a)(ToT_t)^{1-\phi_a} \right]^{\frac{1}{1-\phi_a}}}, \tag{B.12}$$

$$Y_{H,t} = \alpha_a \left(\left[\alpha_a + (1-\alpha_a) ToT_t^{1-\phi_a} \right]^{\frac{\phi_a}{1-\phi_a}} \right) Y_t, \tag{B.13}$$

$$Y_t = \left[\alpha_a^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a-1}{\phi_a}} + (1-\alpha_a)^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a-1}{\phi_a}} \right]^{\frac{\phi_a}{\phi_a-1}}, \tag{B.14}$$

$$\frac{P_{H,t}}{P_t} = \frac{P_{P,t}}{P_t}, \tag{B.15}$$

$$N_{i,t+1} = (1-\delta)(N_{i,t} + N_{E,t}^{i}), \tag{B.16}$$

$$N_{e,t+1} = (1-\delta)(N_{e,t} + N_{E,t}^{e}), \tag{B.17}$$

$$d_{i,t} = (\rho_{i,t} - mc_{i,t}) y_{i,t}, \tag{B.18}$$

$$d_{e,t} = (\rho_{e,t} - mc_{e,t}) y_{e,t}, \tag{B.19}$$

$$\psi_i = (1-\delta)\mathbb{E}_t \Xi_{t+1|t} \left[d_{i,t+1} + \psi_i \right], \tag{B.20}$$

$$\psi_e = (1-\delta)\mathbb{E}_t \Xi_{t+1|t} \left[d_{e,t+1} + \psi_e \right], \tag{B.21}$$

$$N_{i,t} y_{i,t} = z_{i,t} (k_{i,t})^{1-\alpha_i} (L_{i,t})^{\alpha_i}, \tag{B.22}$$

$$N_{e,t} y_{e,t} = z_{e,t} (k_{e,t})^{1-\alpha_e} (L_{e,t})^{\alpha_e}, \tag{B.23}$$

$$Y_t = c_t + i_{i,t} + i_{e,t} + \psi_i N^i_{E,t} + \psi_e N^e_{E,t}, \tag{B.24}$$

$$RER_t Q_{b,t} B_t - RER_t R_{b,t} Q_{b,t-1} B_{t-1} = \left(\frac{1-m}{m}\right) Y^*_{H,t} \frac{P_{H,t}}{P_t} - Y_{F,t} ToT_t \frac{P_{H,t}}{P_t}, \tag{B.25}$$

$$-u_{L_i,t} = w_{i,t} u_{c_i,t}, \tag{B.26}$$

$$-u_{L_e,t} = w_{e,t} u_{c_e,t}, \tag{B.27}$$

$$k_{i,t+1}/\Psi_{t+1} = (1-\delta) k_{i,t} + i_{i,t}, \tag{B.28}$$

$$k_{e,t+1} = (1-\delta) k_{e,t} + i_{e,t}, \tag{B.29}$$

$$w_{i,t} = (1-\alpha_i) mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i} (L_{i,t})^{-\alpha_i}, \tag{B.30}$$

$$w_{e,t} = (1-\alpha_e) mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e} (L_{e,t})^{-\alpha_e}, \tag{B.31}$$

$$r_{i,t} = (\alpha_i) mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i - 1} (L_{i,t})^{1-\alpha_i}, \tag{B.32}$$

$$r_{e,t} = (\alpha_e) mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e - 1} (L_{e,t})^{1-\alpha_e}, \tag{B.33}$$

$$1 = \mathbb{E}_t \Xi_{t+1|t} R_t, \tag{B.34}$$

$$Q_{e,t} = \mathbb{E}_t \Xi_{t+1|t} \left[\alpha_e mc_{e,t+1} z_{e,t+1} k^{\alpha_e - 1}_{e,t+1} L^{1-\alpha_e}_{e,t+1} + Q_{e,t+1} (1-\delta) \right], \tag{B.35}$$

$$Y^*_{i,t} = y^*_{i,t} N^{*\frac{\varepsilon}{\varepsilon-1}}_{i,t}, \tag{B.36}$$

$$\frac{P^*_{i,t}}{P^*_t} = \rho^*_{i,t} N^{*\frac{1}{1-\varepsilon}}_{i,t}, \tag{B.37}$$

$$\rho^*_{i,t} = \frac{\varepsilon}{\varepsilon - 1} mc^*_{i,t}, \tag{B.38}$$

$$Y^*_{e,t} = y^*_{e,t} N^{*\frac{\varepsilon}{\varepsilon-1}}_{e,t}, \tag{B.39}$$

$$\frac{P^*_{e,t}}{P^*_t} = \rho^*_{e,t} {N^*_{e,t}}^{\frac{1}{1-\varepsilon}}, \tag{B.40}$$

$$\rho^*_{e,t} = \frac{\varepsilon}{\varepsilon - 1} mc^*_{e,t}, \tag{B.41}$$

$$Y^*_{i,t} = (1-\alpha^*_y) \left(\frac{P^*_{i,t}}{P^*_t} \left[(\alpha^*_a) + (1-\alpha^*_a) \left(ToT_t\right)^{\phi^*_a - 1} \right]^{\frac{1}{1-\phi^*_a}} \right)^{-\phi^*_y} Y^*_{P,t}, \tag{B.42}$$

$$Y^*_{e,t} = \alpha^*_y \left(\frac{P^*_{e,t}}{P^*_t} \left[(\alpha^*_a) + (1-\alpha^*_a) \left(ToT_t\right)^{\phi^*_a - 1} \right]^{\frac{1}{1-\phi^*_a}} \right)^{-\phi_y} Y^*_{P,t}, \tag{B.43}$$

$$Y^*_{P,t} = \left[(1-\alpha^*_y)^{\frac{1}{\phi^*_y}} Y_{i,t}^{\frac{\phi^*_y - 1}{\phi^*_y}} + (\alpha^*_y)^{\frac{1}{\phi^*_y}} Y_{e,t}^{\frac{\phi^*_y - 1}{\phi^*_y}} \right]^{\frac{\phi^*_y}{\phi^*_y - 1}}, \tag{B.44}$$

$$\frac{P^*_{P,t}}{P^*_t} = \left[(\alpha^*_a) + (1-\alpha^*_a) \left(ToT_t\right)^{\phi^*_a - 1} \right]^{\frac{-1}{1-\phi^*_a}}, \tag{B.45}$$

$$\left(\frac{m}{1-m} \right) Y_{F,t} + Y^*_{F,t} = Y^*_{P,t}, \tag{B.46}$$

$$Y^*_{F,t} = \alpha^*_a \left(\left[(\alpha^*_a) + (1-\alpha^*_a) \left(ToT_t\right)^{\phi^*_a - 1} \right]^{\frac{\phi^*_a}{1-\phi^*_a}} \right) Y^*_t, \tag{B.47}$$

$$Y^*_t = \left[(\alpha^*_a)^{\frac{1}{\phi^*_a}} \left(Y^*_{F,t}\right)^{\frac{\phi^*_a - 1}{\phi^*_a}} + (1-\alpha^*_a)^{\frac{1}{\phi^*_a}} \left(Y^*_{H,t}\right)^{\frac{\phi^*_a - 1}{\phi^*_a}} \right]^{\frac{\phi^*_a}{\phi^*_a - 1}}, \tag{B.48}$$

$$\frac{P^*_{F,t}}{P^*_t} = \frac{P^*_{P,t}}{P^*_t}, \tag{B.49}$$

$$N^*_{i,t+1} = (1-\delta^*)(N^*_{i,t} + N^{i*}_{E,t}), \tag{B.50}$$

$$N^*_{e,t+1} = (1-\delta^*)(N^*_{e,t} + N^{e*}_{E,t}), \tag{B.51}$$

$$d^*_{i,t} = (\rho^*_{i,t} - mc^*_{i,t}) y^*_{i,t}, \tag{B.52}$$

$$d^*_{e,t} = (\rho^*_{e,t} - mc^*_{e,t}) y^*_{e,t}, \tag{B.53}$$

$$\psi^*_i = (1-\delta^*) \mathbb{E}_t \Xi^*_{t+1|t} \left[d^*_{i,t+1} + \psi^*_i \right], \tag{B.54}$$

$$\psi_e^* = (1-\delta^*)\mathbb{E}_t \Xi_{t+1|t}^* \left[d_{e,t+1}^* + \psi_e^*\right], \tag{B.55}$$

$$N_{i,t}^* y_{i,t}^* = z_{i,t}^* (k_{i,t}^*)^{1-\alpha_i^*} (L_{i,t}^*)^{\alpha_i^*}, \tag{B.56}$$

$$N_{e,t}^* y_{e,t}^* = z_{e,t}^* (k_{e,t}^*)^{1-\alpha_e^*} (L_{e,t}^*)^{\alpha_e^*}, \tag{B.57}$$

$$Y_t^* = c_t^* + i_{i,t}^* + i_{e,t}^* + \psi_i^* N_{Ei,t}^* + \psi_e^* N_{Ee,t}^*, \tag{B.58}$$

$$-u_{L_i^*,t} = w_{i,t}^* u_{c_i^*,t}, \tag{B.59}$$

$$u_{L_e^*,t} = w_{e,t}^* u_{c_e^*,t}, \tag{B.60}$$

$$k_{i,t+1}^* / \Psi_{t+1}^* = (1-\delta^*) k_{i,t}^* + i_{i,t}^*, \tag{B.61}$$

$$k_{e,t+1}^* = (1-\delta^*) k_{e,t}^* + i_{e,t}^*, \tag{B.62}$$

$$w_{i,t}^* = (1-\alpha_i^*) mc_{i,t}^* z_{i,t}^* (k_{i,t}^*)^{\alpha_i^*} (L_{i,t}^*)^{-\alpha_i^*}, \tag{B.63}$$

$$w_{e,t}^* = (1-\alpha_e^*) mc_{e,t}^* z_{e,t}^* (k_{e,t}^*)^{\alpha_e^*} (L_{e,t}^*)^{-\alpha_e^*}, \tag{B.64}$$

$$r_{i,t}^* = (\alpha_i^*) mc_{i,t}^* z_{i,t}^* (k_{i,t}^*)^{\alpha_i^*-1} (L_{i,t}^*)^{1-\alpha_i^*}, \tag{B.65}$$

$$r_{e,t}^* = (\alpha_e^*) mc_{e,t}^* z_{e,t}^* (k_{e,t}^*)^{\alpha_e^*-1} (L_{e,t}^*)^{1-\alpha_e^*}, \tag{B.66}$$

$$1 = \mathbb{E}_t \Xi_{t+1|t}^* R_t^*, \tag{B.67}$$

$$Q_{e,t}^* = \mathbb{E}_t \Xi_{t+1|t}^* \left[\alpha_e^* mc_{e,t+1}^* z_{e,t+1}^* k_{e,t+1}^{*\alpha_e^*-1} L_{e,t+1}^{*1-\alpha_e^*} + Q_{e,t+1}^* (1-\delta)\right], \tag{B.68}$$

$$R_{k_i,t+1} = \mathit{\Psi}_{t+1} \frac{\left[r_{i,t+1} + Q_{i,t+1}(1-\delta)\right]}{Q_{i,t}}, \tag{B.69}$$

$$R_{k_i,t+1}^* = \mathit{\Psi}_{t+1}^* \frac{\left[r_{i,t+1}^* + Q_{i,t+1}^*(1-\delta^*)\right]}{Q_{i,t}^*}, \tag{B.70}$$

$$B_t = B_t^* \left(\frac{1-m}{m} \right), \tag{B.71}$$

$$s_{i,t} = k_{i,t+1}/\Psi_{t+1}, \tag{B.72}$$

$$s_{i,t}^* = k_{i,t+1}^*/\Psi_{t+1}^*, \tag{B.73}$$

$$\phi_t = \vartheta_t/(\theta - \mu_t), \tag{B.74}$$

$$\phi_t NW_t = Q_{i,t} s_{i,t} + Q_{b,t}^* B_t^* RER_t, \tag{B.75}$$

$$\mu_t = \mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1} \left(R_{k_i,t+1} - R_{t+1} \right), \tag{B.76}$$

$$\Lambda_{t+1} = (1-\sigma) + \sigma(\vartheta_{t+1} + \phi_{t+1}\mu_{t+1}), \tag{B.77}$$

$$NW_t = (\sigma + \xi) \left(R_{k_i,t} Q_{i,t-1} s_{i,t-1} + R_{b,t}^* Q_{b,t-1}^* RER_t B_{t-1} \right) - \sigma R_t B_{d,t-1}, \tag{B.78}$$

$$B_{d,t} = NW_t(\phi_t - 1), \tag{B.79}$$

$$\vartheta_t = \mathbb{E}_t \Xi_{t+1|t} \Lambda_{t+1} R_{t+1}, \tag{B.80}$$

$$\phi_t^* = \vartheta_t^*/(\theta^* - \mu_t^*), \tag{B.81}$$

$$\phi_t^* NW_t^* = Q_{i,t}^* s_{i,t}^* - Q_{b,t}^* B_t^*, \tag{B.82}$$

$$\mu_t^* = \mathbb{E}_t \Xi_{t+1|t}^* \Lambda_{t+1}^* \left(R_{k_i,t+1}^* - R_{t+1}^* \right), \tag{B.83}$$

$$\Lambda_{t+1}^* = (1-\sigma^*) + \sigma^*(\vartheta_{t+1}^* + \phi_{t+1}^*\mu_{t+1}^*), \tag{B.84}$$

$$NW_t^* = (\sigma^* + \xi^*) R_{k_i,t}^* Q_{i,t-1}^* s_{i,t-1}^* - \sigma^* R_t^* B_{d,t-1}^* - \sigma^* R_{b,t}^* Q_{b,t-1}^* B_{t-1}^*, \tag{B.85}$$

$$B_{d,t}^* = NW_t^*(\phi_t^* - 1), \tag{B.86}$$

$$\vartheta_t^* = \mathbb{E}_t \Xi_{t+1|t}^* \Lambda_{t+1}^* R_{t+1}^*, \tag{B.87}$$

$$\mu_{b,t}^* = \mathbb{E}_t \Xi_{t+1|t}^* \Lambda_{t+1}^* \left(R_{b,t+1}^* - R_{t+1}^* \right), \tag{B.88}$$

$$\phi_{b,t}^* = \vartheta_t^* / (\theta^* - \mu_{b,t}^*), \tag{B.89}$$

$$R_{b,t+1}^* = \mathit{\Psi}_{t+1}^* \frac{\left[r_{i,t+1}^* + Q_{b,t+1}^* \left(1 - \delta^*\right) \right]}{Q_{b,t}^*}, \tag{B.90}$$

$$R_{k_i,t+1} = R_{b,t+1}^* \left(\frac{RER_{t+1}}{RER_t} \right) + \Phi \left[exp(B_t - B) - 1 \right], \tag{B.91}$$

$$\mu_{b,t}^* = \mu_t^*. \tag{B.92}$$

C Empirical Validation: Additional Results

C.1 Alternative Measures Credit-GDP Ratio

First, we use two additional measures of the bank credit-to-GDP ratio to the one presented in the main text, the average ratio over the sample 2000Q1-2018Q3. The two measures that we consider here are the ratio in 2000Q1, and the average between 1990Q1 and 2000Q1. We estimate the regression for the cross-border bank flows to GDP ratio and the one on consumption. The results are in Table C.1 and are robust to the different measures.

Tab. C.1. Fixed-Effects Estimations with Country-Specific Cross-Border Bank Flows and Private Real Consumption as Dependent Variables

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{\text{GDP}_{it}}$			Consumption C_{it}		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs NCO_t	0.195	0.212	0.199			
	(0.148)	(0.153)	(0.148)			
Credit to $\text{GDP}_{i,2000:1} \times \text{NCO}_t$	-0.127**					
	(0.059)					
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{NCO}_t$		-0.149*				
		(0.071)				
Credit to $\text{GDP}_{i,1990:1-1999:4} \times \text{NCO}_t$			-0.137*			
			(0.070)			
Real Exchange Rate RER_{it}				-0.150	-0.192**	-0.180**
				(0.089)	(0.077)	(0.082)
Credit to $\text{GDP}_{i,2000:1} \times \text{RER}_{it}$				0.169		
				(0.105)		
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{RER}_{it}$					0.279**	
					(0.122)	
Credit to $\text{GDP}_{i,1990:1-1999:4} \times \text{RER}_{it}$						0.260*
						(0.121)
Constant	-0.006	-0.006	-0.006	0.001	0.002	0.002
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,022	1,022	1,022	873	873	873
R-squared	0.177	0.176	0.175	0.269	0.283	0.279
Number of countries	14	14	14	14	14	14

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q3. NCO_t, RER_{it}, C_{it} and $\frac{B_{it}}{\text{GDP}_{it}}$ are real, logged and detrended using the Hodrick-Prescott filter. Credit to $\text{GDP}_{2000:1}$ is the bank credit to GDP in 2000:1, Credit to $\text{GDP}_{1990:1-2018:3}$ is the average bank credit to GDP for the period 1990:1-2018:3, whereas Credit to $\text{GDP}_{1990:1-1999:4}$ is the average for the period 1990:1-1999:4. Foreign claims to GDP correspond to foreign claims of each country on U.S. banks to GDP ratio. The sample of EMEs used is comprised of: Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Korea, Malaysia, Mexico, South Africa, Thailand, Turkey and Russia.

C.2 Alternative Controls: Deposits-GDP Ratio

The data on the ratio of bank deposits to GDP is taken from the World Bank's Global Financial Development dataset. This dataset includes annual information for the total value of demand, time and saving deposits at domestic deposit money banks as a share of GDP. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits. Our sample covers 19 EMEs and 22 AEs from 1990 to 2016.

Table C.2 presents results based on a similar empirical analysis to the one in the main text that uses the deposits-GDP ratio as the measure of financial participation. We consider three alternatives way of expressing the deposits-GDP ratio in three different ways. Our main findings remain unchanged. Figure D.1 plots a similar figure to Figure 1 using the deposits-GDP ratio as a control variable.

C.3 Lagged Real Exchange Rate

We run the same regressions as those in the main text using the lag of the real exchange rate as a dependent variable. Table C.3 presents our main findings using this alternative specification, confirming that our main findings remain unchanged. In fact, our main message is even stronger, both statistically and from an economic standpoint, using the lagged real exchange rate.

C.4 Baseline Empirical Results: Advanced Economies

Table C.4 presents results from the same experiment in the main text, but now focusing on AEs (recall that our main empirical analysis in the main text focused solely on EMEs). In particular, we estimate regressions 42 and 43 controlling for different levels of the bank credit-GDP ratio. Table C.5 shows the same exercises using the deposits-GDP ratio as a control variable.

The results using the AE sample differ from those based on EMEs in non-trivial ways. In particular, in contrast to our findings for EMEs, in AEs, the sign of the effect of U.S. net charge-offs on the ratio of foreign claims to GDP is positive and significant. Coupled with the sign and significance of the bank credit-GDP ratio, the marginal effect in AEs ends up being positive. This result is consistent with greater domestic financial participation in AEs bringing about greater vulnerability to external disturbances. Turning to the results that use the deposits-GDP ratio as the financial participation measure, the results in Table C.5 show that this variable is not significant across specifications. Only the shock itself produces movements in the foreign claims-GDP ratio.

Turning to the specification with real private consumption as a dependent variable, the results for AEs also differ from those for EMEs. Specifically, in AEs, the effects of the real exchange rate on consumption are not significant regardless of the specifications.

Tab. C.2. Fixed-Effects Estimations with Country-Specific Cross-Border Bank Flows and Private Real Consumption as Dependent Variables

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{GDP_{it}}$			Consumption C_{it}		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs NCO_t	0.255	0.251	0.248			
	(0.152)	(0.156)	(0.153)			
Deposits to $GDP_{i,2000:1} \times NCO_t$	-0.259**					
	(0.117)					
Deposits to $GDP_{i,1990:1-2018:3} \times NCO_t$		-0.251*				
		(0.118)				
Deposits to $GDP_{i,1990:1-1999:4} \times NCO_t$			-0.311**			
			(0.140)			
Real Exchange Rate RER_{it}				-0.230*	-0.230**	-0.204**
				(0.113)	(0.090)	(0.093)
Deposits to $GDP_{2000} \times RER_{it}$				0.387		
				(0.222)		
Deposits to $GDP_{i,1990-2018} \times RER_{it}$					0.438*	
					(0.207)	
Deposits to $GDP_{i,1990-1999} \times RER_{it}$						0.467*
						(0.253)
Constant	-0.006	-0.006	-0.006	0.002	0.002	0.002
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,022	1,022	1,022	873	873	873
R-squared	0.188	0.185	0.186	0.275	0.283	0.276
Number of countries	14	14	14	14	14	14

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q3. NCO_t, RER_{it}, C_{it} $\frac{B_{it}}{GDP_{it}}$ are real, logged and detrended using the Hodrick-Prescott filter. Deposits to GDP_{2000} is the bank deposits to GDP in 2000, Deposits to $GDP_{1990-2018}$ is the average bank deposits to GDP for the period 1990-2018, whereas Deposits to $GDP_{1990-1999}$ is the average for the period 1990-1999. Foreign claims to GDP correspond to foreign claims of each country on U.S. banks to GDP ratio. The sample of EMEs used is comprised of: Argentina, Brazil, Chile, Colombia, Czech Republic, Hungary, India, Israel, Korea, Malaysia, Mexico, South Africa, Thailand, and Turkey.

Tab. C.3. Fixed-Effects Estimations with Private Real Consumption as Dependent Variable

Dependent variable:	Consumption C_{it}					
	(1)	(2)	(3)	(4)	(5)	(6)
Real Exchange Rate $RER_{i,t-1}$	-0.160**	-0.192***	-0.186***	-0.241***	-0.226***	-0.199***
	(0.063)	(0.048)	(0.052)	(0.078)	(0.059)	(0.063)
Credit to $GDP_{i,2000:1} \times RER_{it-1}$	0.223**					
	(0.090)					
Credit to $GDP_{i,1990:1-2018:3} \times RER_{it-1}$		0.304***				
		(0.092)				
Credit to $GDP_{i,1990:1-1999:4} \times RER_{it-1}$			0.306***			
			(0.094)			
Deposits to $GDP_{i,2000} \times RER_{it-1}$				0.446**		
				(0.178)		
Deposits to $GDP_{i,1990-2018} \times RER_{it-1}$					0.455**	
					(0.163)	
Deposits to $GDP_{i,1990-1999} \times RER_{it-1}$						0.486**
						(0.205)
Constant	0.003	0.002	0.003	0.002	0.002	0.003
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	871	871	871	871	871	871
R-squared	0.269	0.280	0.279	0.272	0.277	0.270
Number of countries	14	14	14	14	14	14

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q2. RER_{it} and C_{it} are real, logged and detrended using the Hodrick-Prescott filter. Credit to $GDP_{2000:1}$ is the bank credit to GDP in 2000:1, Credit to $GDP_{1990:1-2018:3}$ is the average bank credit to GDP for the period 1990:1-2018:3, whereas Credit to $GDP_{1990:1-1999:4}$ is the average for the period 1990:1-1999:4 (same for Deposits to GDP). The sample of EMEs used is comprised of: Argentina, Brazil, Chile, Colombia, Czech Republic, Hungary, India, Israel, Korea, Malaysia, Mexico, South Africa, Thailand, and Turkey.

Tab. C.4. Fixed-Effects Estimations with Country-Specific Cross-Border Bank Flows-GDP Ratio and Private Real Consumption as Dependent Variables for AEs

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{\text{GDP}_{it}}$			Consumption C_{it}		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs NCO_t	0.645***	0.718***	0.576***			
	(0.189)	(0.197)	(0.180)			
Credit to $\text{GDP}_{i,2000:1} \times \text{NCO}_t$	-0.183**					
	(0.082)					
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{NCO}_t$		-0.249**				
		(0.091)				
Credit to $\text{GDP}_{i,1990:1-1999:4} \times \text{NCO}_t$			-0.112			
			(0.093)			
Real Exchange Rate RER_{it}				-0.033	-0.016	-0.020
				(0.029)	(0.039)	(0.031)
Credit to $\text{GDP}_{i,2000:1} \times \text{RER}_{it}$				0.043		
				(0.033)		
Credit to $\text{GDP}_{i,1990:1-2018:3} \times \text{RER}_{it}$					0.019	
					(0.039)	
Credit to $\text{GDP}_{i,1990:1-1999:4} \times \text{RER}_{it}$						0.030
						(0.033)
Constant	-0.041**	-0.042**	-0.041**	-0.013**	-0.012**	-0.013**
	(0.019)	(0.019)	(0.019)	(0.006)	(0.006)	(0.006)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,460	1,521	1,460	1,477	1,551	1,477
R-squared	0.298	0.298	0.294	0.499	0.497	0.498
Number of countries	20	21	20	20	21	20

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q3. NCO_t, RER_{it}, C_{it} and $\frac{B_{it}}{\text{GDP}_{it}}$ are real, logged and detrended using the Hodrick-Prescott filter. Credit to $\text{GDP}_{2000:1}$ is the bank credit to GDP in 2000:1, Credit to $\text{GDP}_{1990:1-2018:3}$ is the average bank credit to GDP for the period 1990:1-2018:3, whereas Credit to $\text{GDP}_{1990:1-1999:4}$ is the average for the period 1990:1-1999:4. Foreign claims to GDP correspond to foreign claims of each country on U.S. banks to GDP ratio. The sample of AEs used is comprised of: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Tab. C.5. Fixed-Effects Estimations for Cross-Border Bank Flows-GDP Ratio: 2000Q1-2018Q3

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{\text{GDP}_{it}}$			Consumption C_{it}		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs NCO_t	0.550***	0.552***	0.550***			
	(0.174)	(0.161)	(0.170)			
Deposits to $\text{GDP}_{i,2000} \times \text{NCO}_t$	-0.047					
	(0.052)					
Deposits to $\text{GDP}_{i,1990-2018} \times \text{NCO}_t$		-0.045				
		(0.037)				
Deposits to $\text{GDP}_{i,1990-1999} \times \text{NCO}_t$			-0.053			
			(0.053)			
Real Exchange Rate RER_{it}				-0.010	0.002	-0.003
				(0.023)	(0.021)	(0.022)
Deposits to $\text{GDP}_{i,2000} \times \text{RER}_{it}$				0.015		
				(0.012)		
Deposits to $\text{GDP}_{i,1990-2018} \times \text{RER}_{it}$					0.005	
					(0.008)	
Deposits to $\text{GDP}_{i,1990-1999} \times \text{RER}_{it}$						0.009
						(0.011)
Constant	-0.048**	-0.046**	-0.048**	-0.013*	-0.012*	-0.013*
	(0.020)	(0.019)	(0.020)	(0.006)	(0.006)	(0.006)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,375	1,448	1,375	1,403	1,477	1,403
R-squared	0.271	0.285	0.271	0.482	0.488	0.482
Number of countries	19	20	19	19	20	19

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

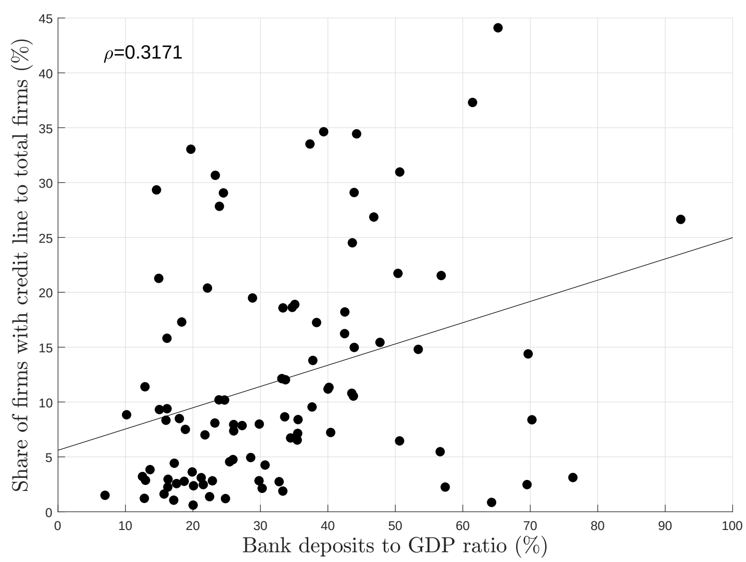
Notes: Authors' calculations using data from the Bank for International Settlements (BIS) and the St. Louis FRED database for the period 2000Q1-2018Q3. NCO_t, RER_{it}, C_{it} and $\frac{B_{it}}{\text{GDP}_{it}}$ are real, logged and detrended using the Hodrick-Prescott filter. Deposits to GDP_{2000} is the bank deposits to GDP in 2000, Deposits to $\text{GDP}_{1990-2018}$ is the average bank deposits to GDP for the period 1990-2018, whereas Deposits to $\text{GDP}_{1990-1999}$ is the average for the period 1990-1999. Foreign claims to GDP correspond to foreign claims of each country on U.S. banks to GDP ratio. The sample of AEs used is comprised of: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden and Switzerland

D Additional Figures

D.1 Empirical Evidence

Figure D.1 plots the counterpart of Figure 1 in the main text using the bank deposits-GDP ratio (instead of the bank credit-GDP ratio). Similar to the facts using the bank credit-GDP ratio in the main text, a larger share of firms with bank credit is strongly associated a higher bank deposits-GDP ratio.

Fig. D.1. Percent of Firms with a Bank Loan or Line of Credit and Ratio of Bank Deposits to GDP: Selected EMEs



Source: Authors' calculations using data from the Global Financial Development dataset and the WBES.

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