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Preliminary Findings

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DISCUSSION  
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# Domestic Financial Participation and External Vulnerability in Emerging Economies\*

Preliminary and Incomplete - PLEASE DO NOT CITE WITHOUT PERMISSION

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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 and mechanisms.

**JEL Classification:** E24, E32, E44, F41, G21

**Keywords:** Banking sector, domestic financial participation, endogenous firm entry, financial shocks, emerging economies

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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, the discussion of such policy frameworks has taken place amid sustained efforts to bolster greater firm participation in the domestic banking system—more succinctly, domestic financial participation—whose current levels are strikingly low relative to those in AEs. Indeed, 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. Moreover, while the ratio of average bank credit to private non-financial firms to GDP in AEs is 96 percent, the corresponding average ratio in EMEs is only 56 percent (details on these facts are presented and discussed in Section 2). Despite the growing body of work on financial shocks and the transmission of such shocks in the aftermath of the GFC, little is known about the extent to which the degree of domestic financial development and financial participation plays a role in the transmission of external financial shocks such as those experienced by EMEs.

In this paper, we build a quantitative framework with banking frictions, endogenous firm entry, and limited domestic financial participation by firms that allows us to shed light on this issue. Using the model, we show that the degree of domestic financial participation is negatively associated with the size of the transmission of foreign financial shocks via the banking system. Moreover, using data for a representative group of EMEs, we present empirical evidence supporting the fact that the degree of domestic financial participation is indeed negatively associated with the size of the transmission of foreign financial shocks (akin to those that characterized the GFC) to EMEs via the foreign claims of EME banks.

Our framework builds on the theoretical literature on banking frictions and policy in EMEs (Cuadra and Nuguer, 2018; Aoki, Benigno and Kiyotaki, 2015) by incorporating endogenous firm entry of financially-excluded and financially-included firms in a two-country (AE and EME) RBC model with banking frictions as in Gertler and Kiyotaki (2010). Endogenous firm entry gives rise to an endogenous share of firms that rely on bank credit to operate, thereby allowing us to have an explicit notion of the extensive margin of firm financial participation, as in the data. This allows us to explicitly analyze reforms that bolster greater financial participation via the extensive margin. We incorporate banking frictions to model credit to financially-included firms as in Gertler and Kiyotaki (2010). In this sense, financially-included firms get loans from domestic banks to finance their capital; financially-excluded firms finance themselves with retained earnings. Banks face a financial constraint on raising domestic deposits from households. AE banks have a larger net worth (relative to the size of their economy) than EME banks and consequently lend to EME banks using cross-border bank flows (non-core bank liabilities), as in Cuadra and Nuguer (2018). We calibrate the model so that the AE represents the U.S. and the EME replicates the average level of firm financial participation in a representative sample of EMEs. We

then consider a reduction in the sunk entry cost of financially-included firms in the AE that generates an increase in the share of EME firms that participate in the domestic banking system that is commensurate with the average in AEs.

Our main model findings show that greater firm domestic financial participation in EMEs reduces the adverse financial and aggregate effects in EMEs of a financial shock originating in the AE. This finding is broadly consistent with the 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. Moreover, we show that the inclusion of endogenous firm entry in our model is critical to match the evidence on changes in U.S. banks' net charge-offs and the response of EMEs. In fact, a standard model without endogenous entry generates a counterfactual link between domestic financial participation and the response of EMEs to foreign financial shocks transmitted via cross-border bank flows. The intuition behind our model findings is straightforward: 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 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. This stabilizing mechanism is absent in a model that abstracts from endogenous firm entry. More broadly, our findings stress the role of firm entry and exit for understanding the transmission of financial shocks from AEs to EMEs when the two 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 and financial policy, which has primarily focused in AEs in the aftermath of the GFC (Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gertler, Kiyotaki and Queralto, 2012), to more recent studies that have extended models of banking frictions to EME contexts (Cuadra and Nuguer, 2018; Aoki *et al.*, 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 in a small-open-economy environment with labor search frictions, endogenous firm entry, and firm heterogeneity in formal-credit usage. A

key difference between our work and theirs is the inclusion of banking frictions in our framework, which allow us to characterize the relevance of financial policies aimed at smoothing credit fluctuations. Our work is also related to 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 in our work relative to existing studies is our focus on the limited participation of firms in the domestic banking system, which is a defining characteristic of firms in EMEs, and the interaction between greater firm domestic financial participation and the use of cyclical financial policies in an environment with banking frictions.

The rest of the paper is structured as follows. Section 2 summarizes the key facts that motivate our work. Section 3 describes the model. Section 4 presents our quantitative analysis and discusses our main findings. Section 5 concludes.

## 2 Empirical Facts

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—firms’ domestic financial participation for short—of these economies. Given limitations on the country coverage of firms’ domestic financial participation, we first establish a relationship between the fraction of firms that have and use bank credit and average bank credit to the private non-financial sector as a share of GDP (a proxy of financial development) in a sample of EMEs. In turn, we focus on the GFC and follow Cuadra and Nuguer (2018); Lambertini and Uysal (2013) by using 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 economies. Changes in U.S. commercial banks’ net charge-offs are transmitted to EMEs through cross-border bank flows. We give more details regarding the rationale behind focusing on this particular variable below.

### 2.1 Data

**Domestic Financial Participation by Firms** We use World Bank Enterprise Survey (WBES) data to characterize firms’ access to external finance in developing and emerging economies. In particular, we focus 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 (henceforth referred to as firm financial participation). Our choice of bank credit as opposed to other sources of formal credit stems from the fact that bank credit represents the primary source of formal external financing in the countries we consider (IFC Enterprise Finance Gap Database 2010). Of note, the data on firm financial participation pertains only to registered (or formal) firms (existing evidence confirms that the bulk of unregistered (or informal) firms do not have formal external financing; see IFC Enterprise Finance Gap Database 2010). In

general, the WBES includes more than one observation per country. The earliest available year in the survey is 2006 and the most recent year is 2018, with the availability of observations for each year varying across countries. We use these series to construct an average measure of domestic financial participation by firms for EMEs.

**Bank Credit to the Non-Financial Private Sector** To overcome the limited availability of country coverage on domestic financial participation by firms, we link the data from the WBES above to data on the share of bank credit to private non-financial sector in GDP from the Bank for International Settlements (BIS). One important benefit of this approach is that the BIS data is available at a quarterly frequency, on average, for 45 years for a sample of 40 economies that includes AEs and EMEs.<sup>1</sup>

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. Importantly, the average bank credit-GDP ratio for AEs is 95.82 percent while the corresponding ratio for EMEs is 55.61 percent.

**U.S. Commercial Banks' Net Charge-Offs** We follow Cuadra and Nuguer (2018); Lambertini and Uysal (2013) and model the GFC as 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 that will not be paid. As in previous papers, in our model this shock is associated to a fall in the value of banks' assets that corresponds to a quality of capital shock in the AE. The data comes from the Federal Reserve Bank of St. Louis (FRED) and covers the 1985-2018 period at a quarterly basis.

**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 consider Consolidated Banking Statistics dataset from the BIS and extract the foreign claims of U.S. banks for specific economies.<sup>2</sup> The data covers 18 EMEs and 21 AEs, and it has unbalanced information from 2000Q1 to 2018Q3.

**Real Exchange Rate** The real exchange rate data comes from Stein, Fernández, Rosenow and Zuluaga (2018), who build a measure of real effective exchange rates that incorporate competition in third markets and adjustments for similarity in export baskets between exporters and their competitors. Given our focus on how changes in external financial conditions affect EMEs, we focus on real exchange rate data with respect to the United

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<sup>1</sup> The data on domestic bank credit does not differentiate between bank credit to firms and to households. Of note, existing evidence suggests that the bulk of bank credit in EMEs is allocated to firms (see, for example Beck, Büyükkarabacak, Rioja and Valev, 2012).

<sup>2</sup> The data is obtained from former Table 9B in the BIS Consolidated Banking Statistics, and involve all-maturities total claims on US banks and excluding domestic positions.



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).

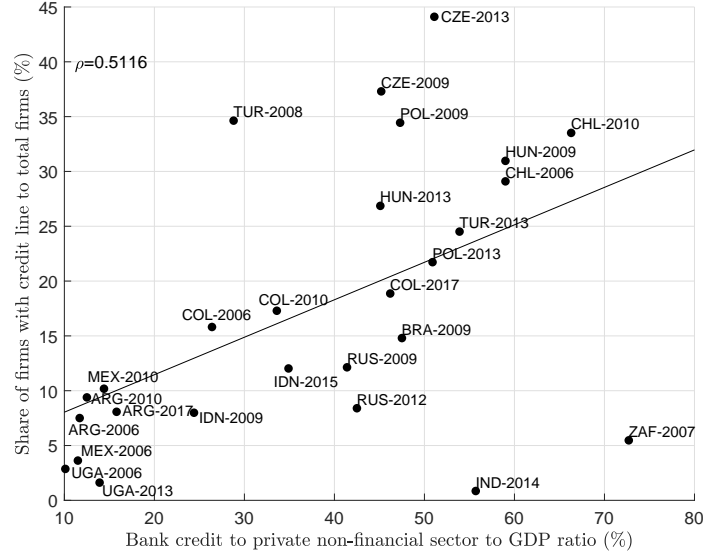
*Notes:* The data spans the period 1996Q1-2018Q2. We follow BIS classification criteria of AEs and EMEs. The average for EMEs excludes China and Hong Kong.

States for each country in our sample (using a standard measure of real exchange rates with respect to a basket of currencies does not change the results).

## 2.2 Stylized Facts

**Firm Financial Participation and Bank Credit-GDP Ratios** First, we want to illustrate a link between our measure of firm financial participation (given by the share of firms with a bank loan or a line of credit) and the ratio of bank credit to the private non-financial sector to GDP. Figure 1 shows this relationship for EMEs, which are the only countries that have data on firm financial participation data. The plot confirms a strong, positive relationship between the share of firms with bank credit and the average bank credit-GDP ratio in EMEs. Given this fact, we now use data on bank credit-GDP ratios to overcome the

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.

coverage limitations of firm financial participation data to characterize how the degree of domestic financial participation by firms is associated with the impact of external financial shocks on macro aggregates of interest in EMEs.

**External Financial Conditions, Firm Financial Participation, and Macroeconomic Dynamics in EMEs** We characterize the effect of U.S. net charge-offs,  $NCO_t$ , on the foreign claims of U.S. reporting banks (reflected in cross-border bank flows in our theoretical framework) to GDP ratio,  $\frac{B_{it}}{GDP_{it}}$ , and how the impact on EMEs may be different given differences in bank credit-GDP ratios,  $\frac{Cr_i}{GDP_i}$ , which we use as a rough proxy of domestic financial participation, for the period 2000Q1-2018Q2. We take three different measures of bank credit-to-GDP ratio, the first one corresponds to the ratio on 2000Q1, the second one corresponds to the average of the complete sample, and the third one corresponds to the average before 2000Q1. The  $NCO_t$  and the  $\frac{B_{it}}{GDP_{it}}$ , are logged and HP-filtered using a smoothing parameter of 1600. We take a standard sample of EMEs that corresponds to data availability.<sup>3</sup>

<sup>3</sup> We start our estimation in 2000Q1 to maximize the amount of data available while also trying to keep a consistent financial framework across time without major changes. Using linear detrending techniques shows that the variables are not stationary. Using quadratic detrending techniques delivers similar results to those using the HP-filter.

First, we estimate the following panel regression with country  $i$  fixed-effects,  $\varepsilon_i$ , and time  $t$  fixed-effects,  $\iota_t$ , where we include the interaction term of the bank credit-GDP ratio with U.S. net charge-offs (which we consider as the external financial shock for EMEs):

$$\frac{B_{it}}{\text{GDP}_{it}} = \beta_0 + \beta_1 \text{NCO}_t + \beta_2 \left( \frac{\bar{C}r_i}{\text{GDP}_i} \right) + \beta_3 \text{NCO}_t \times \left( \frac{\bar{C}r_i}{\text{GDP}_i} \right) + \varepsilon_i + \iota_t + u_{it}. \quad (1)$$

Table 2, columns (1)-(3) summarize our main findings for the three different measures of credit-to-GDP ratio. Column (1) presents the results for the first definition of  $\left( \frac{\bar{C}r_i}{\text{GDP}_i} \right)$ , that corresponds to the level in 2000Q1, column (2) presents similar results but taking the average of the complete sample, and the third column is the one using the average pre-2000Q1. The fact that the interaction term between U.S. net charge-offs and the bank credit-GDP ratio is negative implies that the marginal effect of U.S. net charge-offs on foreign claims is negative, and that this effect is more negative the higher is the credit-to-GDP ratio. In other words, EME countries with higher domestic 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% decrease in the baseline level of bank credit-to-GDP brings about a 12.7% increase in the effect of how foreign claims to GDP react to U.S. net charge-offs. [check the economic significance](#)

Second, we consider a similar estimation to (1), now with a focus on how real exchange rate movements,  $\text{RER}_{it}$ , may be associated with movements in private real consumption,  $C_{it}$ , and whether the bank credit-GDP ratio measures explained above influence the extent of the movements in private real consumption. Formally, the equation with country and time fixed-effects is given by:

$$C_{it} = \delta_0 + \delta_1 \text{RER}_t + \delta_2 \left( \frac{\bar{C}r_i}{\text{GDP}_i} \right) + \delta_3 \text{RER}_t \times \left( \frac{\bar{C}r_i}{\text{GDP}_i} \right) + \varepsilon_i + \iota_t + z_{it}. \quad (2)$$

The results for this specification are shown in columns (3)-(5) of Table 2. The first two parameters have the expected signs. A depreciation in the real exchange rate (an increase) is associated with a decline in consumption relative to trend no matter the credit to GDP ratio. Moreover, all else equal, an increase in bank credit to GDP ratio is associated with an increase in consumption relative to its trend. Importantly, the interaction term in this case is significant. In other words, the transmission channel that operates through the real exchange rate depends on the economy's degree of domestic financial participation. So consumption does react differently according to the initial level of credit to GDP ratio.

For comparison, we run different specifications as robustness checks that we include in the Appendix. First, we check these same regressions but with deposits to GDP ratio as a measure of financial participation instead of credit to GDP. We also have three different measures of a given level of deposits to GDP, the results are in Table C.1, and they do

not present different conclusions to the ones described in this Section. Second, we run the regressions (2) with the lag of the real exchange rate as dependent variable, and again the main messages remain, the results are in Table C.2. Third, we run the same regressions that in this Section but for AE, Table C.3. The results that we find in this Section for EMEs do not hold necessarily for AEs. In particular, the marginal effect of U.S. net charge-offs on foreign claims to GDP is positive; additionally, consumption does not seem to react significantly different from zero to movements in the real exchange rate. We also present the results for AEs using the deposit to GDP ratio as a control variable C.4.

In what follows, we present a model that can replicate the above facts.

Tab. 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 $NCO_t$	0.195 (0.148)	0.233 (0.156)	0.239 (0.155)			
Credit to $GDP_{2000:1} \times NCO_t$	-0.127** (0.059)					
Credit to $GDP_{1960:2-2018:3} \times NCO_t$		-0.215** (0.093)				
Credit to $GDP_{1960:2-1999:4} \times NCO_t$			-0.271* (0.128)			
Real Exchange Rate $RER_{it}$				-0.150 (0.089)	-0.222** (0.079)	-0.230** (0.087)
Credit to $GDP_{2000:1} \times RER_{it}$				0.169 (0.105)		
Credit to $GDP_{1960:2-2018:3} \times RER_{it}$					0.406** (0.165)	
Credit to $GDP_{1960:2-1999:4} \times RER_{it}$						0.500** (0.203)
Constant	-0.006 (0.014)	-0.006 (0.014)	-0.006 (0.014)	0.001 (0.014)	0.002 (0.014)	0.002 (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	0.179	0.269	0.287	0.285
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. Credit to  $GDP_{2000:1}$  is the bank credit to GDP in 2000:1, Credit to  $GDP_{1960:2-2018:3}$  is the average bank credit to GDP for the period 1960:2-2018:3, whereas Credit to  $GDP_{1960:2-1999:4}$  is the average for the period 1960:2-1999:4 (same for Deposits to GDP). 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.

### 3 The 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 limited domestic participation in the banking system by a subset of firms.

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  $1 - m$ . The AE has a higher share of firm participation and higher bank credit to GDP ratio, while the EME has a lower share of firm participation and lower bank credit to GDP ratio. 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 but have a less capital-intensive (and less productive) production technology, and financially-included ( $i$ ) firms, who use bank credit to purchase capital and have a more capital-intensive (and more productive) production technology. Amid endogenous firm entry, the measures of  $e$  and  $i$  firms in each economy are endogenous. Additionally, AE banks lend to EME banks through cross-border bank flows. In what follows, we present the model from the perspective of the AE (or  $H$ ), with analogous conditions for the EME (or  $F$ ) unless otherwise noted.

#### 3.1 Final Goods

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

$$Y_t = \left[ \alpha_a^{\frac{1}{\phi_a}} Y_{H,t}^{\frac{\phi_a-1}{\phi_a}} + (1 - \alpha_a)^{\frac{1}{\phi_a}} Y_{F,t}^{\frac{\phi_a-1}{\phi_a}} \right]^{\frac{\phi_a}{\phi_a-1}}, \quad (3)$$

where the price index in the AE is

$$P_t = \left[ \alpha_a P_{H,t}^{1-\phi_a} + (1 - \alpha_a) P_{F,t}^{1-\phi_a} \right]^{\frac{1}{1-\phi_a}}, \quad (4)$$

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 the EME:

$$Y_{H,t} = \alpha_a (\rho_{H,t})^{-\phi_a} Y_t, \quad (5)$$

and

$$Y_{F,t} = (1 - \alpha_a) (\rho_{F,t})^{-\phi_a} Y_t, \quad (6)$$

respectively. The real prices  $\rho_{H,t} = P_{H,t}/P_t$  and  $\rho_{F,t} = P_{F,t}/P_t$  are defined with respect to the price of the final AE good. 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  $\text{NER}_t$  is the nominal exchange rate.

## 3.2 Domestic Production Structure

There are two broad categories of domestic firms, financially-excluded ( $e$ ) and financially-included ( $i$ ). To make our environment as comparable to standard models with banking frictions as possible, each firm category is comprised of two types of firms. First, a measure 1 of perfectly-competitive intermediate-goods firms. Second, monopolistically-competitive wholesale firms whose entry is 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. Critically, while intermediate-goods  $e$  firms accumulate capital internally and do not participate in the banking system, intermediate-goods  $i$  firms borrow funds from banks to purchase capital from capital producers. 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 presentation 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

Perfectly-competitive intermediate-goods firms in each firm category  $j \in \{i, e\}$  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 producers.

Formally,  $e$  firms choose  $L_{e,t}$  and  $k_{e,t+1}$  to maximize their profits:

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

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

$$w_{e,t} = (1 - \alpha_e) mc_{e,t} z_{e,t} (k_{e,t})^{\alpha_e} (L_{e,t})^{-\alpha_e}, \quad (7)$$

and

$$Q_{e,t} = \mathbb{E}_t \Xi_{t+1|t} [r_{e,t+1} + Q_{e,t+1} (1 - \delta)], \quad (8)$$

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

Turning to  $i$  firms, these firms choose  $L_{i,t}$ ,  $k_{i,t+1}$ , and bank credit  $s_{i,t}$  to also maximize profits defined by

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

where  $\alpha_i > \alpha_e$  and  $R_{k_{i,t}}$  denotes the cost of bank credit. Credit from the financial intermediaries to  $i$  firms is  $s_{i,t}$ . The optimal demand for labor is given by

$$w_{i,t} = (1 - \alpha_i) mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i} (L_{i,t})^{-\alpha_i}. \quad (9)$$

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

$$R_{k_{i,t+1}} = \Psi_{t+1} \frac{[r_{i,t+1} + Q_{i,t+1} (1 - \delta)]}{Q_{i,t}}, \quad (10)$$

where  $r_{i,t} = \alpha_i mc_{i,t} z_{i,t} (k_{i,t})^{\alpha_i - 1} (L_{i,t})^{1 - \alpha_i}$ ,  $s_{i,t} = k_{i,t+1} / \Psi_{t+1}$ , and  $\Psi_{t+1}$  is a capital quality shock as in Gertler and Kiyotaki (2010).

### 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  $\Omega_j$  denote the potential mass of firms in firm category  $j$ . We 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  $\omega_j$ , so that  $\omega_j$  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  $\omega_j$  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  $\omega_j$  purchases inputs from their intermediate-goods counterparts at price  $mc_{j,t}$ , with the real price of their output being  $\rho_{j,t}(\omega_j) = p_{j,t}(\omega_j) / P_{j,t}$ . Then, individual profits for firm  $\omega_j$  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  $\omega_j$  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 financially-included ( $i$ ) wholesale firms,  $Y_{i,t}$ . For-



mally, a representative perfectly-competitive domestic output aggregator solved the following problem:

$$\begin{aligned} & \max_{Y_{e,t}, Y_{i,t}} P_{P,t} Y_{P,t} - P_{i,t} Y_{i,t} - P_{e,t} Y_{e,t} \\ \text{s.t. } & Y_{P,t} = \left[ (1 - \alpha_y)^{\frac{1}{\phi_y}} Y_{i,t}^{\frac{\phi_y - 1}{\phi_y}} + (\alpha_y)^{\frac{1}{\phi_y}} Y_{e,t}^{\frac{\phi_y - 1}{\phi_y}} \right]^{\frac{\phi_y}{\phi_y - 1}}, \end{aligned}$$

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

### 3.3 Capital Producers

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

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

and

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

where following the literature on banking frictions,  $k_{i,s} = \Psi_t s_{i,s}$  and  $\Psi_t$  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  $j \in \{e, i\}$ :

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

### 3.4 Banks

The structure of financial intermediaries follows Cuadra and Nuguer (2018). Households are the ultimate owners of financial intermediaries. Banks obtain funds to lend to firms from domestic households,  $b_{d,t}$ , and use retained earnings from previous periods,  $nw_t$ . We further assume that banks in the EME also obtain funds from the AE banks,  $b^*$ . Following the literature on banking frictions, banks in both economies are constrained in 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 particular, we assume that with i.i.d. probability  $\sigma$  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 relative 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, banks decide how much to lend to intermediate-goods firms  $i$ . Since there are no frictions when transferring resources to  $i$  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 separate the description of the banks in each economy.

### 3.4.1 AE ( $H$ ) Banks

The balance sheet of an individual bank in  $H$  is such that the value of the loans to  $i$  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 EME banks pay to AE banks. Then, the net worth of an individual bank in AE 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, households limit the funds supplied to 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:

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

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 benefits 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

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

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

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

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 to the EME, and  $\vartheta_{d,t}$  is the marginal cost of domestic deposits. Solving for the problem of the bank, and assuming that  $\lambda_t$  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  $\mu_t$  as the excess value of a unit of assets relative to domestic deposits

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

The last first-order condition can be rewritten as

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

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

The last two equations establish how tightly the constraint is binding. Leverage,  $\phi_t$ , shows that when banks are more borrowing-constrained (a higher  $\theta$ ), 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 deposits (a higher  $\mu$ ), leverage also falls as a result of the greater accumulation of assets.

Let  $\Lambda_{t+1}$  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  $\mu_t$  and  $\vartheta_{d,t}$  satisfy

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

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

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

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  $H$  domestic assets equals the discounted rate of return on cross-border bank flows

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

AE banks are indifferent between providing funds to intermediate goods domestic firms and to EME banks because the expected return on both assets is equalized.

### 3.4.2 EME ( $F$ ) Banks

The problem of  $F$  banks is similar to the one of  $H$  banks, except for one feature: cross-border bank flows,  $b_t^*$ , are a liability; therefore, the balance sheet of an EME bank 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 at period  $t - 1$ , net of borrowing costs which in this case include the cross-border loans:

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

The interpretation of the variables is equivalent to the  $H$  case. The borrowing constraint must hold for each bank individually to ensure that a bank does not divert funds:

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

This equation established that  $F$  banks cannot divert funds from AE banks. We also guess that the value function is a linear combination of the asset and liability configuration; 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

$$\frac{v_{s,t}^*}{Q_{i,t}^*} = \frac{v_{b,t}^*}{Q_{b,t}^*}. \quad (25)$$

In terms of returns, the last equation reads:

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

In this framework, the cross-border bank flows' return transmits a shock in the  $H$  economy to the  $F$  one through the impact on the return on the domestic asset. Additionally, the expected discounted rate of return on the cross-border bank asset equalizes to the one on loans to non-financial AE firms. In turn,  $H$  and  $F$  loan markets behave in a similar way.

### 3.4.3 Aggregate Banking Conditions

Aggregating across  $H$  banks, from equation (18), we have

$$Q_{i,t} S_{i,t} + Q_{b,t} B_t = \phi_t N W_t, \quad (27)$$

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

$$N W_t = (\sigma + \xi) (R_{k_i,t} Q_{i,t-1} S_{i,t-1} + R_{b,t} Q_{b,t-1} B_{t-1}) - \sigma R_{t-1} B_{d,t-1}. \quad (28)$$

For  $F$  banks the two equations look similar:

$$Q_{i,t}^* S_{i,t}^* - Q_{b,t}^* B_t^* = \phi_t^* N W_t^* \quad (29)$$

$$N W_t^* = (\sigma^* + \xi^*) R_{k_i,t}^* Q_{i,t-1}^* S_{i,t-1}^* - \sigma^* R_{b,t}^* Q_{b,t-1}^* B_{t-1}^* - \sigma^* R_{t-1}^* B_{d,t-1}^*. \quad (30)$$

In equilibrium,  $H$  banks lend to  $F$  bank because the  $H$  economy has excess resources in comparison to what the  $H$  needs; this translates into the agency problem of each banking system that results in a stronger borrowing constraint in the  $F$  economy. This economy is relatively small and we assume that 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. Specifically, we assume that Equation (23) becomes:

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

The last term is the risk premium associated with lending to the  $F$  economy. The parameter  $\Phi$  reflects the elasticity of deviating from the steady state of the cross-border bank flows. Note that at the steady state this term is zero.

Regarding 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 bears all the risk from the exchange rate. And this is going to be an important channel of transmission of shocks. When the  $F$  currency depreciates, the  $F$  collateral expressed in foreign currency falls, then  $H$  banks lend less to  $F$  banks, because the risk of running away with  $H$  money is higher. In equilibrium,  $H$  banks are indifferent between lending to  $F$  banks or  $H$  firms; moreover,  $F$  banks do not have excess return from borrowing from  $H$  banks, so the return on loans to  $F$  firms equalizes to the interest rate on  $H$  banks, then, there is perfect asset market integration.

### 3.5 Households and Firm Creation

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

$$c_t + \psi_e N_{E,t}^e + \psi_i N_{E,t}^i + B_{d,t} = w_{e,t} L_{e,t} + w_{i,t} L_{i,t} + R_{t-1} B_{d,t-1} + d_{e,t} N_{e,t} + d_{i,t} N_{i,t} + \Pi_{e,t} + \Pi_{i,t} + \Pi_{k,t} + \Pi_{b,t}, \quad (32)$$

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

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

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  $j \in \{e, i\}$ .  $\Pi_{e,t}$ ,  $\Pi_{i,t}$ , and  $\Pi_{k,t}$  denote profits from intermediate goods  $e$  firms, intermediate goods  $i$  firms and profits from capital producers, respectively, while  $\Pi_{b,t}$  denotes bank profits. Following the macro literature on endogenous firm entry,  $0 < \delta < 1$  is the exogenous exit probability of firms.

Optimal labor supply to each firm category is given by

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

for  $j \in \{e, i\}$ . In turn, the Euler equation over 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 condition for each category are given by

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

for  $j \in \{e, i\}$ . We assume that  $\psi_i > \psi_e$  but as we discuss below,  $i$  firms have access to bank credit and a more productive production technology. The expressions for labor supply and the Euler equation for deposits are standard. The job 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 present discounted value of individual-firm profits and the continuation value if the firm survives into the next period with probability  $(1 - \delta)$ .

### 3.6 Market Clearing

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

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

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

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

and

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

The resource constraint in  $H$  is given by

$$Y_t = c_t + i_{i,t} + i_{e,t} + \psi_i N_{E,t}^i + \psi_e N_{E,t}^e. \quad (40)$$

Finally, the current account can be written as

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

where  $\text{RER}_t = \text{NER}_t P_t^*/P_t$  denotes the real exchange rate and  $\text{ToT}_t$  the terms of term. And the 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 and the role of financial policies amid external shocks to EMEs, 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** For both  $H$  and  $F$ , we set  $\sigma_c = 2$ ,  $\alpha_e = 0.2$ ,  $\alpha_i = 0.32$ ,  $\beta = 0.985$ ,  $\chi = 1$ , and  $\delta = 0.025$  (all standard values in the business cycle literature). As noted in Section 3, we assume that financially-excluded firms in both economies have less capital-intensive production technologies, which gives rise to endogenously-higher labor productivity in  $i$  firms (alternative values for  $\alpha_e$  to not change our main conclusions). Following the literature, we analyze the response of both economies to a shock to the quality of capital in  $H$ ,  $\Psi$ , and keep exogenous productivity in each category of intermediate-goods firms constant at  $z_i = z_e = 1$ . The elasticity of substitution of firm output for each firm category in each economy  $\epsilon = 6$ . As a baseline, we assume a relatively high degree of substitutability between domestic  $e$ -firm-category total output and  $i$ -firm-category total output,  $\phi_y = 5$ .

In terms of the trade structure between the two economies, we set the country size for  $H$ ,  $0 < m < 1$ , to 0.90. In turn, the degree of home bias in  $H$ ,  $\alpha_a$ , is influenced by the economy's degree of openness  $\lambda$ , so that  $\alpha_a = 1 - (1 - m)\lambda$ . Analogously, the degree of home bias in  $F$ ,  $\alpha_a^*$ , 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 real business cycle literature.

Turning to the banking-sector parameters, we 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 set  $\phi_k = 1$  and the foreign debt adjustment cost  $\eta_b = 0.01$ .

**Calibrated Parameters** We calibrate the remaining parameters  $\kappa$ ,  $\kappa^*$ ,  $\psi_i$ ,  $\psi_e$ ,  $\psi_i^*$ ,  $\psi_e^*$ ,  $\alpha_y$ ,  $\alpha_y^*$ ,  $\theta$ , and  $\theta^*$  to match the following targets based on U.S. data and data using averages for the EME sample used in Section 2: a share of total hours worked in both economies ( $H$  or AE and  $F$  or EME) of 0.33; a cost of creating  $i$  firms in  $H$  (or AE) 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  $F$  (or EME) 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 (as a fraction of



the economy's total number of firms) in  $H$  (or AE) of 0.80; a share of  $i$  firms (as a fraction of the economy's total number of firms) in  $F$  (or EME) of 0.20; a share of output from  $i$  firms in total output of 0.80 in  $H$  (or AE); a share of output from  $i$  firms in total output of 0.70 in  $F$  (or EME); 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  $\theta^* = 0.8952$ .

## 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,  $\psi_i^*$  from its baseline level, which delivers a steady-state share of  $i$  firms in our representative EME of 0.20, to a level that generates a steady-state share of  $i$  firms of 0.70, which is consistent with the level of firm domestic financial participation in our representative AE. Importantly, we lower  $\psi_i^*$  holding all other parameters at their original values.

### 4.2.1 Steady State

Table 3 shows how the steady state of key variables of interest in the representative baseline EME (recall that EME variables in the model are denoted by a  $*$ ) changes when we reduce the sunk entry cost of  $i$  firms  $\psi_i^*$  in that economy.

The reduction in  $\psi_i^*$  increases firm participation in the domestic banking system, and leads to greater total output, consumption, equilibrium bank credit, greater labor in  $i$  firms and lower labor in  $e$  firms, higher wages and bank net worth, and greater labor productivity across firm categories in the representative EME.

Intuitively, a lower  $\psi_i^*$  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. The sharp reduction in labor in  $e$  firms increases these firms' labor productivity despite a 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 these firms 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 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

Tab. 3. Steady State Equilibria: EME baseline, with 50, and 70 percent of firm financial participation (FFP)

Variable	Baseline	50 Percent FFP	70 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
$\psi_i^*/Y^*$	0.150	0.0218	0.007

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).

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

Figure 2 shows the response of the model under the baseline calibration (that is, the AE with a steady-state share of firm financial participation of 70 percent and the baseline EME with a steady-state share of firm financial participation of 20 percent) and a model with a lower  $\psi_i^*$  such that the EME has a steady-state share of firm financial participation of 70 percent, holding all other parameters at their baseline values.

The figure shows that greater 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, 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 domestic financial participation expands EME banks' steady-state borrowing from AE banks, which makes the response of EME foreign borrowing more sensitive to the same shock to the quality of capital in the AE. However, since EME banks' steady-state net worth is greater under greater steady-state firm financial participation (recall Table 3), EME banks' net worth becomes more resilient to shocks. Importantly, this last fact makes bank credit to EME  $i$  firms less sensitive to AE capital-quality shocks, resulting in smoother EME asset price dynamics, a smaller medium- and long-term contraction in EME investment, in the number of EME  $i$ -firms, and ultimately in EME consumption. All told, even though greater domestic firm financial participation makes EME foreign borrowing more sensitive to an external shock, the positive impact of having a larger share of firms using bank credit on EME banks' net worth makes the EME more resilient to financial shocks originating from the AE.

### 4.3 The Role of Endogenous Firm Entry

To highlight the relevance of modeling the extensive margin of firm participation in the domestic banking system in EMEs, we consider a simplified version of our benchmark model without endogenous firm entry. In this simpler framework, firm financial participation is embodied in the contribution of  $i$  firms to total output (as opposed to the share of  $i$ -category firms, which is normalized to 1 absent endogenous firm entry). To change the degree of firm financial participation in the EME absent endogenous firm entry, we change parameter  $\alpha_y$  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 70 percent in our benchmark model.

Figure 3 shows the response of 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 domestic financial participation leads to negligible changes in the sensitivity of EME banks' net worth and EME asset prices to a shock to capital quality 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 a smoother response in EME macro aggregates, but occur in a context where the qualitative changes in steady-state firm-financial-participation equilibria in the two models is 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 bond holdings). 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 in all asset prices. This mechanism is naturally absent in a model that abstracts from endogenous firm entry.

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

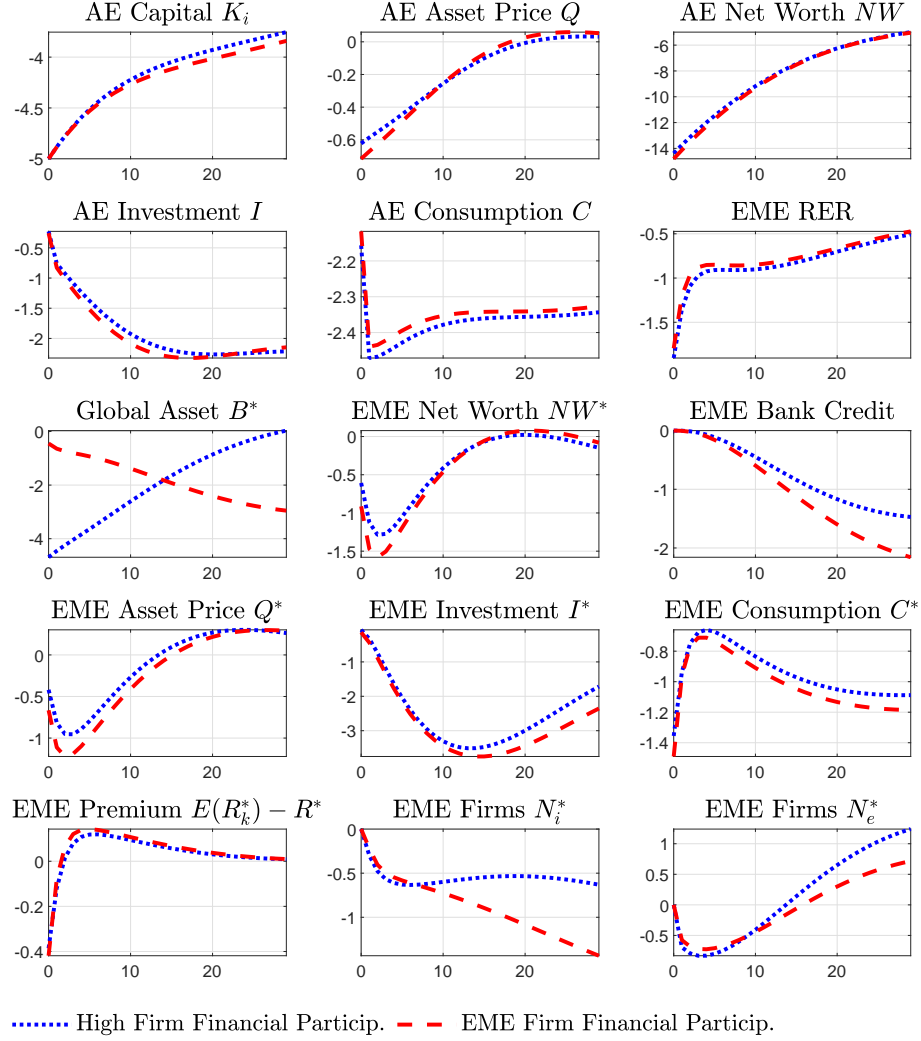
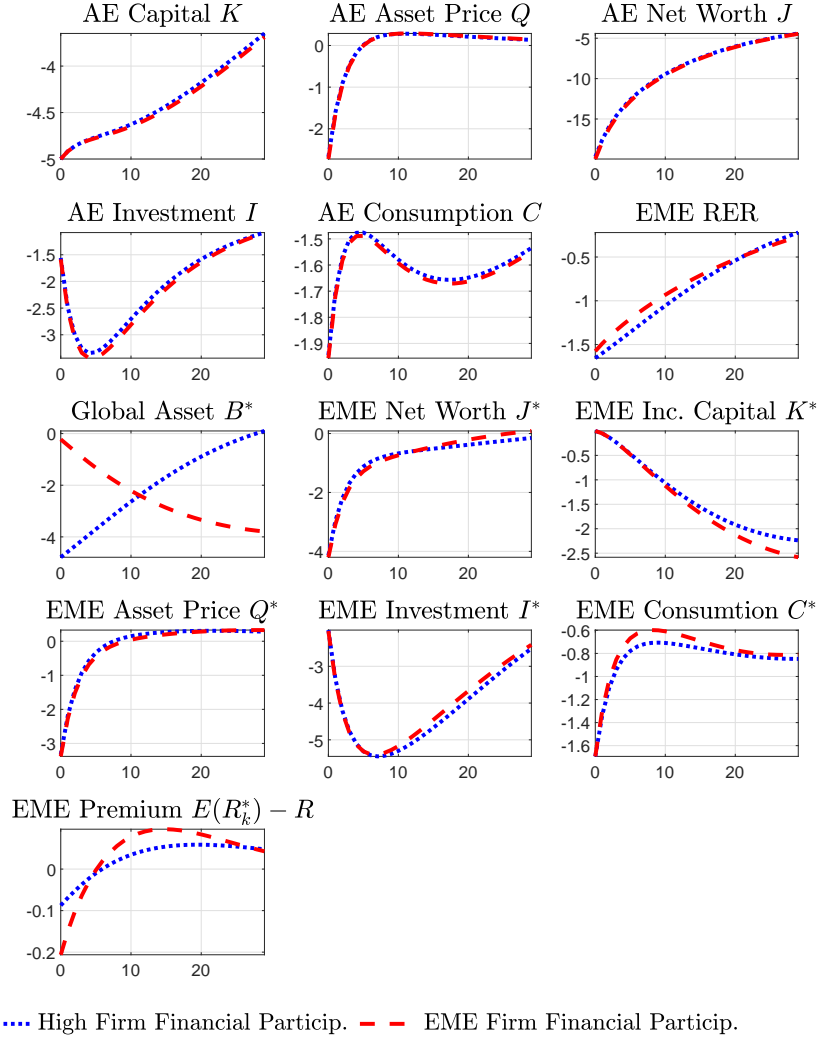


Fig. 3. Impulse Response to an Adverse Shock to the Quality of Capital in the AE: No Endogenous Entry



## 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, 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? How should cyclical financial policies adapt to increasingly greater levels of firm domestic financial participation? 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 adapt to the average degree of domestic financial participation.

## A Additional Model Derivations and Details

In what follows, we present 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

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

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:

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

and

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

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 as the ratio of the price of imports to the price of exports,  $ToT_t = P_{F,t}/P_{H,t}$ , we can write

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

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 terms of trade:

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

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

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

where the price index

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

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

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

and

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

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 terms of trade 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

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

and

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

we can write



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

and

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

## A.2 Real Exchange Rate

Define the real exchange rate 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

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

## A.3 Domestic Production

### A.3.1 Domestic Output Aggregators

Domestic output in the home economy is given by

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

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 real profits

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

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 terms of trade 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 the foreign economy 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

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

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

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

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

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

and

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

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

## A.4 Market Clearing

### A.4.1 Total Domestic Output

From the Home ( $H$ ) economy's perspective, total demand for output produced in Home 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, the Foreign ( $F$ ) economy 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

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

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

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

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

$\left\{ Y_{i,t}, \rho_{i,t}, mc_{i,t}, Y_{e,t}, \rho_{e,t}, mc_{e,t}, \frac{P_{i,t}^*}{P_t^*}, \frac{P_{e,t}^*}{P_t^*}, Y_{P,t}, \frac{P_{P,t}}{P_t}, Y_{H,t}^*, ToT_t, Y_{H,t}, Y_t, \frac{P_{H,t}}{P_t}, N_{i,t}, N_{e,t} \right\}$   
 $\left\{ d_{i,t}, d_{e,t}, N_{E,t}^i, N_{E,t}^e, y_{i,t}, y_{e,t}, c_t, RER_t, L_{i,t}, L_{e,t}, i_{i,t}, i_{e,t}, w_{i,t}, w_{e,t}, r_{i,t}, r_{e,t}, R_t, k_{e,t}, k_{i,t} \right\}$   
 $\left\{ Y_{i,t}^*, \rho_{i,t}^*, mc_{i,t}^*, Y_{e,t}^*, \rho_{e,t}^*, mc_{e,t}^*, \frac{P_{i,t}^*}{P_t^*}, \frac{P_{e,t}^*}{P_t^*}, Y_{P,t}^*, \frac{P_{P,t}}{P_t^*}, Y_{F,t}, Y_{F,t}^*, Y_t^*, \frac{P_{F,t}}{P_t^*}, N_{i,t}^*, N_{e,t}^*, d_{i,t}^*, d_{e,t}^* \right\}$   
 $\left\{ N_{E,t}^{i*}, N_{E,t}^{e*}, y_{i,t}^*, y_{e,t}^*, c_t^*, L_{i,t}^*, L_{e,t}^*, i_{i,t}^*, i_{e,t}^*, w_{i,t}^*, w_{e,t}^*, r_{i,t}^*, r_{e,t}^*, R_t^*, k_{e,t}^*, k_{i,t}^*, B_t^*, s_{i,t}, s_{i,t}^*, \phi_t \right\}$   
 $\left\{ \vartheta_t, \mu_t, \Lambda_t, NW_t, B_{d,t}, R_{k_{i,t}}, \phi_t^*, \vartheta_t^*, \mu_t^*, \Lambda_t^*, NW_t^*, B_{d,t}^*, R_{k_{i,t}}^*, \mu_{b,t}^*, \phi_{b,t}^*, R_{b,t}^*, Q_{b,t}^*, B_t \right\}$  satisfy the following equations:

$$Y_{i,t} = y_{i,t}N_{i,t}^{\frac{\varepsilon}{\varepsilon-1}}, \quad (\text{B.1})$$

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

$$\rho_{i,t} = \frac{\varepsilon}{\varepsilon-1}mc_{i,t}, \quad (\text{B.3})$$

$$Y_{e,t} = y_{e,t}N_{e,t}^{\frac{\varepsilon}{\varepsilon-1}}, \quad (\text{B.4})$$

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

$$\rho_{e,t} = \frac{\varepsilon}{\varepsilon-1}mc_{e,t}, \quad (\text{B.6})$$

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

$$Y_{P,t}^* = \left[ (1 - \alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{i,t}^{\frac{\phi_y^*-1}{\phi_y^*}} + (\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{e,t}^{\frac{\phi_y^*-1}{\phi_y^*}} \right]^{\frac{\phi_y^*}{\phi_y^*-1}}, \quad (\text{B.8})$$

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

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

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

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

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

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

$$\frac{P_{H,t}}{P_t} = \frac{P_{P,t}}{P_t}, \quad (\text{B.15})$$

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

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

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

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

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

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

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

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

$$Y_t = c_t + i_{i,t} + i_{e,t} + \psi_i N_{E,t}^i + \psi_e N_{E,t}^e, \quad (\text{B.24})$$

$$RER_t Q_{b,t} B_t - RER_t R_{b,t} Q_{b,t-1} B_{t-1} = \left( \frac{1-m}{m} \right) Y_{H,t}^* \frac{P_{H,t}}{P_t} - Y_{F,t} T o T_t \frac{P_{H,t}}{P_t}, \quad (\text{B.25})$$

$$-u_{L_{i,t}} = w_{i,t} u_{c_{i,t}}, \quad (\text{B.26})$$

$$-u_{L_{e,t}} = w_{e,t} u_{c_{e,t}}, \quad (\text{B.27})$$

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

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

$$w_{i,t} = (1 - \alpha_i) m c_{i,t} z_{i,t} (k_{i,t})^{\alpha_i} (L_{i,t})^{-\alpha_i}, \quad (\text{B.30})$$

$$w_{e,t} = (1 - \alpha_e) m c_{e,t} z_{e,t} (k_{e,t})^{\alpha_e} (L_{e,t})^{-\alpha_e}, \quad (\text{B.31})$$

$$r_{i,t} = (\alpha_i) m c_{i,t} z_{i,t} (k_{i,t})^{\alpha_i-1} (L_{i,t})^{1-\alpha_i}, \quad (\text{B.32})$$

$$r_{e,t} = (\alpha_e) m c_{e,t} z_{e,t} (k_{e,t})^{\alpha_e-1} (L_{e,t})^{1-\alpha_e}, \quad (\text{B.33})$$

$$1 = \mathbb{E}_t\Xi_{t+1|t} R_t, \quad (\text{B.34})$$

$$Q_{e,t} = \mathbb{E}_t\Xi_{t+1|t} \left[ \alpha_e m c_{e,t+1} z_{e,t+1} k_{e,t+1}^{\alpha_e-1} L_{e,t+1}^{1-\alpha_e} + Q_{e,t+1} (1 - \delta) \right], \quad (\text{B.35})$$

$$Y_{i,t}^* = y_{i,t}^* N_{i,t}^{*\frac{\varepsilon}{\varepsilon-1}}, \quad (\text{B.36})$$



$$\frac{P_{i,t}^*}{P_t^*} = \rho_{i,t}^* N_{i,t}^{*\frac{1}{1-\varepsilon}}, \quad (\text{B.37})$$

$$\rho_{i,t}^* = \frac{\varepsilon}{\varepsilon - 1} m c_{i,t}^*, \quad (\text{B.38})$$

$$Y_{e,t}^* = y_{e,t}^* N_{e,t}^{*\frac{\varepsilon}{\varepsilon-1}}, \quad (\text{B.39})$$

$$\frac{P_{e,t}^*}{P_t^*} = \rho_{e,t}^* N_{e,t}^{*\frac{1}{1-\varepsilon}}, \quad (\text{B.40})$$

$$\rho_{e,t}^* = \frac{\varepsilon}{\varepsilon - 1} m c_{e,t}^*, \quad (\text{B.41})$$

$$Y_{i,t}^* = (1 - \alpha_y^*) \left( \frac{P_{i,t}^*}{P_t^*} \left[ (\alpha_a^*) + (1 - \alpha_a^*) (T_o T_t)^{\phi_a^* - 1} \right]^{\frac{1}{1-\phi_a^*}} \right)^{-\phi_y^*} Y_{P,t}^*, \quad (\text{B.42})$$

$$Y_{e,t}^* = \alpha_y^* \left( \frac{P_{e,t}^*}{P_t^*} \left[ (\alpha_a^*) + (1 - \alpha_a^*) (T_o T_t)^{\phi_a^* - 1} \right]^{\frac{1}{1-\phi_a^*}} \right)^{-\phi_y} Y_{P,t}^*, \quad (\text{B.43})$$

$$Y_{P,t}^* = \left[ (1 - \alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{i,t}^{*\frac{\phi_y^* - 1}{\phi_y^*}} + (\alpha_y^*)^{\frac{1}{\phi_y^*}} Y_{e,t}^{*\frac{\phi_y^* - 1}{\phi_y^*}} \right]^{\frac{\phi_y^*}{\phi_y^* - 1}}, \quad (\text{B.44})$$

$$\frac{P_{P,t}^*}{P_t^*} = \left[ (\alpha_a^*) + (1 - \alpha_a^*) (T_o T_t)^{\phi_a^* - 1} \right]^{\frac{-1}{1-\phi_a^*}}, \quad (\text{B.45})$$

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

$$Y_{F,t}^* = \alpha_a^* \left( \left[ (\alpha_a^*) + (1 - \alpha_a^*) (T_o T_t)^{\phi_a^* - 1} \right]^{\frac{\phi_a^*}{1-\phi_a^*}} \right) Y_t^*, \quad (\text{B.47})$$

$$Y_t^* = \left[ (\alpha_a^*)^{\frac{1}{\phi_a^*}} (Y_{F,t}^*)^{\frac{\phi_a^* - 1}{\phi_a^*}} + (1 - \alpha_a^*)^{\frac{1}{\phi_a^*}} (Y_{H,t}^*)^{\frac{\phi_a^* - 1}{\phi_a^*}} \right]^{\frac{\phi_a^*}{\phi_a^* - 1}}, \quad (\text{B.48})$$

$$\frac{P_{F,t}^*}{P_t^*} = \frac{P_{P,t}^*}{P_t^*}, \quad (\text{B.49})$$

$$N_{i,t+1}^* = (1 - \delta^*) (N_{i,t}^* + N_{E,t}^{i*}), \quad (\text{B.50})$$

$$N_{e,t+1}^* = (1 - \delta^*)(N_{e,t}^* + N_{E,t}^{e*}), \quad (\text{B.51})$$

$$d_{i,t}^* = (\rho_{i,t}^* - mc_{i,t}^*)y_{i,t}^*, \quad (\text{B.52})$$

$$d_{e,t}^* = (\rho_{e,t}^* - mc_{e,t}^*)y_{e,t}^*, \quad (\text{B.53})$$

$$\psi_i^* = (1 - \delta^*)\mathbb{E}_t \Xi_{t+1}^* [d_{i,t+1}^* + \psi_i^*], \quad (\text{B.54})$$

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

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

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

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

$$-u_{L_i^*,t} = w_{i,t}^* u_{c_i^*,t}, \quad (\text{B.59})$$

$$u_{L_e^*,t} = w_{e,t}^* u_{c_e^*,t}, \quad (\text{B.60})$$

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

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

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

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

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

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

$$1 = \mathbb{E}_t \Xi_{t+1}^* R_t^*, \quad (\text{B.67})$$

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

$$R_{k_i,t+1} = \Psi_{t+1} \frac{[r_{i,t+1} + Q_{i,t+1} (1 - \delta)]}{Q_{i,t}}, \quad (\text{B.69})$$

$$R_{k_i,t+1}^* = \Psi_{t+1}^* \frac{[r_{i,t+1}^* + Q_{i,t+1}^* (1 - \delta^*)]}{Q_{i,t}^*}, \quad (\text{B.70})$$

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

$$s_{i,t} = k_{i,t+1} / \Psi_{t+1}, \quad (\text{B.72})$$

$$s_{i,t}^* = k_{i,t+1}^* / \Psi_{t+1}^*, \quad (\text{B.73})$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\vartheta_t^* = \mathbb{E}_t \Xi_{t+1}^* \Lambda_{t+1}^* R_{t+1}^*, \quad (\text{B.87})$$

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

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

$$R_{b,t+1}^* = \Psi_{t+1}^* \frac{[r_{i,t+1}^* + Q_{b,t+1}^* (1 - \delta^*)]}{Q_{b,t}^*}, \quad (\text{B.90})$$

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

$$\mu_{b,t}^* = \mu_t^*. \quad (\text{B.92})$$

## C Additional Tables

### C.1 Deposit-to-GDP ratio as control variable

C.1 presents results based on a similar empirical analysis to the one in the main text but using the deposits-to-GDP ratio as a control variable. We also calculate the given deposit-to-GDP ratio in three different ways, similar to the one in the main text. Our main findings remain unchanged.

Bank deposits to GDP data is taken from the Global Financial Development dataset, released by the World Bank. We have 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. In this case, our sample covers 19 EMEs and 22 AEs from 1960 until 2016.

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 $\frac{B_{it}}{GDP_{it}}$			Consumption $C_{it}$		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs $NCO_t$	0.255 (0.152)	0.259 (0.158)	0.253 (0.157)			
Deposits to $GDP_{2000:1} \times NCO_t$	-0.259** (0.117)					
Deposits to $GDP_{1960:2-2018:3} \times NCO_t$		-0.359* (0.169)				
Deposits to $GDP_{1960:2-1999:4} \times NCO_t$			-0.445* (0.210)			
Real Exchange Rate $RER_{it}$				-0.230* (0.113)	-0.235** (0.094)	-0.204* (0.096)
Deposits to $GDP_{2000:1} \times RER_{it}$				0.387 (0.222)		
Deposits to $GDP_{1960:2-2018:3} \times RER_{it}$					0.588* (0.274)	
Deposits to $GDP_{1960:2-1999:4} \times RER_{it}$						0.595* (0.307)
Constant	-0.006 (0.014)	-0.006 (0.014)	-0.006 (0.014)	0.002 (0.014)	0.001 (0.014)	0.001 (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	0.188	0.186	0.185	0.275	0.280	0.273
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  $GDP_{2000:1}$  is the bank deposits to GDP in 2000:1, Deposits to  $GDP_{1960:2-2018:3}$  is the average bank deposits to GDP for the period 1960:2-2018:3, whereas Deposits to  $GDP_{1960:2-1999:4}$  is the average for the period 1960:2-1999:4. 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, Czech Republic, Hungary, India, Israel, Korea, Malaysia, Mexico, South Africa, Thailand, and Turkey.

## C.2 Lag in the real exchange rate

We run the same regressions that in the main text but with the lag of the real exchange rate as dependent variable; this allows us to control better for a potential problem of endogeneity and at the same time determination of the real exchange rate and consumption. The results are in Table C.2 and they do not present a different message to the one in the main text. On the contrary, the message is reinforced by this lag on the variable, and the results are stronger statistically and economically.

Tab. C.2. Fixed-Effects Estimations with Private Real Consumption as Dependent Variable

Dependent variable:	Consumption $C_{it}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Real Exchange Rate $RER_{t-1}$	-0.156** (0.065)	-0.219*** (0.048)	-0.232*** (0.051)	-0.236** (0.081)	-0.224*** (0.064)	-0.187** (0.070)
Credit to GDP <sub>2000:1</sub> $\times$ $RER_{it-1}$	0.424*** (0.119)					
Credit to GDP <sub>1960:2-2018:3</sub> $\times$ $RER_{it-1}$		0.217** (0.094)				
Credit to GDP <sub>1960:2-1999:4</sub> $\times$ $RER_{it-1}$			0.543*** (0.146)			
Deposits to GDP <sub>2000:1</sub> $\times$ $RER_{it-1}$				0.583** (0.230)		
Deposits to GDP <sub>1960:2-2018:3</sub> $\times$ $RER_{it-1}$					0.437** (0.186)	
Deposits to GDP <sub>1960:2-1999:4</sub> $\times$ $RER_{it-1}$						0.554* (0.282)
Constant	0.006 (0.007)	0.001 (0.014)	0.002 (0.014)	0.006 (0.007)	0.002 (0.013)	0.003 (0.013)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	862	871	871	862	871	871
R-squared	0.270	0.283	0.283	0.269	0.287	0.285
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.  $NCO_t$  and  $\frac{B_{it}}{GDP_{it}}$  are logged and detrended using the Hodrick-Prescott filter. Credit to GDP<sub>2000:1</sub> is the bank credit to GDP in 2000:1, Credit to GDP<sub>1960:2-2018:3</sub> is the average bank credit to GDP for the period 1960:2-2018:3, whereas Credit to GDP<sub>1960:2-1999:4</sub> is the average for the period 1960:2-1999:4. 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, Czech Republic, Hungary, India, Israel, Korea, Malaysia, Mexico, South Africa, Thailand, and Turkey.

### C.3 Advanced economies empirical results

Table C.3 presents results from the same experiment in the main text for AEs (recall that our main empirical analysis in the main text focused on EMEs). In particular, we estimate regressions 1 and 2 controlling for different levels of given credit to GDP ratio. In Table C.4 shows the same exercises but using the deposits to GDP ratio as control variable.

The results using the AE sample differ from those based on EMEs. In particular, in contrast to our findings in EMEs, for AEs the sign of the effect of U.S. net charge-offs on the ratio of foreign claims to GDP is positive and significant, and the bank credit-GDP ratio for the magnitude of the effect negative and statistically significant, but the marginal effect ends up being positive. This result is consistent with greater domestic financial

participation in AEs bringing about greater vulnerability to external disturbances. In terms of considering deposits to GDP as the financial participation measure, the results in Table C.4 show that this variable is not significant for any specification. Only the shock by itself produces a movement in foreign claims to GDP.

Turning to considering private consumption as a dependent variable, the results for AEs are also different compared to those in EMEs. Specifically, in AEs, the effects of the real exchange rate on consumption are not significant, for any of the specifications.

Tab. C.3. Results from 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 $\frac{B_{it}}{GDP_{it}}$			Consumption $C_{it}$		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs $NCO_t$	0.645*** (0.189)	0.695*** (0.194)	0.587*** (0.180)			
Credit to $GDP_{2000:1} \times NCO_t$	-0.183** (0.082)					
Credit to $GDP_{1960:2-2018:3} \times NCO_t$		-0.276** (0.120)				
Credit to $GDP_{1960:2-1999:4} \times NCO_t$			-0.157 (0.112)			
Real Exchange Rate $RER_t$				-0.033 (0.029)	-0.056 (0.043)	-0.051 (0.032)
Credit to $GDP_{2000:1} \times RER_t$				0.043 (0.033)		
Credit to $GDP_{1960:2-2018:3} \times RER_t$					0.076 (0.050)	
Credit to $GDP_{1960:2-1999:4} \times RER_t$						0.090** (0.041)
Constant	-0.041** (0.019)	-0.042** (0.019)	-0.041** (0.019)	-0.013** (0.006)	-0.012** (0.006)	-0.013** (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	0.297	0.295	0.499	0.498	0.500
Number of countries	20	21	20	20	21	20

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

Notes: Complete

Tab. C.4. Results from fixed-effects estimations for cross-border bank flows to GDP: 2000:1-2018:3

Dependent variable:	Foreign claims to GDP $\frac{B_{it}}{GDP_{it}}$			Consumption $C_{it}$		
	(1)	(2)	(3)	(4)	(5)	(6)
US net charge-offs $NCO_t$	0.550*** (0.174)	0.565*** (0.163)	0.571*** (0.168)			
Deposits to GDP <sub>2000:1</sub> $\times NCO_t$	-0.047 (0.052)					
Deposits to GDP <sub>1960:2–2018:3</sub> $\times NCO_t$		-0.077 (0.074)				
Deposits to GDP <sub>1960:2–1999:4</sub> $\times NCO_t$			-0.103 (0.131)			
Real Exchange Rate $RER_t$				-0.010 (0.023)	-0.010 (0.024)	-0.023 (0.025)
Deposits to GDP <sub>2000:1</sub> $\times RER_t$				0.015 (0.012)		
Deposits to GDP <sub>1960:2–2018:3</sub> $\times RER_t$					0.022 (0.019)	
Deposits to GDP <sub>1960:2–1999:4</sub> $\times RER_t$						0.048* (0.027)
Constant	-0.041** (0.019)	-0.042** (0.019)	-0.041** (0.019)	-0.013** (0.006)	-0.012** (0.006)	-0.013** (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	1,403	1,477	1,477
R-squared	0.298	0.297	0.295	0.482	0.488	0.488
Number of countries	20	21	20	19	20	20

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

Notes: [Complete](#)

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