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FINANCIAL GLOBALIZATION:
RISK SHARING OR RISK EXPOSURE?

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Working Paper 34689
http://www.nber.org/papers/w34689

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2026

This paper was prepared for the EC-CEPR-JIE conference "Global Shocks, Macroeconomic Spillovers and Geopolitical Risks: Policy Challenges" held April 7th-8th, 2025 at the European Commission in Brussels. We thank our discussant, Cedric Tille, and conference participants for their comments and suggestions. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 34689
January 2026
JEL No. F40, F41, G01

ABSTRACT

We study how the increased cross-country ownership of financial assets between advanced and emerging economies impacted their financial and macroeconomic volatility. While cross-country ownership improved risk-sharing and reduced volatility associated with financial crises, it also increased the exposure of countries to foreign crises, leading to higher international co-movement. Through quantitative applications of a two-region model representative of advanced and emerging economies, we find that financial globalization reduced volatility worldwide, but significantly more in emerging economies.

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1. INTRODUCTION

The increased ownership of foreign financial assets is a defining feature of the financial globalization era. As shown in Figure 1, the gross holdings of foreign assets and liabilities in advanced and emerging economies grew substantially from 1991 to 2020. In advanced economies (AEs), foreign holdings as a percentage of GDP more than quadrupled and in emerging economies (EMEs) almost doubled. Although the increase in emerging economies appears small compared to advanced economies, it is important to consider that during this period the GDP of EMEs grew faster than in AEs. Thus, in absolute value, the growth of foreign assets and liabilities in emerging economies has been very large.

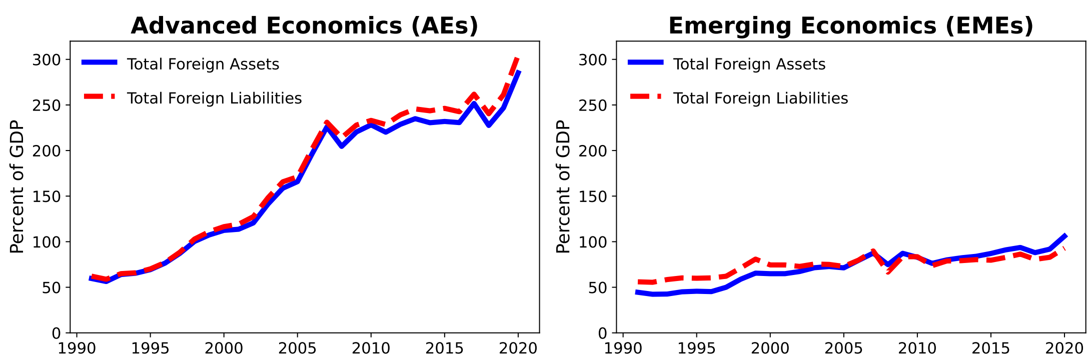

FIGURE 1.—Dynamics of gross assets and liabilities in Advanced and Emerging Economies, 1991-2020.

Note: **Emerging economies**: Algeria, Argentina, Brazil, Bulgaria, Chile, China, Colombia, Czech Republic, Estonia, Hong.Kong, Hungary, India, Indonesia, Israel, South Korea, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey, Ukraine, Venezuela. **Advanced economies**: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. **Sources**: *External Wealth of Nations* database (Lane and Milesi-Ferretti (2018)).

The data plotted in Figure 1 do not show whether the increases in AEs foreign assets and liabilities came from larger holdings within AEs or in EMEs. For emerging economies, however, it is more likely that the increases reflected greater ownership of financial assets issued by AEs and liabilities purchased by AEs, rather than cross-holdings within EMEs. Thus, there has been significant financial integration through portfolio diversification between advanced and emerging economies over the past three decades.

The international diversification of portfolios may result in greater macro and financial stability for an individual country, provided that foreign assets are characterized by similar degrees of volatility as domestic assets. To the extent that macroeconomic fluctuations depend on financial asset fluctuations, greater cross-regional diversification should lead to lower macroeconomic volatility. If foreign assets display higher volatility than domestic assets, however, international diversification may lead to the opposite outcome for the integrating country—that is, it may result in greater, not lower, volatility. This is especially relevant for the integration between advanced and emerging economies due to the higher financial instability of EMEs.

Figure 2 plots in colored bars estimates from Laeven and Valencia (2018) showing the percentage of countries in advanced economies (left panel) and emerging economies (right panel) that experienced three types of crises: (i) banking, (ii) currency, and (iii) sovereign debt crises. The continuous line plots the percentage of countries that experienced at least one of the three crises. With the exception of the Great Recession in 2008, advanced economies did not experience many financial crises during this period. By contrast, the right-hand panel shows that financial crises have been much more recurrent in emerging economies. As indicated in the graph legends, the average percentage of advanced economies that were in a crisis over the period 1991–2017 is 3.88% but for emerging economies is 6.69%.

These estimates, which can be interpreted as average probabilities of crises in the two regions, are based on a simple count of countries. A refined measure that weights countries according to their sizes (GDP) gives similar percentages. This suggests that the foreign portfolio of advanced economies invested in emerging economies is roughly twice as vulnerable to financial crises as domestic investments. As a result, the international diversification of AEs may not necessarily bring greater portfolio stability to advanced economies: even if the risk of financial crises is uncorrelated between the two regions, EMEs' assets are on average riskier. The opposite, however, could be true for emerging economies, as financial integration allows them to hold safer AEs' assets. The goal of this paper is to investigate whether the financial integration of advanced and emerging economies has led to lower or higher macroeconomic volatility in each of the two regions.

We address this question with a quantitative model that features two regions, one representative of advanced economies and one representative of emerging economies. In each

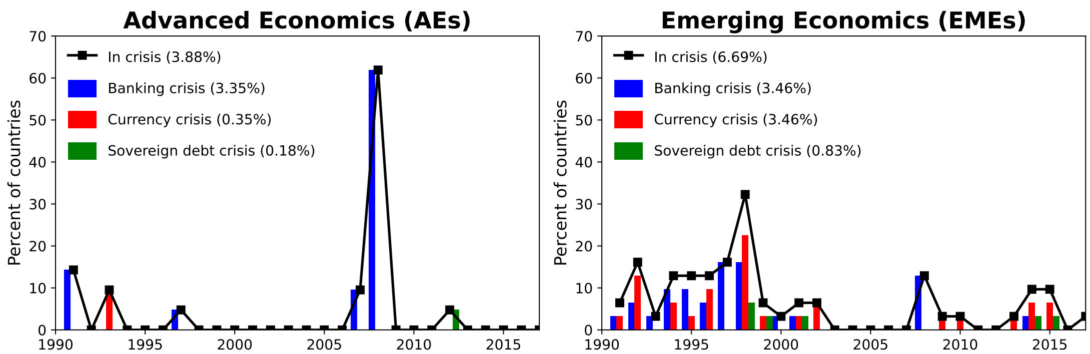

FIGURE 2.—Percentage of countries that experienced a crisis in each year, 1991-2017. The graph shows three types of financial crises: (i) banking, (ii) currency, and (iii) sovereign debt. The continuous line indicates the percentage of countries that experienced at least one of the three crises.

Note: **Emerging economies**: Algeria, Argentina, Brazil, Bulgaria, Chile, China, Colombia, Czech Republic, Estonia, Hong.Kong, Hungary, India, Indonesia, Israel, South Korea, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey, Ukraine, Venezuela. **Advanced economies**: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. **Sources**: *Systemic Banking Crises Revisited* database (Laeven and Valencia (2018)).

region, there is a borrowing sector and a lending sector. Financial assets are issued by private firms in the borrowing sector and provide a convenience yield to other firms as they are used for production. Because financial assets are risky, but the risk of domestic assets is not perfectly correlated with the risk of foreign assets, lending firms hold an internationally diversified portfolio and in equilibrium borrowing firms sell their liabilities to both domestic and foreign lending firms. In this way, the model generates well-defined cross-region holdings of *gross* assets and liabilities. It is the gross holdings of foreign assets that is important for the results of the paper, not the net holdings (imbalances).

A financial crisis occurs when the debt issued by borrowers grows larger than the liquidation value of their real assets. This generates not only haircuts in credit recovery but also wealth redistribution from creditors to borrowers. This wealth redistribution is central to the mechanism by which a financial crisis has severe real macroeconomic consequences. Moreover, due to the cross-country ownership of financial assets, a crisis induces a macroeconomic contraction in both regions, independently of whether it originates in

AEs or EMEs. Thus, the model generates cross-country spillovers that strengthen with the international diversification of portfolios.

Consistent with Figure 2, the calibrated model features a higher probability of crises in EMEs than in AEs. This implies that assets issued by EMEs are riskier than those issued by AEs. For advanced economies, this implies that a diversified portfolio containing both AEs' and EMEs' assets is not necessarily safer than a non-diversified portfolio composed solely of domestic assets. As stressed above, adding foreign financial assets that are imperfectly correlated with domestic ones reduces portfolio volatility. However, increasing the share of riskier EME assets could raise the overall volatility of the portfolio. Whether the first effect (a higher number of imperfectly correlated assets) dominates the second effect (a larger share of riskier assets) is a quantitative question. The calibrated model shows that the first effect has been stronger than the second effect and, as a result, financial integration has reduced macroeconomic volatility in both regions. However, the predicted reduction in volatility has been much larger for EMEs than for AEs, especially in the more recent period.

The most relevant literature related to our paper pertains to financial crises and sudden stops. It includes studies such as Calvo and Mendoza (1996), Caballero and Krishnamurthy (2001), Edwards (2004), Mendoza and Quadrini (2010), Mendoza and Smith (2014), and Fornaro (2018). See also the survey provided in Bianchi and Mendoza (2020). As in some of the models proposed in this literature such as Aghion et al. (2001) and Perri and Quadrini (2018), our model features self-fulfilling crises that originate in the financial sector. However, the mechanism through which financial crises are transmitted to the real sector of the economy is different in our model and relies on the international diversification of portfolios. In particular, we emphasize that international diversification, enabled by financial liberalization, does not necessarily lead to lower macroeconomic stability.

An important branch of the literature in international macro-finance explores the causes and consequences of global imbalances—that is, the phenomenon whereby, following financial liberalization, some countries (and particularly the United States) ran large external deficits and became net borrowers from the rest of the world. Contributions to this literature include Caballero et al. (2008), Cova et al. (2009), Mendoza et al. (2009), Angeletos and Panousi (2011), Song et al. (2011), Sandri (2014), Bacchetta and Benhima (2015), Coeurdacier et al. (2015), and Fogli and Perri (2015). Our paper differs from this literature in two important ways. First, while most of these papers focus on long-term or low frequency effects, our analysis centers on macroeconomic stability or higher frequency fluctuations. Second—and most importantly—our focus is not on global imbalances, that is, the rise in *net* foreign asset positions observed in emerging economies, but rather on the growth of *gross* foreign assets and liabilities. As we will show, gross positions are the ones critical for determining the international spillover effects of a crisis. Net positions, i.e. the imbalances, are not important for our study and the mechanisms outlined in the paper would also operate if the net positions remain balanced.

Our work is also related to the large literature on international portfolio diversification. Attig et al. (2023) provide a detailed survey of the literature. They also conduct an empirical analysis using a large monthly dataset showing that international diversification outperformed industrial diversification over the 1991-2021 period, and that the gains from international diversification derive mainly from reducing market, political, and inflation risks (i.e., diversification benefits are related to the gained stability). Closer to the focus of this paper, Schwebach et al. (2002) examined the data from the 1990s Asian financial crisis and found that correlations among 11 country indices and their volatilities rose sharply after the collapse of the Thai baht in July 1997. This result suggests that the benefits of international diversification decline in periods of high macro-financial volatility.

The model employed in this paper is similar to that developed in Mendoza and Quadrini (2023). However, the research question addressed here is fundamentally different. While our previous study investigated how the accelerated growth of emerging economies and changes in the financial structures of both advanced and emerging markets influenced macroeconomic volatility, this paper focuses on the role of financial integration, specifically accounting for regional heterogeneity in financial stability. The emphasis is placed on the risk-sharing mechanisms enabled by financial integration, which are not studied in our other work. To this end, we made changes to the model to consider differential costs in the purchase of foreign relative to domestic assets, and calibrated these costs to match observed gross foreign asset positions.

The remainder of this paper is organized as follows: Section 2 describes the two-region model. Section 3 conducts the quantitative analysis. Section 4 concludes.

2. MODEL

The world economy is composed of two regions indexed by $j \in \{1, 2\}$. Region 1 represents advanced economies and Region 2 emerging economies. There are two sectors in each region: (i) household sector; (ii) business sector with two types of firms.

By having two types of firms, we generate borrowing and lending within and across regions. This allows us to distinguish the private 'demand' for financial assets (from firms with positive financial positions) from the private 'supply' (from firms with negative financial positions). Financial assets provide a convenience yield as they are needed for production but they are risky because borrowers can default on their obligations.

The two regions are heterogeneous in four elements: (i) economic *size*, captured by differences in aggregate productivity, $z_{j,t}$; (ii) a parameter $\phi_{j,t}$ that affects directly the *demand* for financial assets, (iii) a parameter $\kappa_{j,t}$ that affects directly the *supply* of financial assets; and (iv) the probability of financial crises captured by the parameter λ_j. The first three elements—$z_{j,t}$, $\phi_{j,t}$, and $\kappa_{j,t}$—are time-varying, deterministic, and fully anticipated. The heterogeneity in crisis probability λ_j, instead, is time-invariant.

The only source of uncertainty in the model comes from financial crises driven by "sunspot" shocks. Importantly, the sunspot shocks drawn in each region (and hence the occurrence of crises) are statistically independent. This implies that the returns from domestic and foreign assets are not perfectly correlated, and hence risk-averse agents could gain from portfolio diversification. The heterogeneity in λ_j also implies, however, that holding foreign assets may increase the risk exposure for one of the two countries (the country with the lower value of λ_j).

2.1. *Household sector*

In each region, there is a unit mass of households that choose consumption ($c_{j,t}$) and labor supply ($h_{j,t}$) so as to maximize this lifetime utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(c_{j,t} - z_{j,t-1}^{\frac{1}{\gamma}} \frac{h_{j,t}^{1+\frac{1}{\nu}}}{1+\dfrac{1}{\nu}} \right),$$

subject to the budget constraint

$$c_{j,t} = w_{j,t}h_{j,t} + \text{div}_{j,t}.$$

For analytic tractability we assume that the utility function is linear in consumption and separable in labor dis-utility. This additive-separability removes the income effect on the supply of labor by making the marginal rate of substitution between labor and consumption independent of the latter. However, the dependence of labor dis-utility on lagged productivity $z_{j,t-1}$ generates a similar income effect. This insures that the labor supply is constant in the long-run even if the wage rate continues to grow. In particular, we will show that wages, output and capital all grow at the long-run rate $g^{1/\gamma}$, where g is the long-run growth rate of productivity z_t, and γ is the factor share parameter in the production function of final goods (specified below).

In the households' budget constraint, the sources of funds are wage income, $w_{j,t}h_{j,t}$, and dividends, $\text{div}_{j,t}$, distributed by the firms owned by households. The supply of labor is given by the first-order condition

$$z_{j,t-1}^{\frac{1}{\gamma}} h_{j,t}^{\frac{1}{\nu}} = w_{j,t}. \tag{1}$$

2.2. *Business sector*

Each region produces final goods with intermediate inputs produced by two types of firms. The first type of firms are owned by households and produce intermediate goods $X_{j,t}$. The second type of firms are owned by entrepreneurs and produce intermediate goods $N_{j,t}$. The two intermediate goods are aggregated into final output Y_t with the Cobb-Douglas technology

$$Y_t = X_{j,t}^{1-\gamma} N_{j,t}^{\gamma}.$$

We can think of the aggregation of inputs into final goods either as directly done by final users or by perfectly competitive firms. Final goods produced by the two regions are tradable. Since they are homogeneous, the relative price is always 1.

Differently from final goods, intermediate goods are not traded internationally. Their prices, expressed in units of final goods, are equal to the marginal products, that is,

$$p_{j,t}^X = (1-\gamma)X_{j,t}^{-\gamma} N_{j,t}^{\gamma}, \qquad p_{j,t}^N = \gamma X_{j,t}^{1-\gamma} N_{j,t}^{\gamma-1}.$$

An important difference between the two intermediate goods is that production of $X_{j,t}$ is capital intensive and production of $N_{j,t}$ is labor intensive. Because capital is pledgeable as collateral, capital-intensive producers are able to borrow. On the other hand, labor-intensive producers lack collateral assets. This implies that in the general equilibrium, intensive-capital firms are borrowers (they hold net financial liabilities) while labor-intensive firms are lenders (they hold net financial assets). In this way we generate borrowing and lending within the business sector.[1]

2.2.1. *Capital-intensive firms*

Capital-intensive firms operate the linear technology $x_{j,t} = z_{j,t}k_{j,t}$, where $z_{j,t}$ is the country-specific aggregate productivity, and $k_{j,t}$ is the input of capital. Thus, capital is the only production input used by these firms. The intermediate goods are sold at the market price $p^X_{j,t}$ in units of final goods.

In the long-run, productivity $z_{j,t}$ grows at rate g in both countries. In the short-run, however, the growth of productivity could deviate from g.

Capital accumulates without adjustment costs and, in normal conditions, its relative price is 1. For tractability, we assume that investment and capital are time-varying but exogenous. In the quantitative analysis, we will feed to the model the actual investment series from the data.

Borrowing and default. At the end of date $t-1$, a capital-intensive firm borrows by selling debt $d_{j,t}$ at a price of $1/R_{j,t-1}$, where $R_{j,t-1}$ is the gross interest rate. The borrowed resources are $d_{j,t}/R_{j,t-1}$ and the repayment promised at the beginning of period t is $d_{j,t}$. However, the firm may default when the repayment is due, in which case creditors can liquidate the firm's capital, $k_{j,t}$. If the liquidation value is insufficient to repay $d_{j,t}$, the debt is renegotiated and the parties agree to a reduced repayment that matches the liquidation

[1]Differences in financial structure could reflect the tangibility of capital rather than the intensity of general capital. Firms that are intensive in intangible capital do not have enough collateral assets to borrow and, as a result, accumulate financial assets or cash (see Falato et al. (2022)). However, the feature that producers of $X_{j,t}$ are net borrowers and producers of $N_{j,t}$ are net lenders should be interpreted more generally. What is central to our model is that there is production complementarity between the two groups of firms. When firms in one group cut production due to financial conditions, the other firms also cut their production due to lower product demand. Effectively, a financial crisis induces a negative demand shock.

value, so that capital is never actually liquidated. The threat of liquidation only guarantees that creditors receive some repayment. Still, even if liquidation does not arise at equilibrium, default and renegotiation have real consequences that we describe below. We refer to a default event as a 'financial crisis.'

Denote by $\ell_{j,t}$ the liquidation price of capital at the beginning of period t. The debt is renegotiated if $d_{j,t} > \ell_t k_{j,t}$. Assuming that the borrower has all the bargaining power, renegotiation yields the following repayment,

$$\tilde{d}(d_{j,t}, \ell_{j,t}k_{j,t}) = \min\Big\{ d_{j,t}\ ,\ \ell_{j,t}k_{j,t} \Big\}. \tag{2}$$

After renegotiation, the market for capital returns to normal without market exclusion.

Financial crises are caused by 'sunspot' shocks $\varepsilon_{j,t}$ that reduce $\ell_{j,t}$ below the normal price of capital ($\ell_{j,t} = 1$) at the beginning of the period. With probability $1 - \lambda_j$, the shock takes the value $\varepsilon_{j,t} = 1$ and the liquidation price is $\ell_{j,t} = 1$. With probability λ_j, the shock is $\varepsilon_{j,t} = 0$ and the liquidation price is $\ell_{j,t} = \kappa_{j,t} < 1$, where $\kappa_{j,t}$ varies exogenously, and deterministically, over time. These probabilities define the stochastic distribution of the sunspot shocks, which are the only stochastic disturbances in the model.[2] As we will show below, a higher $\kappa_{j,t}$ increases the firms' borrowing capacity because the debt repayment falls less in default.

In this model, financial crises have both exogenous (non-fundamental) and endogenous (fundamental) causes. In particular, $\ell_{j,t} = \kappa_{j,t}$ is necessary but not sufficient for a crisis to occur. It is also necessary that firms arrive at date t with sufficiently high leverage to trigger renegotiation (i.e., $d_{j,t} > \kappa_{j,t}k_{j,t}$). This second requirement can be restated as saying that the "effective leverage" ratio $d_{j,t}/\kappa_{j,t}k_{j,t}$ (the ratio of debt over the minimum liquidation value of capital) must be above 100%.

Capital-intensive firms also incur a convex cost for issuing new debt at the end of date t,

$$\varphi\left(d_{j,t+1}, \kappa_{j,t+1}k_{j,t+1}\right) = \eta\left[\frac{\max\{\,0\ ,\ d_{j,t+1} - \kappa_{j,t+1}k_{j,t+1}\,\}}{d_{j,t+1}}\right]^2 d_{j,t+1}. \tag{3}$$

[2] In this paper, we treat these fluctuations in $\ell_{j,t}$ as purely exogenous. See Mendoza and Quadrini (2024) for a detailed analysis of a setup in which self-fulfilling expectations driven by realizations of a sunspot shock about the liquidation price of capital lead to drops in $\ell_{j,t}$ as an endogenous equilibrium outcome.

Debt issued at t is costless for borrowing amounts that are below the minimum liquidation value of capital at $t+1$, $\kappa_{j,t+1}k_{j,t+1}$ (low effective leverage). Higher amounts carry an increasing cost. For a given stock of capital, the curvature parameter η affects the rate at which the cost rises with the borrowed amount. This matters for the response of leverage to changes in the interest rate. The response is larger when η is smaller. As $\eta \to \infty$, the cost imposes a strict borrowing limit independent of the interest rate, $d_{j,t+1} \leq \kappa_{j,t+1}k_{j,t+1}$, which is equivalent to a standard collateral constraint. A (lower) finite value of η provides more flexibility for the model to generate endogenous responses of leverage to interest rate movements.

It is important to note that both $\kappa_{j,t}$ and $\kappa_{j,t+1}$ matter for the equilibrium at time t. The value of $\kappa_{j,t}$ determines the renegotiated repayment of the outstanding debt if there is default at the beginning of date t. The value of $\kappa_{j,t+1}$ is a determinant of the marginal cost for newly issued debt. The two values of κ are known since the entire sequence is deterministic and perfectly anticipated.

The budget constraint of capital-intensive firms after renegotiation is

$$\mathrm{div}_{j,t} = p^X_{j,t}x_{j,t} - i_{j,t} - \tilde{d}(d_{j,t}, \ell_{j,t}k_{j,t}) + \frac{d_{j,t+1}}{R_{j,t}} - \varphi(d_{j,t+1}, \kappa_{j,t+1}k_{j,t+1}), \qquad (4)$$

where $i_{j,t} = k_{j,t+1} - (1-\tau)k_{j,t}$ is investment and τ is the depreciation rate.

To characterize the equilibrium, we need to distinguish the firm-specific gross interest rate $R_{j,t}$ from the "market" interest rate $\overline{R}_{j,t}$. The interest rate $R_{j,t}$ depends on individual borrowing decisions: As the firm borrows more and its leverage rises, the repayment expected for next period falls and the interest rate on the newly issued debt increases. In contrast, $\overline{R}_{j,t}$ is the expected gross return on a diversified portfolio of debt issued by capital-intensive firms in country j at time t.

Because firms are atomistic and financial markets are competitive, these interest rates must satisfy a no-arbitrage condition equating the expected return on an individual firm's debt to the expected return on the diversified portfolio:

$$\frac{d_{j,t+1}}{R_{j,t}} = \frac{1}{\overline{R}_{j,t}}\mathbb{E}_t\tilde{d}(d_{j,t+1}, \ell_{j,t+1}k_{j,t+1}). \qquad (5)$$

The left-hand-side is the amount of resources borrowed in period t, and the right-hand-side is the expected repayment in period $t+1$, discounted by the market return

$\overline{R}_{j,t}$. Since the firm renegotiates the debt when $d_{j,t+1} > \ell_{j,t+1} k_{j,t+1}$, it is possible that $\tilde{d}(d_{j,t+1}, \ell_{j,t+1} k_{j,t+1}) < d_{j,t+1}$.

The optimization problem can be formulated with the following Bellman equation:

$$\begin{aligned} & V(d_{j,t}, k_{j,t}) = \max_{d_{j,t+1}} \left\{ \text{div}_{j,t} + \beta \mathbb{E} V(d_{j,t+1}, k_{j,t+1}) \right\}, \\ & \text{s.t.} \\ & \tilde{d}(d_{j,t}, \ell_{j,t} k_{j,t}) + \text{div}_{j,t} + \varphi(d_{j,t+1}, \kappa_{j,t+1} k_{j,t}) \; = \\ & \qquad p^X_{j,t} z_{j,t} k_{j,t} + (1-\tau) k_{j,t} - k_{j,t+1} + \frac{1}{\overline{R}} \mathbb{E} \tilde{d}(d_{j,t+1}, \ell_{j,t+1} k_{j,t+1}), \end{aligned}$$

where $k_{j,t}$ and $k_{j,t+1}$ are exogenous.

The following Euler equation characterizes the optimal choice of $d_{j,t+1}$,

$$\frac{1}{\overline{R}_{j,t}} = \beta + \Phi\left(\frac{d_{j,t+1}}{\kappa_{j,t+1} k_{j,t+1}}\right). \tag{6}$$

where the function $\Phi(.)$ captures the marginal cost of issuing new debt and is given by:

$$\Phi\left(\frac{d_{j,t+1}}{\kappa_{j,t+1} k_{j,t+1}}\right) = \begin{cases} \left(\frac{1}{1-\lambda_j}\right) \eta \left[1 - \left(\frac{\kappa_{j,t+1} k_{j,t+1}}{d_{j,t+1}}\right)^2\right], & \text{if } \frac{d_{j,t+1}}{\kappa_{j,t+1} k_{j,t+1}} \geq 1 \\ \\ 0, & \text{if } \frac{d_{j,t+1}}{\kappa_{j,t+1} k_{j,t+1}} < 1. \end{cases}$$

Hence, $\Phi(\cdot)$ is increasing in effective leverage, $d_{j,t+1}/\kappa_{j,t+1} k_{j,t+1}$.[3]

Aggregating across capital-intensive firms within a region, condition (6) determines the aggregate supply of financial assets. Because $\Phi(.)$ is increasing in its argument, the supply of assets is decreasing in $\overline{R}_{j,t}$. An increase in $\kappa_{j,t}$ or in $K_{j,t}$ shifts the supply to the right.

2.2.2. *Labor-intensive firms (entrepreneurs)*

In addition to households, each region is inhabited by a unit mass of atomistic entrepreneurs, each of whom owns a labor-intensive firm. Entrepreneurs maximize expected

[3] The function $\Phi(\cdot)$ incorporates expectations of a possible default at $t+1$. We can obtain an analytic solution for it because $\varepsilon_{j,t}$ is the only source of uncertainty and the distribution of future repayments is known at t.

lifetime utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln(c^e_{j,t}),$$

where $c^e_{j,t}$ is date-t consumption in country j.

Entrepreneurs produce a single intermediate good with the linear production function $n_{j,t} = z_{j,t} l_{j,t}$, where $z_{j,t}$ is the country-specific aggregate productivity—common to both types of firms—and $l_{j,t}$ is the input of labor. Intermediate inputs are traded only domestically.[4]

Production is subject to the working capital constraint

$$m_{j,t} \geq \phi_{j,t} w_{j,t} l_{j,t}, \tag{7}$$

where $m_{j,t}$ denotes the financial assets held by the entrepreneur, and $\phi_{j,t}$ is an exogenous, time-varying (and country specific) parameter.

Although this constraint can be interpreted as advanced payment of a fraction of wages, we interpret it more broadly as capturing other mechanisms that make the production scale dependent on a firm's financial wealth. For example, larger production scales could be facilitated by the insurance that financial wealth provides for dividend smoothing (Angeletos (2007)), or by improving hiring outcomes (see Monacelli et al. (2023)) and workers' retention (Baghai et al. (2021)).

The parameter $\phi_{j,t}$ is key in determining the demand for financial assets. As $\phi_{j,t}$ rises, financial wealth provides higher production value, and this increases the entrepreneurs' incentive to hold $m_{j,t}$.

Financial wealth is made of the holdings of debt issued by capital-intensive producers from both regions. The price of that debt, denoted by $q_{j,t}$, is not the same in the two regions because the expected repayments could differ. Also, since ex-post defaults are not perfectly correlated, the debt issued by one region is not a perfect substitute for the debt issued by the

[4] Allowing for trade in intermediate inputs would add another vehicle for financial crises to have international spillovers: As production of labor-intensive inputs drops in one region because of a financial crises, final-goods output in the other region drops to the extent that domestic and foreign inputs are poor substitutes. As we show later, however, international spillovers are present in our model even without this trade link, because of cross-border holdings of defaultable debt.

other region. Hence, entrepreneurs choose a portfolio of bonds that is optimally-diversified. With risk-neutral entrepreneurs the composition of portfolios would be undetermined.

The representative entrepreneur in country j enters period t with bonds issued by capital-intensive firms in region 1, $b_{1,j,t}$, and in region 2, $b_{2,j,t}$. The first subscript denotes the region of the bond issuer, and the second the region of the bond holder.

The losses that entrepreneurs suffer in the event of a default are proportional to their ownership of bonds, with $\delta_{1,t}$ and $\delta_{2,t}$ denoting the fractions of the contracted repayment repaid by borrowers in region 1 and region 2, respectively. These fractions are endogenous outcomes determined in general equilibrium. Their values are realized at the beginning of the period and, after they are observed, the entrepreneur's wealth at the start of period t, $m_{j,t}$, becomes

$$m_{j,t} = \delta_{1,t} b_{1,j,t} + \delta_{2,t} b_{2,j,t}.$$

Because of the working capital constraint (7), the value of $m_{j,t}$ is key for determining the firm's output. More specifically, lower values of $m_{j,t}$ force the firm to cut production.

The end-of-period wealth after production, but before consumption, is

$$a_{j,t} = m_{j,t} + p^N_{j,t} n_{j,t} - w_{j,t} l_{j,t},$$

which is equal to the beginning-of-period wealth plus profits. Wealth is then allocated to consumption and new bonds, subject to the budget constraint

$$c^e_{j,t} + \omega_{1,j} q_{1,t} b_{1,j,t+1} + \omega_{2,j} q_{2,t} b_{2,j,t+1} = a_{j,t}. \tag{8}$$

The parameter $\omega_{i,j}$ captures a cost or wedge associated to the acquisition of foreign bonds. Without loss of generality, we assume that $\omega_{i,j} = 1$ for $i = j$ and $\omega_{i,j} > 1$ for $i \neq j$. The purpose of the wedge is to generate portfolio home bias. This matters for the regional spillover of financial crises.

The entrepreneur's optimization problem can be written as

$$\max_{\{l_{j,t}, c^e_{j,t}, b_{1,j,t+1}, b_{2,j,t+1}\}_{t=0}^{\infty}} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln(c^e_{j,t}) \tag{9}$$

s.t.

$$m_{j,t} = \delta_{1,t} b_{1,j,t} + \delta_{2,t} b_{2,j,t} \geq \phi_{j,t} w_{j,t} l_{j,t},$$

$$a_{j,t} = m_{j,t} + p^N_{j,t} z_{j,t} l_{j,t} - w_{j,t} l_{j,t},$$
$$c^e_{j,t} = a_{j,t} - \omega_{1,j} q_{1,t} b_{1,j,t+1} - \omega_{1,j} q_{2,t} b_{2,j,t+1}.$$

Following Mendoza and Quadrini (2023), when the working capital constraint binds it follows that $p^N_{j,t} z_{j,t} > w_{j,t}$ and the optimal demand for labor is

$$l_{j,t} = \left(\frac{1}{\phi_{j,t} w_{j,t}} \right) m_{j,t},$$

while if the constraint does not bind we have that $p^N_{j,t} z_{j,t} = w_{j,t}$ and the demand for labor is supply determined.

When the condition $p^N_{j,t} z_{j,t} > w_{j,t}$ holds, the cost of labor is lower than its marginal value product. Under this condition, profits $\pi_{j,t} = (p^N_t z_{j,t} - w_{j,t}) l_{j,t}$ are positive, which incentivizes the firm to increase production until the working capital constraint binds, that is, $m_{j,t} = \phi_{j,t} w_{j,t} l_{j,t}$. We can then derive the demand for labor by solving the working capital constraint for $l_{j,t}$. Note that we can use the working capital constraint $m_{j,t} = \phi_{j,t} w_{j,t} l_{j,t}$ and the first-order condition for $l_{j,t}$ from the above problem to express profits as $\pi_{j,t} = \hat{\xi}_{j,t} m_{j,t}$, where $\hat{\xi}_{j,t} \equiv \xi_{j,t}/u'(c_{j,t}) = \xi_{j,t} c_{j,t}$, and $\xi_{j,t}$ is the multiplier for the working capital constraint. This makes it clear that there is indeed a convenience yield for holding $m_{j,t}$.

When $p^N_{j,t} z_{j,t} = w_{j,t}$, the marginal cost and value product of labor are the same. In this case, profits are zero, and hence the firm does not have an incentive to increase output and the working capital constraint does not bind. Therefore, the financial wealth of the entrepreneur $m_{j,t}$ and the parameter $\phi_{j,t}$ are irrelevant for the individual choice of production. Aggregate production of N-goods is then determined by the demand for the intermediate inputs used in the production of final goods.

In general, the working capital constraint (7) could be occasionally binding. Specifically, it tends to bind when entrepreneurs have low financial wealth $m_{j,t}$, and when the input requirement $\phi_{j,t}$ and/or the productivity $z_{j,t}$ are high. Hence, faster productivity growth and sustained rise in the parameter ϕ increase the need for financial assets and make the constraint binding.

Notice that labor demand depends on the beginning-of-period wealth $m_{j,t}$ (see constraint (7)). In contrast, consumption and portfolio choices depend on the end-of-period wealth,

$a_{j,t}$. In Appendix A we show that the entrepreneurs' optimal consumption and portfolio choices take the form:

$$c^e_{j,t} = (1-\beta)a_{j,t},$$
$$\omega_{1,j}q_{1,t}b_{1,j,t+1} = \theta_{j,t}\beta a_{j,t},$$
$$\omega_{2,j}q_{2,t}b_{2,j,t+1} = (1-\theta_{j,t})\beta a_{j,t}.$$

The logarithmic preferences and linear technology deliver the result that entrepreneurs consume the fraction $1-\beta$ of their end-of-period wealth and save the remaining fraction β. Savings $\beta a_{j,t}$ are then allocated to region-1 bonds according to the portfolio share $\theta_{j,t}$ and region-2 bonds receive the portfolio share $1-\theta_{j,t}$. The optimal portfolio satisfies the following no-arbitrage condition

$$\mathbb{E}_t \left\{ \frac{\dfrac{\delta_{1,t+1}}{\omega_{1,j}q_{1,t}}}{\theta_{j,t}\dfrac{\delta_{1,t+1}}{\omega_{1,j}q_{1,t}} + (1-\theta_{j,t})\dfrac{\delta_{2,t+1}}{\omega_{2,j}q_{2,t}}} \right\} = 1,$$

Without the wedges $\omega_{1,j}$ and $\omega_{2,j}$ (or with $\omega_{1,j} = \omega_{2,j}$), the portfolio shares would be equal in the two regions ($\theta_{1,t} = \theta_{2,t}$). With the wedges, however, the two regions choose different portfolios.

The mechanism that pins down $\theta_{j,t}$ is an arbitrage condition embedded in the Euler equations for $b_{1,j,t+1}$ and $b_{2,j,t+1}$. Entrepreneurs take into account that the liabilities issued by capital-intensive producers are risky, and hence they take expectations over $\delta_{1,j,t+1}$ and $\delta_{2,j,t+1}$ when evaluating the marginal benefit of holding bonds issued by each region. They also take into account that there is a benefit from holding more bonds if this relaxes the working capital constraint at $t+1$.

The bond decision rules represent the demands for assets (domestic and foreign) of entrepreneurs. Combining the demand for each of the two bonds in region j we obtain

$$b_{1,j,t+1} + b_{2,j,t+1} = \left(\frac{\theta_{j,t}}{\omega_{1,j}q_{1,t}} + \frac{1-\theta_{j,t}}{\omega_{1,j}q_{2,t}} \right) \beta a_{j,t}.$$

The left-hand-side of this expression defines the aggregate demand for assets by entrepreneurs from region j. The right-hand-side shows that, given $a_{j,t}$, that aggregate demand is increasing in the interest rate, which is inversely related to bond prices $q_{1,j}$ and

$q_{2,j}$. In addition, an increase in wealth $a_{j,t}$ shifts the demand. As we will see, the faster growth of EMEs is associated with faster growth of $a_{j,t}$ and, therefore, with a shift of their demand for assets. An increase in $\phi_{j,t}$ also shifts the demand for assets to the right. This, however, arises gradually as entrepreneurs increase $a_{j,t}$ over time by retaining profits.[5]

2.3. *General equilibrium*

We use capital letters to denote aggregate variables. The set of aggregate states at date t includes the bonds held by entrepreneurs at the start of the period, $B_{1,1,t}$, $B_{2,1,t}$, $B_{1,2,t}$, $B_{2,2,t}$, and the date-t shocks $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$. It also includes the sequences of productivity—$z_{1,t}$ and $z_{2,t}$—financial variables—$\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$ and $\kappa_{2,t}$—and capital stocks—$K_{1,t}$ and $K_{2,t}$. Since these sequences are exogenous and perfectly anticipated, their evolution into the infinite future is part of the state space. The state vector is

$$\mathbf{s}_t \equiv (z_{1,t}^{\infty}, z_{2,t}^{\infty}, \phi_{1,t}^{\infty}, \phi_{2,t}^{\infty}, \kappa_{1,t}^{\infty}, \kappa_{2,t}^{\infty}, K_{1,t}^{\infty}, K_{2,t}^{\infty}, B_{1,1,t}, B_{2,1,t}, B_{1,2,t}, B_{2,2,t}, \varepsilon_{1,t}, \varepsilon_{2,t}).$$

where the history of a variable starting at date t into the infinite future is indicated with subscript t and superscript ∞.

The general equilibrium of the model satisfies the optimality conditions of households, capital-intensive firms and entrepreneurs, and also the following three market-clearing conditions: (1) market for liquidated capital; (2) market for labor (and intermediate goods); (3) market for financial assets. We describe the details of the equilibrium conditions in Appendix B. Here we highlight four important properties.

The particular structure of the model yields a sequential property by which the date-t equilibrium can be solved for independently of future equilibria. Given the state vector $\mathbf{s}_t$, the equilibrium values of all date-t variables are found by solving a system of nonlinear equations that involve only date-t equilibrium conditions (see Appendix B). We can then

[5] As shown earlier, higher $\phi_{j,t}$ reduces the demand for labor and, therefore, the unit production cost. This increases profits per unit of production. At the same time, the firm produces less, which reduces total profits for a given profit rate. Thus, the impact on total profits depends on two opposing effects: the positive effect from a higher unitary profit and the negative effect from the lower production scale. The quantitative exercises show that the first effect is dominant and total profits increase. By forcing labor-intensive firms to cut production, there is an increase in profits similar to what happens in a monopsony market.

solve the model sequentially starting from any initial date. In the quantitative application, we first solve for $t = 1991$, then for $t = 1992$, and continue until $t = 2020$. This sequential property is an implication of the specific functional forms for preferences and technology, and the assumption that capital follows an exogenous path.

Since the sequential property of the equilibrium implies that date-t endogenous variables are only affected by $z_{j,t}$, $\phi_{j,t}$, $\kappa_{j,t}$, $\kappa_{j,t+1}$, $K_{j,t}$ and $K_{j,t+1}$, the sufficient set of state variables reduces to

$$\mathbf{s}_t \equiv \big(z_{1,t}, z_{2,t}, \phi_{1,t}, \phi_{2,t}, \kappa_{1,t}, \kappa_{2,t}, \kappa_{1,t+1}, \kappa_{2,t+1},$$
$$K_{1,t}, K_{2,t}, K_{1,t+1}, K_{2,t+1}, B_{1,1,t}, B_{2,1,t}, B_{1,2,t}, B_{2,2,t}, \varepsilon_{1,t}, \varepsilon_{2,t}\big).$$

This greatly simplifies the computation of the equilibrium, facilitating the quantitative analysis we conduct in the next Section.

The model's equilibrium has three other interesting features. First, it displays stochastic dynamics because of fluctuations in $\varepsilon_{j,t}$ that shift the economy between 'normal' and 'crisis' times. Second, default redistributes wealth away from where it has a productive use, reducing labor demand and the supply of $N_{j,t}$, and hence the output of final goods. The same redistribution drives cross-regional spillovers because of cross-border holdings of private debt. Third, the risk-free interest rate is on average lower than the inter-temporal discount rate $1/\beta - 1$, and this occurs not only because of self-insurance incentives of entrepreneurs but, more importantly, because of the convenience yield provided by financial assets. As noted earlier, whenever the working capital constraint binds, financial wealth allows entrepreneurs to earn profits on top of the interests earned on bonds. This result is also in line with studies on the convenience yield of bonds as an explanation for the low real interest rate relative to the rate of growth (see, for example, Holston et al. (2017)).

3. QUANTITATIVE ANALYSIS

The goal of this paper is to examine the tradeoff between risk-sharing and risk exposure in determining the impact of financial integration on macroeconomic volatility in both advanced economies (AEs) and emerging economies (EMEs). To do so, we conduct a quantitative analysis based on a calibration of the model using 1991-2020 data. The countries included in AEs and EMEs are listed in the note to Figure 1.

After the calibration, we conduct a counterfactual simulation in which we impose financial autarky, that is, AEs cannot hold bonds issued by EMEs, and EMEs cannot hold assets issued by AEs. This also implies that the net foreign asset positions and trade balances of both regions are always zero. The comparison between the baseline simulation with this counterfactual simulation allows us to assess the effects of financial globalization on macroeconomic volatility.

3.1. *Calibration of fixed parameters*

The model is calibrated to an annual frequency with a discount factor of $\beta = 0.93$, which implies an annual intertemporal discount rate of about 7%. The elasticity of labor supply is $\nu = 2$, which is in the upper range of estimates typically used in macroeconomic models. Capital depreciates at a standard 8% rate. Hence, we set $\tau = 0.08$.

Regarding the probabilities of financial crises in advanced and emerging economies, the data plotted in Figure 2 yield average probabilities of 3.88% in AEs and 6.69% in EMEs, respectively. Therefore, we set $\lambda_1 = 0.0388$ and $\lambda_2 = 0.0669$. These calibration values imply that on average a crisis arises every 15 years in EMEs, and every 25 years in AEs. Since sunspot shocks are independent across regions, a *global* financial crisis is even rarer with a probability of only 0.26% ($0.0388 \times 0.0669 \approx 0.00259$). However, the key feature of the model is that, even if a shock hits only one region, the macroeconomic consequences are global due to spillovers induced by cross-regional portfolio holdings.

The labor share parameter in the production function of final goods is set to a standard value, $\gamma = 0.65$. Because profits are positive in the labor-intensive sector when working capital constraints bind, the actual labor share in final output is lower than 0.65. On average, though, the labor share is not very different from this number.

We have limited information to calibrate the borrowing cost parameter η. In the baseline model we set it to 0.1 but in Appendix C we conduct a sensitivity analysis.

In the long-run, productivity $z_{j,t}$ grows at the constant rate g in both regions. Given g, we impose that the long-run growth rate of capital, which is exogenous in the model, is $(1+g)^{1/\gamma} - 1$. This guarantees that the endogenous growth rate of output in the long-run is also $(1+g)^{1/\gamma} - 1$. The value of g is set to the average growth rate of productivity experienced by advanced economies over the period 1991-2020. The assumption is that in the long-run, AEs and EMEs will converge to the same growth rate. In the short-run, however, the two regions could experience very different productivity growth rates. We describe the construction of the productivity series later in this section.

The last set of fixed parameters we calibrate are the portfolio cost wedges $\omega_{i,j}$. For simplicity, we assume that the wedges are symmetric across regions, that is, $\omega_{1,2} = \omega_{2,1}$ (recall $\omega_{1,1}$ and $\omega_{2,2}$ were already normalized to 1). Hence, we need to calibrate only one parameter, which we pin down by targeting the EME's gross foreign asset position as a percentage of GDP in 1991 (first simulation year). Using the *External Wealth of Nations* database, we impose a target of 44.5% (see second panel of Figure 1). To find the value of $\omega_{1,2} = \omega_{2,1}$ consistent with this target, we apply an iterative procedure. We first guess the value of the wedge. Then, given the values of all other parameters, we check whether the model replicates the target. If the value generated by the model is above (below) the target, we increase (reduce) the wedge and solve for the equilibrium again. The resulting value of the calibrated wedge is $\omega = 0.999316$, and the implied 1991 portfolio shares are $\theta_{1,1} = 0.857$, $\theta_{2,1} = 0.143$, $\theta_{1,2} = 1.260$ and $\theta_{2,2} = -0.260$.

It is important to note that, even if the wedge does not change over time, the model predicts an increase in cross-regional asset holdings. This follows from the expansion of the financial sector in both regions that are driven by the time-varying parameters $z_{j,t}$, $\phi_{j,t}$, and $\kappa_{j,t}$.

TABLE I

PARAMETER VALUES.

Description	*Parameter*	*Value*
Discount factor	β	0.93
Share of labor in production	γ	0.65
Depreciation rate	τ	0.08
Elasticity of labor supply	ν	2.00
Crisis probabilities (low sunspot shock)	λ_1, λ_2	0.02, 0.04
Cost of borrowing	η	0.10
Long-run growth rate of productivity	g	0.011474
Foreign investment wedge	ω	0.999316

3.2. *Measurement of time-varying parameters $z_{j,t}$, $\phi_{j,t}$, $\kappa_{j,t}$*

Cross-regional differences in size and financial structure are driven by the deterministic sequences $z_{j,1991}^{2020}$, $\phi_{j,1991}^{2020}$, and $\kappa_{j,1991}^{2021}$.[6] We describe next how we combined the model with the data to construct them.

3.2.1. *Productivity and capital ($z_{j,t}$ and $K_{j,t}$).*

The productivity series $z_{1,1991}^{2020}$ and $z_{2,1991}^{2020}$ are constructed as Solow residuals from the production function of final goods using standard measures of production inputs and outputs. The empirical counterpart of output is GDP at nominal exchange rates, which is preferred to PPP measures because it allows our constructed productivity series to reflect movements in real exchange rates. These movements are important for determining the purchasing power of a country in the acquisition of foreign assets. The constructed productivity series also capture differences in population growth that we do not model explicitly.

The computation of the productivity series are based on the following expressions:

$$z_{1,t} = \frac{Y_{1,t}}{L_{1,t}^{\gamma} K_{1,t}^{1-\gamma}}, \qquad\qquad z_{2,t} = \frac{P_{2,t} Y_{2,t} / P_{1,t}}{L_{2,t}^{\gamma} K_{2,t}^{1-\gamma}}. \tag{10}$$

The numerator of each equation is total GDP in the particular region, deflated by the AEs' price index. $P_{j,t}$ is the nominal price index for region j expressed in U.S. dollars. $L_{j,t}$ is per-capita employment and $K_{j,t}$ is per-capita capital.[7] The presence of the variable $L_{j,t}$ shows that differences in $z_{j,t}$ across regions may reflect differences in employment growth which in turn could be driven by population growth. Moreover, the expression for $z_{2,t}$ shows that a higher (measured) relative productivity in EMEs may actually reflect a real appreciation in this region relative to AEs ($P_{2,t}/P_{1,t}$ is the real exchange rate of EMEs relative to AEs). Even if this does not change actual productivity, it raises EMEs' ability to purchase assets in advanced economies.

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[6]Size differences are also driven by the exogenous evolution of capital $K_{j,t}$. We discuss later how we constructed the capital stock sequences.

[7]Since aggregate production of capital-intensive inputs is $X_{j,t} = z_{j,t} K_{j,t}$ and that of labor-intensive inputs is $N_{j,t} = z_{j,t} L_{j,t}$, we can express the aggregate production function of final goods ($X_{j,t}^{1-\gamma} N_{j,t}^{\gamma}$) as $z_{j,t} K_{j,t}^{1-\gamma} L_{j,t}^{\gamma}$. This is per-capita output which, multiplied by population, yields aggregate output $Y_{j,t}$. See Mendoza and Quadrini (2024) for full details of the Solow residuals calculations.

We use the above equations and data from the *World Development Indicators* for the period 1991-2020 to construct the productivity estimates. Final outputs $Y_{1,t}$ and $P_{2,t}Y_{2,t}/P_{1,t}$ are computed by aggregating the GDP at constant U.S. dollars for AEs and EMEs respectively. The countries included in the two regions are those listed in the note to Figure 1. Regional aggregates are obtained by adding up the values of each country belonging to the corresponding region.

Labor input is the ratio between employment and population over 15 years of age. The regional aggregates divide the sum of the employment of all countries in the region by the sum of their corresponding populations to arrive at labor per capita $L_{j,t}$.

To construct the capital sequences $K_{j,t}$, we apply the perpetual inventories method using investment and depreciation data aggregated at the regional level. We construct regional aggregates for investment and depreciation, $I_{j,t}$ and $DEP_{j,t}$, by adding the values of each variable for all countries included in the region. All quantities are in constant US dollars. We guess the initial capital, $K_{j,0}$, and compute $K_{j,1} = K_{j,0} - DEP_{j,0} + I_{j,0}$. The value of $K_{j,1}$ is then used to compute $K_{j,2} = K_{j,1} - DEP_{j,1} + I_{j,1}$. We continue until the end of the sample period. At this point we update the guess for $K_{j,0}$ and repeat the procedure. We continue until each region's capital-GDP ratio displays no trend over the sample period.

The first three Panels (a)-(c) in Figure 3 plot the empirical values of GDP, labor, and capital in AEs and EMEs. The resulting productivity measures are plotted in the last Panel (d). Productivity displays an upward trend in both regions, but steeper in emerging economies.

3.2.2. *Financial structure parameters ($\phi_{j,t}$ and $\kappa_{j,t}$).*

We use the sequential property of the model's equilibrium in order to construct sequences of $\phi_{j,1991}^{2020}$ and $\kappa_{j,1991}^{2021}$ such that the model matches the values of four chosen empirical targets at each date t. This allows us to find the values of $\phi_{j,1991}$ and $\kappa_{j,1992}$ without knowing their values beyond 1991 (and 1992 for $\kappa_{j,t}$). We can then solve for $\phi_{j,1992}$ and $\kappa_{j,1993}$ without knowing their values beyond 1992 (1993 for $\kappa_{j,t}$), and continue until 2020, the last simulation year.

Since the values of $\phi_{j,1991}^{2020}$ and $\kappa_{j,1991}^{2021}$ that match the data targets depend on the stochastic realizations of the sunspot shocks over the simulation period 1991-2020, we need to specify particular sequences for the sunspot variables $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$. We set $\varepsilon_{j,t} = 1$ (no crises) except for $\varepsilon_{2,1997} = 0$ (1997 crisis in EMEs), $\varepsilon_{2,2009} = 0$ (2009 crisis in EMEs), and $\varepsilon_{1,2009} = 0$

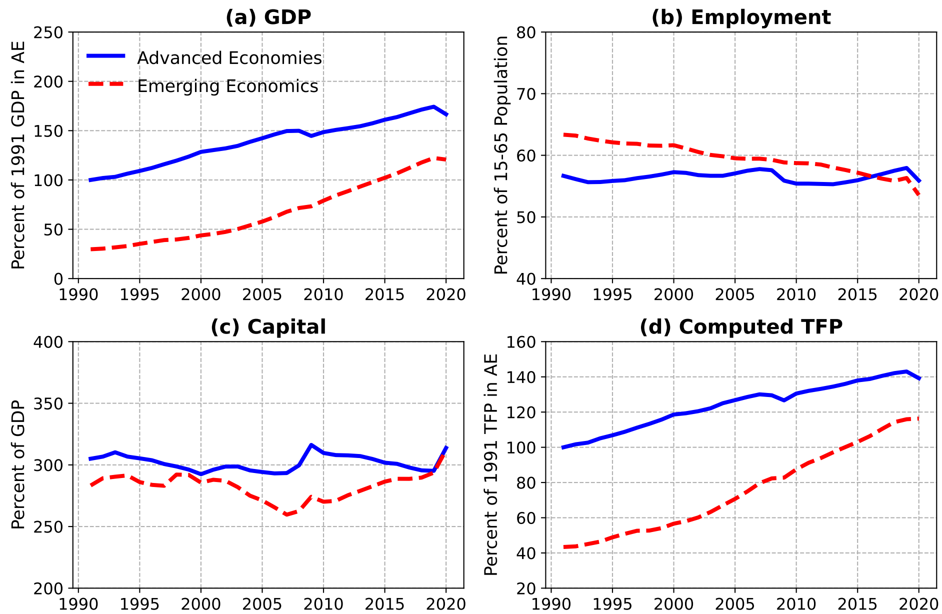

FIGURE 3.—GDP, employment, capital and computed productivity series for advanced and emerging economies, 1991-2020.

(2009 crisis in AEs). These three crises capture the 1997 Sudden Stops in South-East Asia that involved several emerging economies, and the Global Financial Crisis that involved both emerging and advanced economies. However, agents do not anticipate the specific realizations of $\varepsilon_{j,t}$. Therefore, they make decisions using the probabilities λ_1 and λ_2.

Given the fixed parameters and the sequences of productivity, capital, and sunspot shocks, the sequences of $\phi_{j,1991}^{2020}$ and $\kappa_{j,1991}^{2021}$ are constructed so that the model replicates the empirical time series for the following variables over the 1991-2020 period: (i) domestic credit in AEs; (ii) domestic credit in EMEs; (iii) gross foreign assets in EMEs; and (iv) US risk-free real interest rate.

The first two targets—domestic credit in AEs and EMEs—are the empirical counterparts of $d_{j,t}$ in the model. For the third target, we chose the gross foreign asset position in EMEs, instead of that of AEs. We did this because of data limitation. Specifically, the model considers the cross-region holdings between AEs and EMEs, and not between individual countries within a region. For example, as part of the foreign assets of region 1, it includes assets held by the United States issued by Argentina but not those issued by Canada. In contrast, the *External Wealth of Nations* database provides data on assets and liabilities for each individual country vis-a-vis the rest of the world, without breaking down whether the assets held by a given country were issued by AEs or EMEs. As a result, when we calculate the aggregate foreign assets for AEs, we do not know how they are split across assets issued by other advanced economies and by emerging economies. Since a sizable share of foreign assets held by AEs are issued by other AEs, the use of AEs gross foreign holdings would exaggerate the actual integration between AEs and EMEs. For EMEs, however, a sizable share of foreign assets are likely to be issued by AEs, instead of other EMEs. Thus, by using the gross foreign assets of EMEs as a calibration target, we better capture the actual integration between AEs and EMEs. The fourth target is the US risk-free interest rate which we think as representative of the 'world' interest rate.

The precise mapping between the four empirical targets and the corresponding variables in the model is as follows:

$$\text{Business Credit-to-GDP AEs} = \frac{q_{1,t}D_{1,t+1}}{Y_{1,t}}, \tag{11}$$

$$\text{Business Credit-to-GDP EMEs} = \frac{q_{2,t}D_{2,t+1}}{Y_{2,t}}, \tag{12}$$

$$\text{Gross Foreign Assets-to-GDP EMEs} = \frac{q_{1,t}B_{1,2,t+1}}{Y_{2,t}}, \tag{13}$$

$$\text{US real interest rate} = \frac{\mathbb{E}\delta_{j,t+1}}{q_{j,t}} - 1. \tag{14}$$

The terms in the right-hand-side of these expressions are the equilibrium values of the endogenous variables in the model. For given values of $\phi_{j,t}$ and $\kappa_{j,t+1}$ (in addition to $z_{j,t}$, $K_{j,t}$ and $K_{j,t+1}$), we compute these variables by solving the system of nonlinear equations shown in Appendix B. Given the sequential properties of the equilibrium, we start in 1991 and move forward until we reach 2020.

We find the sequences of $\phi_{j,t}$ and $\kappa_{j,t+1}$ that match the data targets using an iterative procedure with two nested nonlinear solvers. After initializing $\kappa_{1,1991}$ and $\kappa_{2,1991}$, we apply the inner solver to compute the equilibrium for given values of $\phi_{1,1991}$, $\phi_{2,1991}$, $\kappa_{1,1992}$ and $\kappa_{2,1992}$.[8] After that, we apply the outer solver to assess whether the equilibrium vari-

[8]If the realizations of the sunspot shocks in the initial simulation year do not cause a crisis, the initial values of $\kappa_{1,1991}$ and $\kappa_{2,1991}$ are not relevant.

ables computed with the inner solver for given values of $\phi_{1,1991}$, $\phi_{2,1991}$, $\kappa_{1,1992}$ and $\kappa_{2,1992}$ match the targets (i.e., whether conditions (11)-(14) hold). The values of $\phi_{1,1991}$, $\phi_{2,1991}$, $\kappa_{1,1992}$ and $\kappa_{2,1992}$ are then updated until conditions (11)-(14) are satisfied. After convergence, we move to the next period and solve for the values of $\phi_{1,1992}$, $\phi_{2,1992}$, $\kappa_{1,1993}$ and $\kappa_{2,1993}$. We continue until the final year 2020 (see Appendix B for further details).

Panels (a)-(c) in Figure 4 plot the time series of the four empirical targets, and Panels (d)-(e) plot the constructed time series of the financial parameters that enable the model to match those targets. Panel (a) shows that domestic credit in percent of output grew steadily in both regions during the 1991-2020 period, from 110% to 175% in AEs and 50% to 125% in EMEs. The EMEs gross foreign assets as a share of GDP shown in Panel (b) also grew significantly, from slightly above 40% to roughly 120%. The real interest rate fell sharply from 4% to about zero (see Panel (c)).

Panel (d) shows that $\phi_{1,t}$ in advanced economies grew steadily between 1991 and 2008, with an overall increase of about 50%. After that, there is a marked drop at the time of the global financial crisis followed by a gradual recovery. In emerging economies, $\phi_{2,t}$ displays a sharp and sustained upward trend during the full sample period, rising from around 0.7 to 3.2. This suggests that, as emerging economies experienced faster growth, their need for financial wealth also increased. Overall, the model predicts a large "structural" increase in demand for financial assets (driven by the parameter ϕ) from both AEs and EMEs over the 1991-2020 period. This is over and above the contribution of the productivity growth reflected in the evolution of $z_{j,t}$, which props up the demand for assets by requiring additional working capital for given values of $\phi_{j,t}$.

In contrast with the clear increase in the parameter driving asset demand, the financial parameters driving the supply ($\kappa_{1,t}$ and $\kappa_{2,t}$), shown in Panel (e), are relatively stable. We do see again a marked drop and slow recovery in AEs after the global financial crisis, and there is also a drop in EMEs, but of smaller magnitude. By 2020, however, the model predicts that $\kappa_{1,t}$ had returned to about the same value it had in the 1990s (0.4), while $\kappa_{2,t}$ rose from around 0.2 to roughly 0.28. Note also that the parameter $\kappa_{1,t}$ is uniformly higher than $\kappa_{2,t}$ and by a sizable margin. This is in line with broad evidence of higher financial development in advanced economies.

Panels (a) in Figure 5 plots the gross foreign assets and liabilities for EMEs predicted by the model, as a percentage of output. Recall that in the model these represent foreign gross

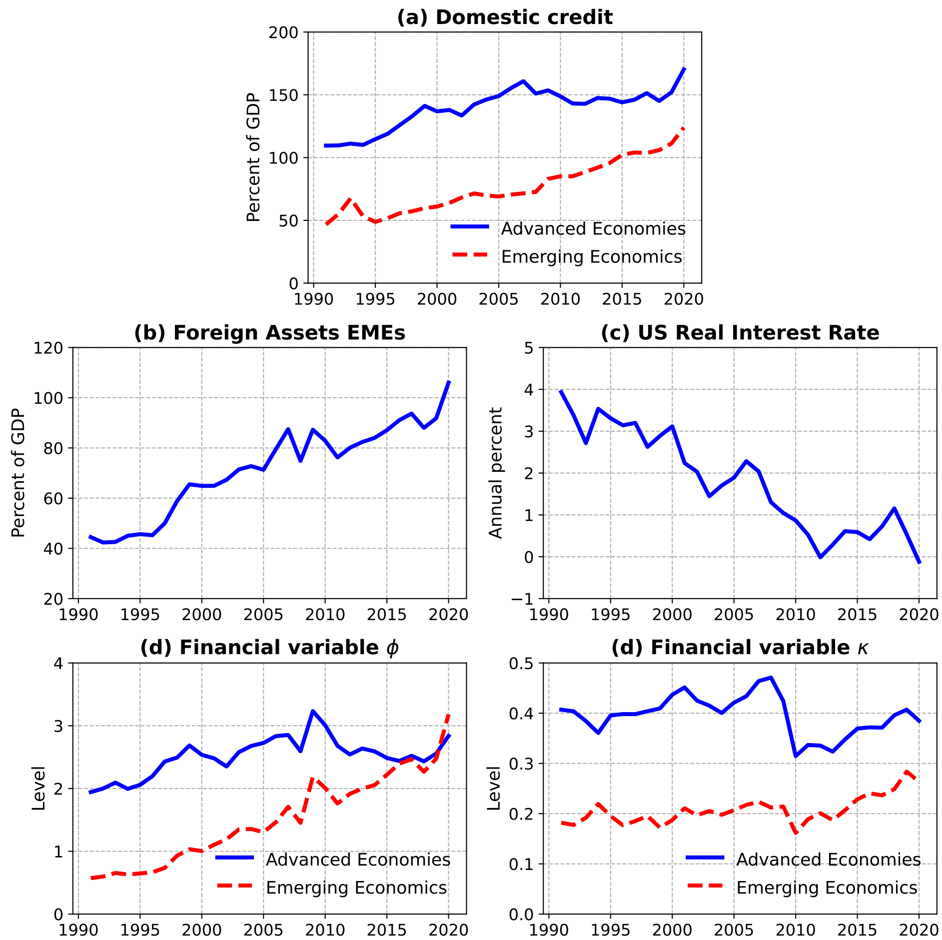

FIGURE 4.—Empirical targets and financial parameters in advanced and emerging economies, 1991-2020

positions of EMEs with AEs, not vis-a-vis other EMEs. As stressed earlier, our empirical data does not allow us to separate the country that issued the foreign assets held in the portfolio of a particular country. Therefore, we cannot easily compare the predictions of the model with our data. However, for emerging economies, as we discussed before, their aggregate regional position may be a good proxy for their foreign position with AEs.

The predicted series of EMEs foreign assets in panel (a) matches the data by construction, because one of the targets for pinning down the financial parameters $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$ and $\kappa_{2,t}$, was the gross foreign assets of EMEs. However, the gross foreign liabilities and its difference—the Net Foreign Asset position—are not targeted by the calibration. The model replicates the overall upward trend observed in the foreign liabilities of EMEs, al-

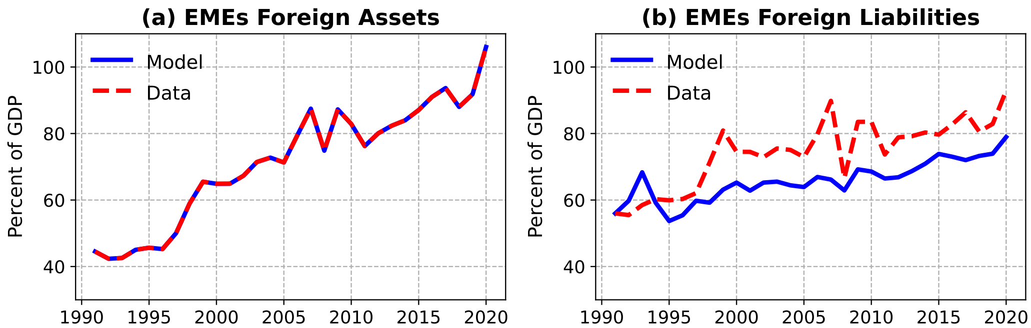

FIGURE 5.—Foreign assets and liabilities in emerging economies, 1991-2020.

though the predicted growth is somewhat lower than in the data. But overall the model seems consistent with the data.

It is important to note that, even if the investment wedge ω does not change over time, foreign assets and liabilities grow because the size of the financial system in both regions becomes bigger. This is driven by the increase in the exogenous variables $\phi_{j,t}$ and $\kappa_{j,t}$ (see Figure 4). With the higher need for financial wealth, entrepreneurs in both regions increase the holdings of both domestic and foreign assets. This must be accompanied by an increased supply of assets, which is made possible by the reduction in the interest rate: with a lower interest rate, capital-intensive firms issue more debt even if $\kappa_{j,t}$ does not change.

3.3. *Leverage and portfolio properties*

To explore further the properties of the model and its dynamics over time, Figure 6 shows the pattern of key financial variables, starting with effective leverage. Effective leverage is defined as the debt issued by borrowing firms, D_{t+1}, over the liquidation value of capital in the event of default, $\kappa_{t+1}K_{t+1}$. Panel (a) shows that leverage has increased over time in both regions.[9] This trend follows from the decline in the interest rate.

Higher leverage implies that, in the event of default, a larger share of the debt is not repaid. Panel (b) shows the expected haircut—that is, the expected losses from holding the debt issued by AEs (continuous line) and EMEs (dashed line). The expected haircuts

[9] Since leverage is a function of the interest rate, which is common to both regions when there is capital mobility, both regions have the same leverage. However, since $\kappa_{1,t} > \kappa_{2,t}$, the debt in AEs, as a percentage of output, is larger than in EMEs.

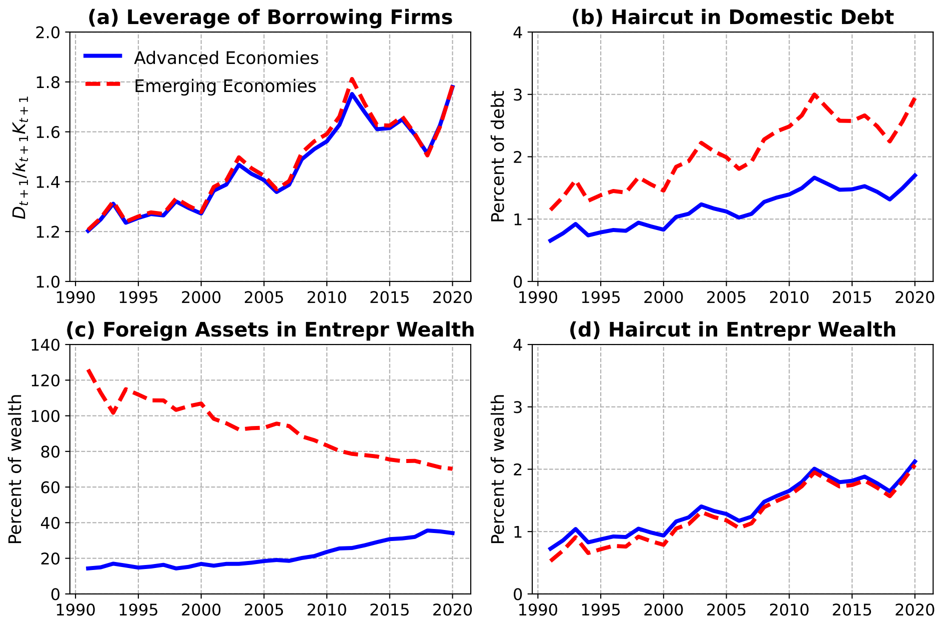

FIGURE 6.—Key financial variables, 1991-2020.

displays an upward trend as a consequence of the growing leverage we showed in Panel (a). The reason the expected haircut is higher for EMEs' debt is that financial crises are more frequent in EMEs (based on our calibration motivated by Figure 5).

Since the bonds issued by the two regions have different levels of risk, the composition of the entrepreneur's portfolio matters for the overall risk. Panel (c) shows the share of foreign assets (bonds) held by entrepreneurs in the two regions. At the beginning of the 1990s, advanced economies held less than 20% of foreign assets (bonds issued by EMEs). Over time, however, the share increased, reaching almost 40% by the end of the sample. Entrepreneurs in EMEs, instead, experienced a decline in their share of foreign assets (bonds issued by AEs). Even if their foreign assets rose as a share of their GDP (see panel (a) of Figure 5), the share in their total wealth fell due to the large increase in domestic financial assets. Panel (d) shows that the riskiness of the portfolios increased in both regions. This increase was driven by the rising haircuts on both AE and EME bonds.

Panel (d) reveals also an interesting property. Even though AEs and EMEs are characterized by different degrees of financial instability (EMEs have a higher probability of experiencing a financial crisis), the portfolio risk faced by entrepreneurs is not very different between the two regions. In fact, the portfolio risk faced by entrepreneurs in AEs (continuous line) is slightly higher than that faced by entrepreneurs in EMEs (dashed line). As we will see, these patterns are important for understanding the macroeconomic volatility experienced by the two regions, and how this is affected by financial integration.

3.4. *Financial integration and macroeconomic volatility.*

To explore how financial integration affected macroeconomic volatility in both AEs and EMEs, we conduct a counterfactual exercise in which we compare the macro volatility generated by the baseline model with that generated by the same model but in a regime with financial autarky. In this regime, entrepreneurs can only hold domestic bonds and, therefore, there is no cross-country ownership of assets. This removes both the entrepreneurs' benefit of diversifying the portfolio of assets globally, and the cost of being exposed to the repayment risk of foreign asset holdings.

We focus on output volatility which we construct via Monte Carlo simulation. In particular, we conduct 10,000 repeated stochastic simulations of the model, each over a period of 130 years and driven by random draws of the sunspot shocks, $\varepsilon_{j,t} = 0$ with probability λ_j and $\varepsilon_{j,t} = 1$ with probability $1 - \lambda_j$. During the first 100 years of each simulation, productivity grows at its long-run rate $g = 0.011474$ in both regions, and $\phi_{j,t}$ and $\kappa_{j,t}$ are kept constant at their 1991 values. The simulation for the first 100 years allows us to set the initial states for the remaining 30 years, corresponding to the 1991-2020 period, as a draw from the invariant state distribution. During the remaining 30 years, which is the focus of the paper, $z_{j,t}$, $\phi_{j,t}$, $\kappa_{j,t}$, and $K_{j,t}$ take the values plotted in Figures 3 and 4.

The 130-years simulation is repeated 10,000 times, each time with a new sequence of independent random draws of the sunspot shocks $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$. Thus, each of the last 30 years start from a different state. The repeated simulations allows us to construct a panel dataset with a cross-section of 10,000 data points in each year. Output volatility in a particular year is the standard deviation of the 10,000 cross-sectional points for that year. The volatility measure is then normalized by dividing it by the mean of output in that year (cross-sectional average over the 10,000 output values for the year). Thus, our measure of output volatility in a year is the cross-sectional coefficient of variation of the 10,000 output points in that year. We do this first with the baseline model where financial markets are integrated, and then we do it again with the model without financial integration (autarky).

Figure 7 plots the output volatility in percent of the mean with and without financial integration. Panel (a) is for advanced economies and Panel (b) is for emerging economies.

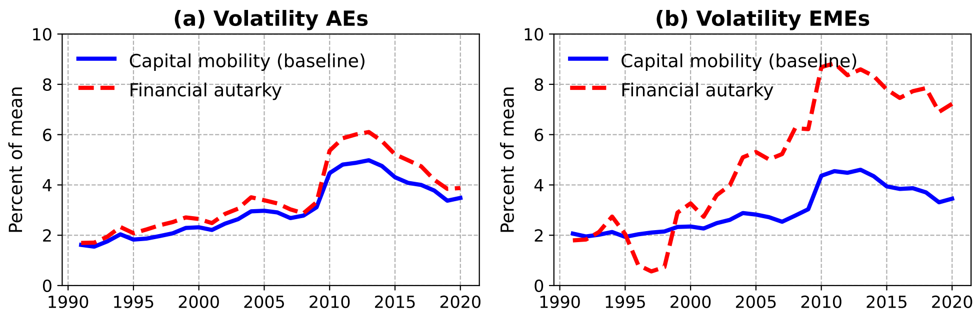

FIGURE 7.—Output volatility, 1991-2020. The volatility measure is the coefficient of variation of the 10,000 values of output generated by the repeated simulations of the model for each calendar year (i.e., the standard deviation divided by the mean of the 10,000 values of output of each year).

The first result that emerges in Figure 7 is that the model generates an increase in volatility over the 1991-2020 period in both advanced and emerging economies. This is a consequence of the increase in leverage. As shown in the first panel of Figure 4, domestic credit in percentage of GDP has increased in both AEs and EMEs. This is captured in the model by the increase in the time-varying parameters $\phi_{j,t}$. This causes a decline in the equilibrium interest rate which then incentivizes more issuance of debt. In short, the economy becomes more levered over time, and when a crisis hits there is more redistribution of wealth away from entrepreneurs with stronger macroeconomic consequences.

But the central question of the paper is whether macroeconomic volatility would have been different in the two regions in absence of financial integration. We can answer this question by comparing the continuous line (financial integration) with the dashed line (financial autarky) in Figure 7. Panel (a) shows that, without integration, advanced economies would have experienced only a slightly higher volatility. Thus, even if AEs added riskier securities in their asset portfolio by holding EME's securities (which are defaulted with higher probability), the diversification benefit of adding securities with independent returns reduced the overall portfolio and macroeconomic risk. For emerging economies, instead, the benefits of financial integration in terms of lower volatility was much bigger. Financial integration allowed EMEs to diversify their financial portfolio by adding securities issued by AEs that are safer (lower probability of default) and less correlated with their domestic securities. In absence of financial integration, the macroeconomic volatility of emerging economies would have been twice as large.

Before concluding, we note two important caveats in our analysis. First, in both the baseline and the financial autarky counterfactual, we use the same sequences of $z_{j,t}$, $\phi_{j,t}$, $\kappa_{j,t}$, and $K_{j,t}$ used in the baseline calibration. This calibration was done using the model with full financial integration and targeting data on GDP, labor, capital, credit, gross foreign assets and real interest rate for the 1991-2020 period. This period was characterized by high international capital mobility. To the extent that these observed outcomes are endogenous to financial integration, the values of $z_{j,t}$, $\phi_{j,t}$, $\kappa_{j,t}$, and $K_{j,t}$ could have been affected by the international capital regime. The counterfactual we conducted abstracts from the possible endogeneity of these parameters.

Second, the gross foreign assets of EMEs used as calibration targets include foreign reserves, which are risk-free government bonds issued by AEs, largely short-term U.S. treasuries. These are not subject to default, differently from the debt held by firms in the model. In Mendoza and Quadrini (2024), we introduce both foreign reserves holdings by EMEs and public debt issued by AEs in a similar setup, with entrepreneurs holding both private defaultable debt and riskless government debt. Entrepreneurs still hold a diversified portfolio because of the uncorrelated risk of the private and public debt, and are still exposed to cross-country spillovers when foreign private borrowers default. That paper, however, has a different focus centered on an externality that emerges on the accumulation of foreign reserves by EMEs: Individually, EMEs may see a benefit from accumulating reserves to provide bailouts to entrepreneurs when a crisis hits. However, they do not internalize that, when all EMEs accumulate reserves, the world real interest rate falls, thereby increasing leverage and making themselves more vulnerable to financial crises.

4. CONCLUSION

Financial integration could lead to significant cross-country risk-sharing by allowing for the international diversification of portfolios. Through portfolio diversification, however, countries also become more vulnerable to adverse spillovers: a financial crisis that originates in one country or region can be transmitted to others. To the extent that financial integration occurs between countries that are fairly homogeneous and exhibit similar degrees of financial stability, it is reasonable to expect that macroeconomic volatility should fall. However, if integration takes place among countries with differing degrees of financial stability, it may actually lead to higher macroeconomic instability in some of them. This could be the case, for example, with the integration of advanced and emerging economies.

We have documented that financial crises have been more frequent in emerging economies than in advanced ones, making investments in EMEs riskier. This implies that the diversification of AEs' portfolios with assets issued by EMEs could increase the macroeconomic volatility of advanced economies. On the one hand, the addition of EMEs' assets makes AEs' portfolios less volatile due to the imperfect correlation of returns between domestic and foreign assets. On the other hand, EMEs' assets are riskier and could make AEs' portfolios more volatile. Since these are two contrasting effects, whether advanced economies become more or less volatile by integrating with emerging economies is a quantitative question.

Our quantitative analysis, based on a two-region model, shows that the first effect (more uncorrelated assets) dominates the second (more volatile assets). However, while for AEs the two effects are of similar magnitude—so that the overall change in volatility is small—for EMEs, the benefits of international diversification are much larger. Thus, in terms of macroeconomic stability, we find that emerging economies have benefited substantially from becoming financially integrated with advanced economies.

Our results should be interpreted with some caution. Our model assumes that the probability of crises in EMEs is not affected by their degree of integration in international financial markets. This assumption overlooks the view that at least some financial crises in EMEs are caused by capital flight driven by reversals in international investment. These types of crises, of course, can only occur if a country is financially integrated into global financial markets. Although we cannot rule out the possibility that such crises do emerge in certain countries, crises are also recurrent in countries that tend to be relatively insulated from international financial markets. More generally, it is difficult to dismiss the view that financial investments in EMEs tend to be riskier than in AEs.

APPENDIX A: SAVING AND PORTFOLIO CHOICES OF ENTREPRENEURS

Since profits can be expressed as $\hat{\xi}_{j,t} m_{j,t}$ and end-of-period wealth is the sum of financial wealth and profits, it follows that $a_{j,t} = (1 + \hat{\xi}_{j,t}) m_{j,t}$. Using this result and the definition of beginning-of-period wealth, $m_{j,t} = \delta_{1,t} b_{1,j,t} + \delta_{2,t} b_{2,j,t}$, we can write the end-of-period wealth at time t and at $t+1$ as

$$a_{j,t} = (1 + \hat{\xi}_{j,t})(\delta_{1,t} b_{1,j,t} + \delta_{2,t} b_{2,j,t}),$$
$$a_{j,t+1} = (1 + \hat{\xi}_{j,t+1})(\delta_{1,t+1} b_{1,j,t+1} + \delta_{2,t+1} b_{2,j,t+1}).$$

The first-order conditions in Problem (9) with respect to $b_{1,j,t+1}$ and $b_{2,j,t+1}$ return

$$\frac{\omega_{1,j} q_{1,t}}{c_{j,t}} = \beta \mathbb{E}_t \left(\frac{(1 + \hat{\xi}_{j,t+1}) \delta_{1,t+1}}{c_{j,t+1}} \right), \quad \frac{\omega_{2,j} q_{2,t}}{c_{j,t}} = \beta \mathbb{E}_t \left(\frac{(1 + \hat{\xi}_{j,t+1}) \delta_{2,t+1}}{c_{j,t+1}} \right). \quad (15)$$

The right-hand-sides of the Euler equations reflect again the convenience yield of financial wealth. The marginal benefit of buying bonds at t to carry over to $t+1$ increases by $(1 + \hat{\xi}_{j,t+1})$ if the working capital constraint binds, because holding additional bonds relaxes the constraint. This is in addition to the contractual yield of each of the bonds (the reciprocal of their prices augmented by the investment wedge). As shown earlier, the convenience yield is equal to profits per unit of financial wealth, but in terms of expected profits for $t+1$.

We now guess that optimal consumption is a fraction $1 - \beta$ of wealth, that is, $c_{j,t} = (1 - \beta) a_{j,t}$. Its complement, the saved wealth, is then allocated to bonds issued by country 1 and country 2. Denoting by $\theta_{j,t}$ the share allocated to bonds issued by country 1, we have

$$\omega_{1,j} q_{1,t} b_{1,j,t+1} = \theta_{j,t} \beta a_{j,t}, \qquad \omega_{2,j} q_{2,t} b_{2,j,t+1} = (1 - \theta_{j,t}) \beta a_{j,t}. \quad (16)$$

We now multiply the two equations in (15) by $b_{1,j,t+1}$ and $b_{2,j,t+1}$ respectively. Adding the resulting expressions and using the equations for consumption and next period wealth, we obtain $\omega_{1,j} q_{1,t} b_{1,j,t+1} + \omega_{2,j} q_{2,t} b_{2,j,t+1} = \beta a_{j,t}$. This is satisfied given (16). Since we derived this condition from the Euler equations in (15), we have proved that, if consumption is a fraction $1 - \beta$ of wealth, the two Euler equations are satisfied. This verifies our guess.

We now replace the guess for $c_{j,t}$ into equations (15) to obtain

$$\mathbb{E}_t \left\{ \frac{\delta_{1,t+1}/\omega_{1,j}q_{1,t}}{\theta_{j,t}(\delta_{1,t+1}/\omega_{1,j}q_{1,t}) + (1-\theta_{j,t})(\delta_{2,t+1}/\omega_{2,j}q_{2,t})} \right\} = 1. \tag{17}$$

APPENDIX B: GENERAL EQUILIBRIUM

The set of aggregate states includes the bonds held by entrepreneurs, $B_{1,1,t}$, $B_{2,1,t}$, $B_{1,2,t}$, $B_{2,2,t}$, and the sunspot shocks $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$.[10] Additionally, it includes the sequences of productivity—$z_{1,t}$ and $z_{2,t}$—financial variables—$\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$ and $\kappa_{2,t}$—and capital stocks—$K_{1,t}$ and $K_{2,t}$. Since all of these variables are exogenous and perfectly anticipated, their full time sequence into the infinite future is part of the state space. Thus, the complete state vector is

$$\mathbf{s}_t \equiv (z_{1,t}^{\infty}, z_{2,t}^{\infty}, \phi_{1,t}^{\infty}, \phi_{2,t}^{\infty}, \kappa_{1,t}^{\infty}, \kappa_{2,t}^{\infty}, K_{1,t}^{\infty}, K_{2,t}^{\infty}, B_{1,1,t}, B_{2,1,t}, B_{1,2,t}, B_{2,2,t}, \varepsilon_{1,t}, \varepsilon_{2,t}).$$

where we denote the future history of a variable starting from date t into the infinite future with subscript t and superscript ∞.

The general equilibrium results from market clearing in three markets: (1) market for liquidated capital; (2) market for labor (and intermediate goods); (3) market for financial assets. We can think of these three markets as clearing sequentially and for exposition purposes it will be convenient to describe them separately.

1. **Market for liquidated capital**: The sunspot shock $\varepsilon_{j,t}$ is observed. If $\varepsilon_{j,t} = 0$, the liquidation price of capital drops to $\kappa_{j,t} < 1$. If $\varepsilon_{j,t} = 1$, the price remains 1. Capital-intensive producers make their default decision and choose the fraction of the contracted debt that they repay

$$\delta_{j,t} = \begin{cases} \frac{\kappa_{j,t}K_{j,t}}{D_{j,t}}, & \text{if} \quad D_{j,t} \geq \kappa_{j,t}K_{j,t} \text{ and } \varepsilon_{j,t} = 0 \\ \\ 1, & \text{otherwise} \end{cases}.$$

The aggregate post-default wealth of entrepreneurs is $M_{j,t} = \delta_{1,t}B_{1j,t} + \delta_{2,t}B_{2j,t}$. As explained earlier, a financial crisis occurs when $\delta_{j,t} < 1$, and this requires two

[10] The aggregate debt issued by capital-intensive firms does not need to be included here because it can be calculated as $D_{1,t} = B_{11,t} + B_{12,t}$ and $D_{2,t} = B_{21,t} + B_{22,t}$.

conditions. First, a fundamental cause, namely that debt or effective leverage must be large enough ($D_{j,t} \geq \kappa_{j,t} K_{j,t}$). Second, a non-fundamental or multiple-equilibria cause, namely that the realization of the sunspot shock is $\varepsilon_{j,t} = 0$, which is the one that coordinates expectations on the liquidation price of capital being $\kappa_{j,t}$. Because of this, the probability of a crisis changes as the debt issued by borrowers in region j changes. Given the stock of capital $K_{j,t}$, the crisis probability is zero when the debt $D_{j,t} < \kappa_{j,t} K_{j,t}$, then it rises to λ when $D_{j,t} \geq \kappa_{j,t} K_{j,t}$. For $D_{j,t} > K_{j,t}$, a crisis would occur with probability 1, but this never happens at equilibrium.

2. **Market for labor (and intermediate goods)**: Aggregate production aggregates the intermediate inputs produced by capital- and labor-intensive firms, that is, $Y_{j,t} = X_{j,t}^{1-\gamma} N_t^{\gamma}$. The prices of the two intermediate inputs correspond to their respective marginal products,

$$p_{j,t}^X = \frac{(1-\gamma) Y_{j,t}}{X_{j,t}}, \qquad\qquad p_{j,t}^N = \frac{\gamma Y_{j,t}}{N_{j,t}}.$$

   These two equations are the demands for the two intermediate inputs, and they are inversely related to their corresponding prices.

   The production of capital-intensive firms is $X_{j,t} = z_{j,t} K_{j,t}$, while the production of labor-intensive firms depends on whether the working capital constraint binds or not. If it binds, production is given by $N_{j,t} = \left(\frac{z_{j,t}}{\phi_{j,t} w_{j,t}}\right) M_{j,t}$. If it does not bind, production is demand-determined. Inverting the price equation above we obtain $N_{j,t} = \frac{\gamma Y_{j,t}}{p_{j,t}^N}$.

   The demand for labor from labor-intensive firms is obtained by inverting the production function, $L_{j,t} = \frac{N_{j,t}}{z_{j,t}}$, and the supply of labor comes from the household's first-order condition (1), $H_{j,t} = \left(\frac{w_{j,t}}{z_{j,t-1}^{1/\gamma}}\right)^{\nu}$. Market-clearing in the labor market determines the wage rate $w_{j,t}$, and market-clearing in the inputs markets determines the prices of intermediate goods $p_{j,t}^X$ and $p_{j,t}^N$.

3. **Market for financial assets**: The wealth of entrepreneurs at the end of the period is given by $A_{j,t} = M_{j,t} + p_{j,t}^N N_{j,t} - w_{j,t} L_{j,t}$. A fraction $1 - \beta$ is consumed while the remaining fraction β is saved in new bonds, with a fraction $\theta_{j,t}$ allocated to bonds issued in region 1 and a fraction $1 - \theta_{j,t}$ to bonds issued in region 2. Capital-intensive

producers choose the new debt $D_{j,t+1}$. Market-clearing in financial markets requires $B_{j,1,t+1} + B_{j,2,t+1} = D_{j,t+1}$.

As noted earlier, the borrowing decisions of capital-intensive firms (equation (6)) determines the supply of bonds,

$$\frac{1}{\overline{R}_{j,t}} = \beta + \Phi\left(\frac{D_{j,t+1}}{\kappa_{j,t+1}K_{j,t+1}}\right).$$

Competition in financial markets makes bond prices consistent with their expected return, that is, $q_{j,t} = \frac{\mathbb{E}_{t+1}\delta_{j,t+1}}{\overline{R}_{j,t}}$. Using this expression to replace the expected return $\overline{R}_{j,t}$ in the above supply-of-bonds condition, we can write the bond price as

$$q_{j,t} = \left[\beta + \Phi\left(\frac{D_{j,t+1}}{\kappa_{j,t+1}K_{j,t+1}}\right)\right]\mathbb{E}\delta_{j,t+1}. \tag{18}$$

Keep in mind that expectations of future repayment affect $q_{j,t}$ not only directly, but also indirectly via their effect on the function $\Phi(\cdot)$.

B.1. *Sequential property of the equilibrium and system of equations at time t*

As highlighted in the main body of the paper, the *sequential property* of the equilibrium allows us to solve for date-t equilibrium independently of future equilibrium outcomes. Given the state vector $\mathbf{s}_t$, the equilibrium values of all date-t endogenous variables can be solved using a system of nonlinear equations that contains only equilibrium conditions at date t. More specifically, given the values of $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$, $\kappa_{2,t}$, $\kappa_{1,t+1}$, $\kappa_{2,t+1}$, $K_{1,t}$, $K_{2,t}$, $K_{1,t+1}$, $K_{2,t+1}$, and the stochastic states $\mathbf{s}_t$, we can find the values of $\delta_{j,t}$, $M_{j,t}$, $L_{j,t}$, $w_{j,t}$, $p_{j,t}$, $q_{j,t}$, $A_{j,t}$, $B_{j,1,t+1}$, $B_{j,2,t+1}$, $D_{j,t+1}$, $p^N_{j,t}$ and $\theta_{j,t}$, by solving the system of equations:

$$\delta_{j,t} = \begin{cases} \min\left\{1\,,\ \frac{\kappa_{j,t}K_{j,t}}{D_{j,t}}\right\}, & \text{if} \quad \varepsilon_{j,t} = 0 \\ \\ 1, & \text{if} \quad \varepsilon_{j,t} = 1 \end{cases} \tag{19}$$

$$M_{j,t} = \delta_{1,t}B_{1,t} + \delta_{2,t}B_{2,t} \tag{20}$$

$$L_{j,t} = \left(\frac{\gamma}{\phi_{j,t}w_{j,t}}\right)M_{j,t}, \tag{21}$$

$$p^N_{j,t} = \gamma L^{\gamma-1}_{j,t}K^{1-\gamma}_{j,t}, \tag{22}$$

$$L_{j,t} = \left(\frac{w_{j,t}}{z_{j,t}^{1/\gamma}} \right)^{\nu}, \tag{23}$$

$$A_{j,t} = M_{j,t} + \left(p_{j,t}^{N} z_{j,t} - w_{j,t} \right) L_{j,t}, \tag{24}$$

$$B_{1,j,t+1} = \frac{\theta_{j,t} \beta A_{j,t}}{\omega_{1,j} q_{1,t}}, \tag{25}$$

$$B_{2,j,t+1} = \frac{(1-\theta_{j,t}) \beta A_{j,t}}{\omega_{2,j} q_{2,t}}, \tag{26}$$

$$1 = \mathbb{E}_t \left\{ \frac{\frac{\delta_{1,t+1}}{\omega_{1,j} q_{1,t}}}{\theta_{j,t} \frac{\delta_{1,t+1}}{\omega_{1,j} q_{1,t}} + (1-\theta_{j,t}) \frac{\delta_{2,t+1}}{\omega_{2,j} q_{2,t}}} \right\}, \tag{27}$$

$$D_{j,t+1} = B_{j1,t+1} + B_{j2,t+1}, \tag{28}$$

$$q_{j,t} = \left[\beta + \Phi \left(\frac{D_{j,t+1}}{\kappa_{j,t+1} K_{j,t+1}} \right) \right] \mathbb{E}_t \delta_{j,t+1}. \tag{29}$$

Equation (19) defines the optimal renegotiation strategy (the fraction of the debt repaid). Equation (20) defines entrepreneurial wealth after default. Equation (21) is the demand for labor from intermediate-goods firms. Equation (22) is the price of intermediate goods produced by labor-intensive firms. The price is the marginal productivity of intermediate goods in final output. Equations (23) is the supply of labor from households. Equation (24) defines the end-of-period wealth of entrepreneurs after production. This is allocated to bonds issued by the two countries as indicated in equations (25) and (26). Equation (27) is the condition that determines the investment share $\theta_{j,t}$. This is the Euler equation derived from the optimization problem of entrepreneurs. Equation (28) is the equilibrium condition in the bond market. Equation (29) is the Euler equation for the choice of debt from capital-intensive firms. This condition determines the price of bonds.

The above system determines all equilibrium variables in period t independently of the values of these variables and states in future periods. We would like to point out that this would not be the case if capital was endogenous.

APPENDIX C: SENSITIVITY TO THE COST OF BORROWING, η

We show here the sensitivity of the main results to the parameter η which determine the elasticity of the borrowing cost to debt. In particular, we compare the results when η increases from 0.1 in the baseline calibration to 0.2. A higher value of η makes the cost of borrowing more responsive to the debt and, therefore, borrowing become less responsive.

The top panel of Figure C.1 plots the output volatility generated by the model when η is set to the baseline value of 0.1. This is the same graph shown earlier in Figure 7. The bottom panel, instead, plots volatility when η is increased to 0.2.

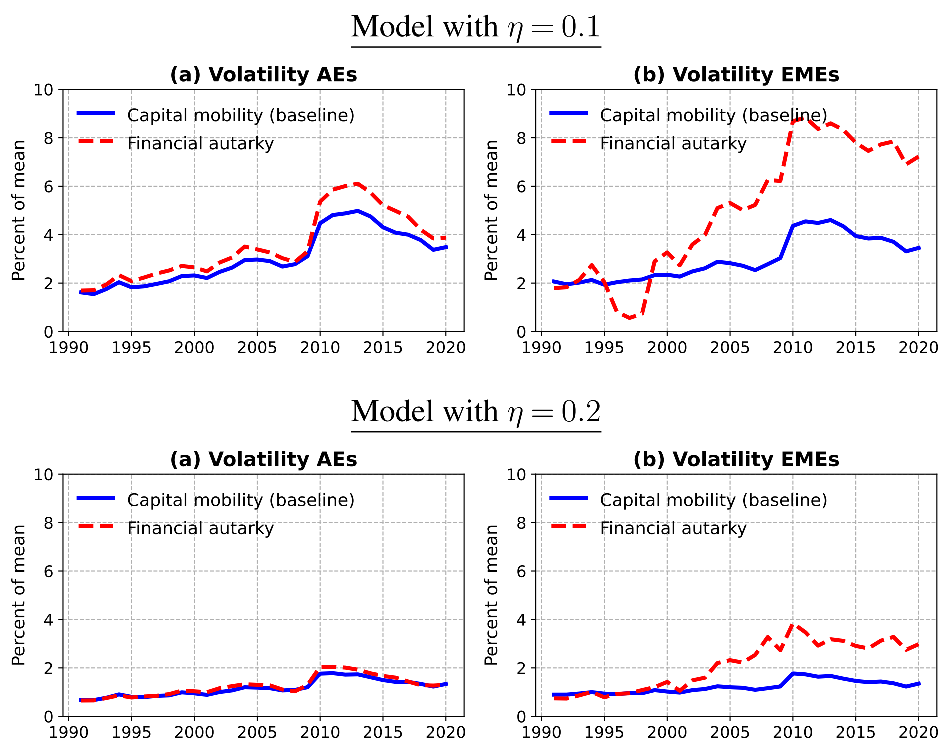

FIGURE C.1.—Output volatility with and without capital mobility when $\eta = 0.1$ and $\eta = 0.2$.

A comparison of the bottom panels with the top panels reveals that output volatility decreases when η is higher. This is because a higher value of η reduces the elasticity of debt with respect to changes in the interest rate. However, the main results of the paper remain unchanged: the impact of capital mobility on the aggregate volatility of AEs is relatively small. For EMEs, by contrast, capital mobility is associated with a relatively large decline in volatility.

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