The growth of emerging economies and global macroeconomic instability

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VERY PRELIMINARY AND INCOMPLETE

Abstract

This paper studies how the unprecedent growth within emerging countries during the last two decades has affected macroeconomic stability in both emerging and industrialized countries. The paper develops a two-region model where crises are more likely and/or more severe when leverage increases. By raising the worldwide 'net demand' of financial assets, the growth of emerging countries raises the incentive to leverage, which in turn contributes to higher financial and macroeconomic instability in both industrialized and emerging economies.

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1 Introduction

During the last two and half decades we have witnessed unprecedent growth within emerging countries. As a result of the sustained growth, the size of their economies has increased dramatically compared to industrialized countries. The top panel of Figure 1 shows that, in PPP terms, the GDP of emerging countries at the beginning of the 1990s was 46 percent the GDP of industrialized countries. This number has increased to 90 percent by 2011. When the GDP comparison is based on nominal exchange rates, the relative size of emerging economies has increased from 17 to 52 percent.

During the same period, emerging economies have increased their net holdings of foreign financial assets. As the second panel of Figure 1 shows, starting in the second half of 1990s, emerging countries have experienced current account surpluses while industrialized countries have experienced current account deficits. Also significant is the fact that the foreign assets acquired by emerging countries were concentrated in safer asset classes.

It is customary to divide foreign assets in four classes: (i) debt instruments and international reserves; (ii) portfolio investments; (iii) foreign direct investments; (iv) other investments (see Gourinchas and Rey (2007) and Lane and Milesi-Ferretti (2007)). The net foreign position in the first class of assets—debt and international reserves—is plotted in the bottom panel of Figure 1, separately for industrialized and emerging countries. As can be seen from the figure, since the early 1990s, emerging countries have accumulated 'positive' net positions in this particular asset class while industrialized countries have accumulated 'negative' net positions.

There are several theories proposed in the literature to explain why emerging economies accumulate financial assets issued by industrialized countries.[1]

[1] One explanation posits that emerging countries have pursued policies aimed at keeping their currencies undervalued and, to achieve this, they have purchased large volumes of foreign financial assets, especially securities issued by foreign governments. Another explanation is based on differences in the characteristics of financial markets. The idea is that lower financial development in emerging countries impairs their ability to create viable saving instruments for intertemporal smoothing (Caballero, Farhi, and Gourinchas (2008)) or for insurance purpose (Mendoza, Quadrini, and Ríos-Rull (2009)). Because of these limitations, they turn to industrialized countries for the acquisition of these saving instruments. A third explanation is based on greater idiosyncratic uncertainty faced by consumers and firms in emerging countries due, for example, to higher idiosyncratic risk or lower safety net provided by the public sector. Theoretical contributions include Carroll and Jeanne (2009), Angeletos and Panousi (2011), Song, Storesletten, and Zilibotti

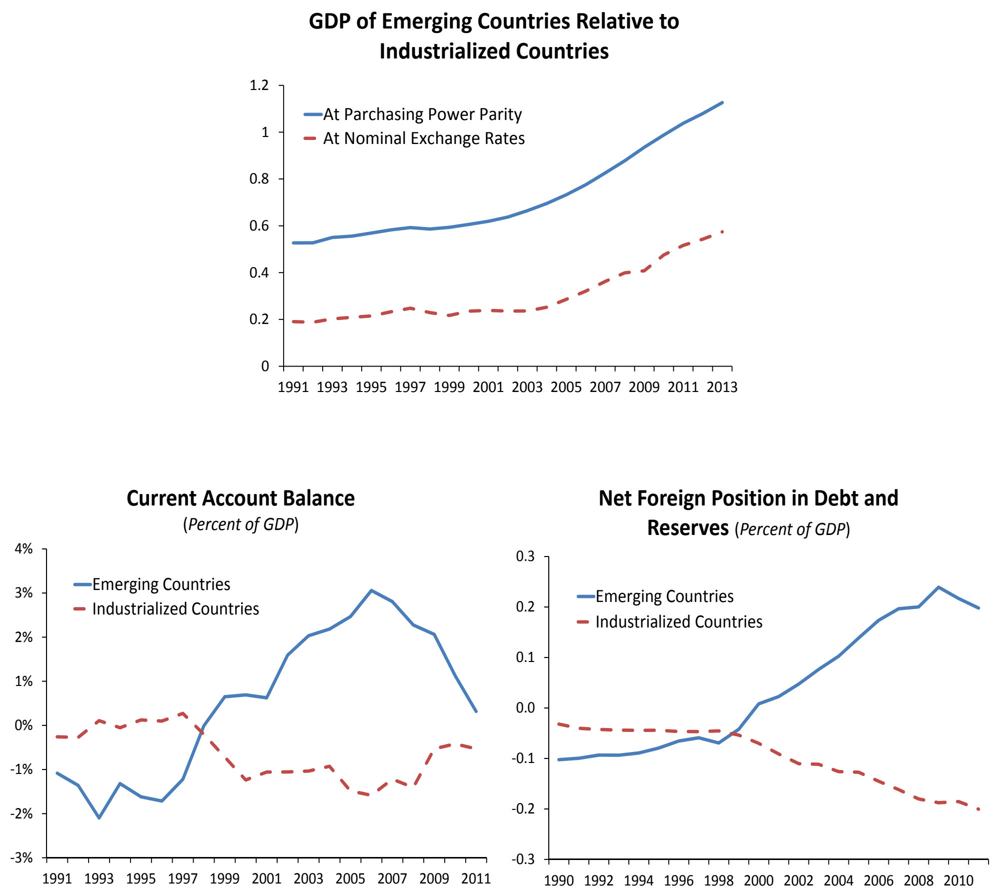

Figure 1: Gross domestic product and net foreign positions in debt instruments and international reserves of emerging and industrialized countries. **Emerging countries**: Argentina, Brazil, Bulgaria, Chile, China, Hong.Kong, Colombia, Estonia, Hungary, India, Indonesia, South Korea, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Ukraine, Venezuela. **Industrialized countries**: 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**: World Development Indicators (World Bank) and External Wealth of Nations Mark II database (Lane and Milesi-Ferretti (2007)).

The primary goal of this paper, however, is not to explain why emerging countries acquire net financial assets issued by industrialized countries. Instead,

(2011), Sandri (2014), Bacchetta, Benhima, and Poilly (2018), Fogli and Perri (2015).

it investigates how the increase in the demand for financial assets that results from the growing size of emerging economies affects financial and macroeconomic stability in both emerging and industrialized countries. More specifically, the goal is not to explain global imbalances but to understand the macroeconomic consequences of the imbalances.

To address this question I develops a two-region model—one representative of emerging countries and the other representative of industrialized countries—where in each region there is a borrowing sector (households) and a lending sector (entrepreneurs). An important difference between emerging and industrialized countries is that the borrowing sector has lower ability to issue debt. A financial crisis creates the conditions for the renegotiation of liabilities and, therefore, it generates a redistribution of wealth from lenders to borrowers. It is through the wealth redistribution that a financial crisis generates real macroeconomic effects. Furthermore, these effects become more likely and/or larger when leverage increases.

The growth of emerging countries increases the world demand for financial assets more than the increase in supply. This drives down the world interest rate, increasing the incentives to leverage. But as countries in both regions levered up, a crisis becomes more likely and/or bigger. As long as the crisis does not materialize, the economy enjoys sustained levels of financial intermediation and economic activity. Eventually, however, a crisis will arise and, at that point, the contraction in overall economic activity will be more severe.

The organization of the paper is as follows. Section 2 describes the model and characterizes the equilibrium. Section 3 uses the model to study the central question addressed in the paper, that is, how the growth of emerging economies affects financial and macroeconomic stability in both emerging and industrialized countries. Section 4 concludes.

2 Model

There are two countries/regions indexed by $j \in \{1, 2\}$. The first country is representative of industrialized economies and the second is representative of emerging economies. In each country there are two sectors: the entrepreneurial sector and the household sector.

Countries are heterogeneous in two dimensions: (i) economic size captured by differences in aggregate productivity $A_{j,t}$; and (ii) financial market development captured by a parameter κ_j. While productivity changes over time, financial market development remains constant. This explains the time subscript in $A_{j,t}$ but not in κ_j. Although changes in the relative size of countries could also be generated by other factors besides productivity (for example population growth, investment, real exchange rates), in the model these additional changes are isomorphic to productivity changes. This will become clear in the quantitative section.

The assumption that only cross-country productivity (as a proxy for economic size) changes over time while differences in financial markets development do not change, is justified by the main question addressed in this paper, that is, how the economic growth of emerging countries impacts financial and macroeconomic stability. In order to isolate the effect of the change in economic size from other factors, I keep everything else constant, including the financial characteristics of these countries. As we will see, financial heterogeneity plays an important role in the way in which the growth of emerging countries affects global macroeconomic stability.

2.1 Entrepreneurial sector

In each country there is a unit mass of atomistic entrepreneurs, indexed by i, with lifetime utility

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

where $c^i_{j,t}$ is the consumption of entrepreneur i in country j at time t.

Entrepreneurs are business owners producing a single good with the production technology described below. Although the model is presented as if all firms are privately owned, we should think of the entrepreneurial sector more broadly and including public companies. In this case consumption should be thought as dividends paid by the firm and the concavity of the utility function captures the risk aversion of managers or major shareholders. It can also be interpreted as capturing, in reduced form, the costs associated with financial distress: even if shareholders and managers are risk-neutral, a convex cost of financial distress would make the objective of the firm concave.

Each entrepreneur operates the production technology

$$y^i_{j,t} = z^i_{j,t} h^i_{j,t},$$

where $h^i_{j,t}$ is the input of labor supplied by households in country j at the market wage $w_{j,t}$, and $z^i_{j,t}$ is productivity.

The productivity of a firm is the product of two components, that is, $z^i_{j,t} = A_{j,t}\pi^i_{j,t}$. The first component, $A_{j,t}$, is the aggregate country-specific productivity and the second, $\pi^i j, t$, is an idiosyncratic shock. The aggregate productivity $A_{j,t}$ is the same for all entrepreneurs of the same country and follows a stochastic process that will be specified later. Growth in the economic size of a country will be captured by higher values of $A_{j,t}$. The idiosyncratic component, $\pi^i_{j,t} \in [\underline{\pi}, \overline{\pi}]$, is an idiosyncratic shock independently and identically distributed among entrepreneurs and over time with probability distribution $\Gamma(\pi)$. Notice that the distribution of the idiosyncratic shock is the same in the two countries. Therefore, the production technology differs across countries only in the aggregate productivity $A_{j,t}$.

As in Arellano, Bai, and Kehoe (2011), the input of labor $h^i_{j,t}$ is chosen before observing $z^i_{j,t}$ (and its components $A_{j,t}$ and $\pi^i_{j,t}$). This implies that the choice of labor is risky. To insure consumption smoothing, entrepreneurs have access to a market for non-contingent bonds at price q_t. As we will see, bonds held by entrepreneurs are the liabilities issued by banks. Notice that the price of bonds does not have the subscript j because capital mobility implies that the price is equalized across countries. Since the bonds cannot be contingent on the realization of productivity $z^i_{j,t}$, they provide only partial insurance.

Appendix A presents the micro-foundation for the limited insurability of productivity shocks and shows that the economy studied here is equivalent to an economy where entrepreneurs have access to state contingent claims but financial contracts are not perfectly enforceable.

An entrepreneur i in country j enters period t with bonds issued in country 1, $b^i_{1j,t}$, and bonds issued in country 2, $b^i_{2j,t}$. The first subscript denotes the country that issued the bonds while the second subscript denotes the residency of the entrepreneur. In the event of a financial crisis, the entrepreneur incurs financial losses that are proportional to the owned bonds. Denoting by $\delta_{1,t}$ and $\delta_{2,t}$ the unit loss realized at the beginning of the period on bonds issued by country 1 and 2, respectively, the residual value of the two bonds are $\tilde{b}^i_{1j,t} = (1-\delta_{1,t})b^i_{1j,t}$ and $\tilde{b}^i_{2j,t} = (1-\delta_{2,t})b^i_{2j,t}$. The unit losses $\delta_{1,t}$ and $\delta_{2,t}$ are endogenous stochastic variables and will be determined in the general equilibrium as described later.

Given the residual wealth $\tilde{b}^i_{1j,t} + \tilde{b}^i_{1j,t}$, the entrepreneur chooses the input of labor $h^i_{j,t}$. Then, after the observation of $z^i_{j,t}$, the entrepreneur chooses consumption $c^i_{j,t}$ and purchases the new bonds $b^i_{1j,t+1}$ and $b^i_{2j,t+1}$ at prices $q_{1,t}$

and $q_{2,t}$. The budget constraint, after the realization of productivity, is

$$c^i_{j,t} + q_{1,t}b^i_{1j,t+1} + q_{2,t}b^i_{2j,t+1} = \tilde{b}^i_{1j,t} + \tilde{b}^i_{2j,t} + (z^i_{j,t} - w_{j,t})h^i_{j,t}. \tag{1}$$

Because labor $h^i_{j,t}$ is chosen before the realization of $z^i_{j,t}$, while the saving decision is made after observing $z^i_{j,t}$, it will be convenient to define $a^i_{j,t} = \tilde{b}^i_{1j,t} + \tilde{b}^i_{2j,t} + (z^i_{j,t} - w_{j,t})h^i_{j,t}$ the entrepreneur's wealth after production. Given the timing assumption, the input of labor $h^i_{j,t}$ depends on $\tilde{b}^i_{1j,t} + \tilde{b}^i_{2j,t}$ while the portfolio decisions $b^i_{1j,t+1}$ and $b^i_{2j,t+1}$ depend on $a^i_{j,t}$. To further clarify the decision timing, it would be convenient to think of a period as divided in three subperiods:

1. **Subperiod 1**: The entrepreneur enters with financial assets $b^i_{1j,t}$ and $b^i_{2j,t}$, and observes the variables $\delta_{1,t}$ and $\delta_{2,t}$. The realization of financial losses brings the residual value of assets to $\tilde{b}^i_{1j,t} = (1-\delta_{1,t})b^i_{1j,t}$ and $\tilde{b}^i_{2j,t} = (1-\delta_{2,t})b^i_{2j,t}$.

2. **Subperiod 2**: Given $\tilde{b}^i_{1j,t}$ and $\tilde{b}^i_{2j,t}$, the entrepreneur chooses the input of labor $h^i_{j,t}$ before knowing the idiosyncratic productivity $\pi^i_{j,t}$ and the aggregate productivity $A_{j,t}$.

3. **Subperiod 3**: Productivity $z^i_{j,t} = A_{j,t}\pi^i_{j,t}$ is realized. The end-of-period wealth $a^i_{j,t} = \tilde{b}^i_{1j,t} + \tilde{b}^i_{2j,t} + (z^i_{j,t} - w_{j,t})h^i_{j,t}$ is in part spent for consumption, $c^i_{j,t}$, and in part saved to purchase new bonds, $q_{1,t}b^i_{1j,t+1} + q_{2,t}b^i_{2j,t+1}$.

Lemma 2.1 *Let $\phi_{j,t}$ satisfy the condition $\mathbb{E}_{z^i_{j,t}}\left\{\frac{z^i_{j,t}-w_{j,t}}{1+(z^i_{j,t}-w_{j,t})\phi_{j,t}}\right\} = 0$. The optimal entrepreneur's policies are*

$$\begin{aligned}
h^i_{j,t} &= \phi_{j,t}(\tilde{b}^i_{1j,t} + \tilde{b}^i_{2j,t}), \\
c^i_{j,t} &= (1-\beta)a^i_{j,t}, \\
q_{1,t}b^i_{1j,t+1} &= \beta\theta_t a^i_{j,t}, \\
q_{2,t}b^i_{2j,t+1} &= \beta(1-\theta_t)a^i_{j,t},
\end{aligned}$$

Proof 2.1 *See Appendix B.*

The demand for labor, which is chosen before observing the realization of productivity, is linear in financial wealth $\tilde{b}^i_{j,t}$. The proportional factor $\phi_{j,t}$ is defined by the condition $\mathbb{E}_{z^i_{j,t}}\left\{\frac{z^i_{j,t}-w_{j,t}}{1+(z^i_{j,t}-w_{j,t})\phi_{j,t}}\right\}=0$, which is the same for all entrepreneurs of the same country (but could differ across countries because of difference in aggregate productivity).

The factor $\phi_{j,t}$ captures the importance of risk aversion for determining the demand of labor. Because productivity is unknown when an entrepreneur chooses the scale of production, labor is risky and entrepreneurs require a premium in order to produce. As a result, the expected marginal product of labor is bigger than the wage rate, that is, $\mathbb{E}_t z^i_{j,t} > w_{j,t}$. Furthermore, higher is the expected unit profit and higher is the scale of production $\phi_{j,t}$. On the other hand, if we fix the expected unit profit, the scale of production decreases with the volatility of productivity, that is, it decreases with risk.

Since the distribution of productivity (aggregate and idiosyncratic) is fixed in the model, the only 'endogenous' variable that affects $\phi_{j,t}$ is the wage rate $w_{j,t}$. I make this explicit by using the function $\phi_{j,t}(w_{j,t})$, which is strictly decreasing in the (country) wage rate.

Lemma 2.1 also indicates that entrepreneurs split their end-of-period wealth in consumption and savings according to the fixed factor β. This is a property that derives from the log specification of the utility function. Finally, a fraction θ_t of savings are allocated to the purchase of country 1 bonds and the remaining fraction $1-\theta_t$ to country 2 bonds. This fraction changes over time. However, it is the same for entrepreneurs of country 1 and 2, which is indicated by the fact that θ_t does not have the j subscript. Essentially, entrepreneurs choose the composition of portfolio between bonds issued by country 1 and country 2.

The aggregate demand for labor in country j is derived by aggregating individual demands and can be written as

$$H_{j,t}=\phi_{j,t}(w_{j,t})\int_i(\tilde{b}^i_{1j,t}+\tilde{b}^i_{2j,t})=\phi_{j,t}(w_{j,t})\tilde{B}_{j,t},$$

where capital letters denote aggregate variables.

The aggregate demand for labor depends negatively on the wage rate—which is a standard property—and positively on the aggregate financial wealth of entrepreneurs even if they are not financially constrained—which is a special property of this model. Since hiring is risky, entrepreneurs are willing to hire more labor when they hold more financial wealth.

2.2 Household sector

In each country there is a unit mass of atomistic households with utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big(c_{j,t} - A_{j,t} h_{j,t} \Big),$$

where $c_{j,t}$ is consumption and $h_{j,t}$ is employment. Households are homogeneous and they do not face idiosyncratic shocks.

The assumption that households have linear utility in consumption simplifies the characterization of the equilibrium (allowing for some analytical results) without affecting the key properties of the model. As I will discuss below, as long as households do not face idiosyncratic risks (or the idiosyncratic risk is significantly lower than entrepreneurs), the model displays similar properties even if households are risk averse.

The linear specification of employment dis-utility can be justified with indivisibility of labor, which is often made in many business cycle studies. The dependence of the dis-utility from country-specific productivity $A_{j,t}$ guarantees balanced growth and can be justified by the assumption that improvements in productivity affect both market and homework production. Without this assumption employment would increase without bound as productivity improves.

Households hold an asset which is available in fixed supply $\overline{K}$. Each unit of the asset produces $A_{j,t}$ units of consumption goods to households but not to entrepreneurs. The productivity of the asset increases with the country-specific productivity, which guarantees balanced growth. The asset is divisible and can be traded by households at the market price $p_{j,t}$. I will interpret the fixed asset as residential houses and its production as housing services.[2]

Debt and default. Households can borrow $l_{j,t+1}/R_{j,t}$ where $R_{j,t}$ is the gross interest rate and $l_{j,t+1}$ is the 'promised' loan repayment. At the beginning of the next period, however, when the repayment $l_{j,t+1}$ is due, the household could default.

In the event of default, creditors have the right to liquidate the households assets $k_{j,t+1}$. However, the market value when the repayment is due may be

[2]In principle, I could allow entrepreneurs to hold and trade houses. However, if houses provide services only to households and renting them to households involves significant agency problems, in equilibrium entrepreneurs would choose not to hold them.

smaller than the loan, that is, $p_{j,t+1}k_{j,t+1} \leq l_{j,t+1}$. In particular, the economy may end up in a state in which the housing market may freeze and the market price drops dramatically to a lower bound $\underline{p}_t$ as I will describe later.

The distribution of the market price of houses, denoted by $f_{j,t}(p_{j,t+1})$, is an endogenous object that will be determined in the general equilibrium. The time subscript t indicates its dependence on the aggregate states of the economy (as specified later) and the subscript j indicates that the distribution is country specific. Since the price is an aggregate variable, individual agents take the distribution function $f_t(p_{t+1})$ as given.

Once the value of $p_{j,t}$ becomes known at the beginning of period t, households could use the threat of default to renegotiate the outstanding liabilities $l_{j,t}$. Of course, the debt will be renegotiated only if the household's liabilities are bigger than the liquidation value, that is, $l_{j,t} > p_t k_{j,t}$. Under the assumption that households have the whole bargaining power, the debt will be renegotiated to the liquidation value. Thus, the post-renegotiation debt is

$$\tilde{l}(l_{j,t}, p_{j,t}k_{j,t}) = \begin{cases} l_{j,t}, & \text{if} \quad l_{j,t} \leq p_t k_{j,t} \\ \\ p_t k_{j,t}, & \text{if} \quad l_{j,t} > p_t k_{j,t} \end{cases} . \tag{2}$$

Renegotiation implies a cost that takes the form

$$\varphi\left(\frac{l_{j,t}}{p_{j,t}k_{j,t}}\right) l_{j,t} = \begin{cases} 0, & \text{if} \quad l_{j,t} \leq p_{j,t}k_{j,t} \\ \\ \frac{1}{2}\left(\frac{l_{j,t}-p_{j,t}k_{j,t}}{l_{j,t}}\right)^2 l_{j,t}, & \text{if} \quad l_{j,t} > p_{j,t}k_{j,t} \end{cases} . \tag{3}$$

This specification is based on the idea that the renegotiation cost is increasing and convex in the size of the renegotiation, that is, $l_{j,t} - p_t k_{j,t}$.

The households' budget constraint, after renegotiation, can be written as

$$\tilde{l}(l_{j,t}, p_{j,t}k_{j,t}) + \varphi\left(\frac{l_{j,t}}{p_{j,t}k_{j,t}}\right) l_{j,t} + \Big(k_{j,t+1} - k_{j,t}\Big) p_{j,t} + c_{j,t} = \frac{l_{j,t+1}}{R_{j,t}} + w_{j,t}h_{j,t} + A_{j,t}k_{j,t}.$$

The gross interest rate $R_{j,t}$ is not taken as given by the household but it depends on the borrowing decision. If the household borrows more, relatively to the purchase of houses, the expected repayment rate could be lower in the next period. This will be reflected in a higher interest rate on the loan.

Denote by $\overline{R}_{j,t}$ the expected gross return from holding the debt issued in period t by 'all' households in country j and repaid in period $t+1$. This is the market return which is taken as given in a single transaction. Since households are atomistic and financial markets are competitive, the expected return on the debt issued by an 'individual' household must be equal to the aggregate expected return $\overline{R}_{j,t}$. Thus, the interest rate on the debt issued by an individual household must satisfy

$$\frac{l_{j,t+1}}{R_{j,t}} = \frac{1}{\overline{R}_{j,t}} \mathbb{E}_t \tilde{l}(l_{j,t+1}, p_{j,t+1} k_{j,t+1}). \tag{4}$$

The left-hand-side is the amount borrowed in period t while the right-hand-side is the expected repayment in period $t+1$, discounted by the market return $\overline{R}_{j,t}$. Since the household renegotiates in the next period if $l_{j,t+1} > p_{j,t+1}k_{j,t+1}$, the actual repayment $\tilde{l}_{j,t+1}(l_{j,t+1}, k_{j,t+1})$ could differ from $l_{j,t+1}$. Competition in financial intermediation requires that the left-hand-side of (4) is equal to the right-hand-side.

First order conditions. As for entrepreneurs, households' decisions are made in two steps with different information sets. The supply of labor is chosen before the realization of aggregate productivity, while borrowing decisions are made after the realization of $A_{j,t}$. Appendix C describes the households' problem and derives the following first order conditions

$$w_{j,t} = \mathbb{E}_t A_{j,t}, \tag{5}$$

$$\tfrac{1}{\overline{R}_{j,t}} = \beta \left[1 + \Phi_{j,t} \left(\tfrac{l_{j,t+1}}{p_{j,t+1}k_{j,t+1}} \right) \right], \tag{6}$$

$$p_{j,t} = \beta \mathbb{E}_t \left[A_{j,t+1} + p_{j,t+1} + \Psi_{j,t} \left(\tfrac{l_{j,t+1}}{p_{j,t+1}k_{j,t+1}} \right) \right]. \tag{7}$$

Since the supply of labor is chosen before the observation of productivity, the aggregate supply depends on the expected value of $A_{j,t}$. The functions $\Phi_{j,t}(.)$ and $\Psi_{j,t}$ are derived in the appendix. They are increasing functions of the leverage ratio $l_{j,t}/p_{j,t+1}k_{j,t+1}$. Thus, when leverage increases, the expected return on household debt must decline while the return from owning houses increases. Another way to interpret these conditions is that, when the interest rate paid by households declines, they become more leveraged and the price of houses increases.

2.3 Housing market freeze and price

The structure of the market for liquidated capital is specified by two assumptions.

Assumption 1 *If houses are liquidated, they can be sold either to other domestic households or entrepreneurs. If sold to entrepreneurs (or foreign households), houses lose their functionality and will be converted to consumption goods at rate* $\kappa_j A_{j,t-1} \equiv \underline{p}_{j,t}$.

The assumption formalizes the idea that houses may lose their functionality if they are reconverted to other uses, which in the model is proxied by the conversion to consumption goods. The parameter κ_j is country specific and determines the liquidation price of houses in the eventuality that the housing market freezes. I think of this parameter as capturing cross-country differences in the development of local financial markets.

The dependence of the conversation rate on productivity guarantees balanced growth. It is the lagged aggregate productivity because at the beginning of period t, when default could take place, $A_{j,t}$ is still unknown.[3]

Assumption 2 *Households can purchase houses only if* $l_{j,t} < p_{j,t} k_t$.

If a household starts with liabilities that are bigger than the liquidation value of its assets, that is, $l_{j,t} > p_{j,t} k_{j,t}$, the household will be unable to raise additional funds to purchase the liquidated assets of other households. Potential investors know that the new liabilities (as well as the outstanding liabilities) are not collateralized and the household will renegotiate immediately after taking the new debt. I refer to a household for which $l_{j,t} < \xi_{j,t} k_{j,t}$ as 'liquid' since it can raise extra funds.

To better understand Assumptions 1 and 2, consider the condition for not renegotiating, $l_{j,t} \leq p_{j,t} k_{j,t}$. If this condition is satisfied, households have the ability to raise funds to purchase the assets of a defaulting household. This insures that the market price for the liquidated assets is $\xi_{j,t} = p_{j,t}$. However, if $l_{j,t} > p_{j,t} k_{j,t}$ for all households, there will be no household able to buy the liquidated assets. As a result, the liquidated assets can only be sold to entrepreneurs. But then the price will be $p_{j,t} = \underline{p}_{j,t}$. Therefore, the value of the liquidated assets depends on the financial decision of households, which in turn depends on the price of the assets. This interdependence creates the conditions for multiple self-fulfilling equilibria.

[3] Since the supply of houses $\overline{K}$ is fixed, while the services from houses depend on productivity, the price of houses grows with productivity.

Proposition 2.1 *There exists multiple equilibria only if the* $l_{j,t} > \underline{p}_{j,t}$.

Proof 2.1 *See appendix G.*

When multiple equilibria are possible, the equilibrium is selected through the random draw of sunspot shocks.

Let $\varepsilon_{j,t}$ be a variable that takes the value of 0 with probability λ and 1 with probability $1-\lambda$. If the condition for multiplicity is satisfied, agents coordinate their expectations on the low liquidation price $\underline{p}_{j,t}$ when $\varepsilon_{j,t}=0$. Thus, the probability distribution of the low price is

$$f_{j,t-1}\Big(p_{j,t} = \underline{p}_{j,t}\Big) = \begin{cases} 0, & \text{if} \quad l_{j,t} \leq \underline{p}_{j,t} k_{j,t} \\ \\ \lambda, & \text{if} \quad \underline{p}_{j,t} k_{j,t} < l_{j,t} < \bar{p}_{j,t} k_{j,t+1} \\ \\ 1, & \text{if} \quad l_{j,t} \geq \bar{p}_{j,t} k_{j,t+1} \end{cases}$$

If leverage is sufficiently small ($l_{j,t}/\underline{p}_{j,t} k_{j,t} < 1$), households remain liquid even if the (expected) liquidation price is $p_t = \underline{p}_{j,t}$. But then the liquidation price cannot be low and the realization of the sunspot shock is irrelevant for the equilibrium. Instead, when the leverage is high, the liquidity of households depends on the price. The realization of the sunspot shock $\varepsilon_{j,t}$ then becomes important for selecting one of the two equilibria. When $\varepsilon_{j,t} = 0$—which happens with probability λ—the market expects that the liquidation price is $p_{j,t} = \underline{p}_{j,t}$, making the household's sector illiquid. On the other hand, when $\varepsilon_{j,t} = 1$—which happens with probability $1-\lambda$—the market expects that the liquidation price is the price determined in the market with the participation of households, validating the expectation of the high liquidation price.[4] If the leverage is very large, however, households are always illiquid and the equilibrium price is $p_{j,t} = \underline{p}_{j,t}$.

Notice that the argument is based on the assumption that κ is sufficiently low (implying a sufficiently low value of $\underline{p}_{j,t}$). The upper bound price $\bar{p}_{j,t}$ is

[4] The assumption that houses lose their functionality if sold to foreign households, in addition to entrepreneurs, allows me to have equilibrium in which the default happens only in one country. If houses could maintain their functionality when sold to foreign entrepreneurs, implies that default in one country could arise only if the other country also defaults. Nevertheless, even if default takes place only in one country, we will see that it impacts the macro-economy of the other country because of the portfolio diversification of entrepreneurs.

endogenous and is determined in equilibrium. However, for practical purpose, the debt $l_{j,t}$ will never exceed $\bar{p}_{j,t}k_{j,t}$ in equilibrium.

2.4 General equilibrium

At the beginning of the period, the aggregate states are given by aggregate productivities, $A_{1,t-1}$ and $A_{2,t-1}$, bonds held by entrepreneurs, $B_{11,t}$, $B_{21,t}$, $B_{21,t}$ and $B_{22,t}$, liabilities issued by households, $L_{1,t}$ and $L_{2,t}$, and sunspot shocks $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$. Since aggregate productivities are unknown at the beginning of the period, the set of state variables includes 'lagged' productivities. To use a compact notation I will denote the vector of state variables by $\mathbf{s}_t \equiv (A_{1,t-1}, A_{2,t-1}, B_{1,t}, B_{2,t}, L_{1,t}, L_{2,t}, \varepsilon_{1,t}, \varepsilon_{2,t})$.

The equilibrium is determined sequentially in three subperiods:

1. **Subperiod 1**: Given the sunspot shock $\varepsilon_{j,t}$ in country j, agents form (self-fulfilling) expectations about the housing price $p_{j,t}$. The equilibrium price is $p_{j,t} = \underline{p}_{j,t}$ if $l_{j,t} \geq \underline{p}_{j,t}k_{j,t}$ and $\varepsilon_{j,t} = 0$. Given the liquidation price, households choose whether to default. The renegotiated liabilities are

$$\tilde{L}_{j,t} = \begin{cases} \underline{p}_{j,t}\bar{K}, & \text{if} \quad l_{j,t} \geq \underline{p}_{j,t}k_{j,t} \text{ and } \varepsilon_{j,t} = 0 \\ L_{j,t}, & \text{otherwise} \end{cases}.$$

   The value of the post-renegotiation bonds held by entrepreneurs in each country are proportional to their pre-renegotiated holdings, that is,

$$\tilde{B}_{1j,t} = \left(\frac{B_{1j,t}}{B_{11,t} + B_{12,t}}\right)\tilde{L}_{1,t},$$
$$\tilde{B}_{2j,t} = \left(\frac{B_{2j,t}}{B_{21,t} + B_{22,t}}\right)\tilde{L}_{2,t}.$$

2. **Subperiod 2**: Given the post-renegotiation wealth $\tilde{B}_{1j,t} + \tilde{B}_{2j,t}$, entrepreneurs in country j choose the demand for labor and workers choose the supply. At this stage the idiosyncratic productivity $\pi^i_{j,t}$ and the aggregate productivity $A_{j,t}$ are unknown. Therefore, decisions are based on their probability distributions.

   The aggregate demand in country j was derived earlier and takes the form $H^D_{j,t} = \phi_{j,t}(w_{j,t})(\tilde{B}_{1j,t} + \tilde{B}_{2j,t})$. It depends negatively on the wage rate $w_{j,t}$ and positively on the aggregate wealth of entrepreneurs, $\tilde{B}_{1j,t}+\tilde{B}_{2j,t}$. The supply of labor is derived from the households' first order condition (5). Market clearing will then determines the wage rate $w_{j,t}$ and employment $H_{j,t}$ in each country.

The dependence of the demand of labor from the financial wealth of entrepreneurs is an important property of this model. When entrepreneurs hold a lower value of wealth $\tilde{B}_{1j,t}+\tilde{B}_{2j,t}$, the demand for labor declines and in equilibrium there will be lower employment and production. Importantly, the reason lower entrepreneurial wealth reduces the demand for labor is not because employers lacks the funds to finance hiring or because they face a higher financing cost. Instead, it derives from the insurance provided against the production risks.[5]

3. **Subperiod 3**: Aggregate and idiosyncratic productivities $A_{j,t}$ and $\pi^i_{j,t}$ are realized. The wealth of entrepreneurs in country j becomes $\tilde{B}_{1j,t}+\tilde{B}_{2j,t}+(A_{j,t}-w_{j,t})H_{j,t}=A_{j,t}$, which is in part consumed and in part saved in new bonds, $q_{1,j}B_{1j,t+1}$ and $q_{1,j}B_{2j,t+1}$. Households choose new debt issuance and new holding of houses.

   Market clearing in financial assets gives rise to the conditions

$$B_{11,t+1}+B_{12,t+1} = L_{1,t+1}, \tag{8}$$
$$B_{21,t+1}+B_{22,t+1} = L_{2,t+1}. \tag{9}$$

   Because of capital mobility and possible cross-country heterogeneity, the net foreign asset positions of the two countries could be different from zero, that is, $B_{1j,t+1}+B_{2j,t+1}\neq L_{j,t+1}$. Competition also implies that the price paid by entrepreneurs to buy households' debt is consistent with the interest rate charged to households, that is,

$$q_{j,t}=\frac{1-\tau_j}{R_{j,t}},$$

   where τ is an intermediation cost. Since $\overline{R}_{j,t}=R_{j,t}(1-\mathbb{E}_{t+1}\delta_{j,t+1})$, the above condition also relates the price paid by entrepreneurs $q_{j,t}$, to the average return from holding the household debt issued in country j.

[5] This mechanism is distinct from the typical 'credit channel' where firms are in need of funds to finance employment (for example, because wages are paid in advance) or to finance investment.

As shown in Lemma 2.1, the optimal savings of entrepreneurs takes the form $q_{1,j}b^i_{1j,t+1} + q_{1,j}b^i_{2j,t+1} = \beta a^i_{j,t}$, where $a^i_{j,t}$ is the end-of-period wealth. Aggregating over all entrepreneurs of each country we obtain the aggregate demand for bonds

$$q_{1,j}B_{1j,t+1} + q_{2,j}B_{1j,t+1} = \beta \int_i a^i_{j,t}. \tag{10}$$

The supply of bonds is derived from the borrowing decisions of households. From the first order condition (6) we have

$$\frac{1}{\overline{R}_{j,t}} = \beta\left[1 + \Phi_{j,t}\left(\frac{L_{j,t+1}}{\overline{K}}\right)\right].$$

Since in equilibrium $\overline{R}_{j,t} = R_{j,t}(1 - \mathbb{E}\delta_{j,t})$ and $q_{j,t} = (1-\tau_j)/R_{j,t}$, the first order condition can be rewritten as

$$q_{j,t} = \beta(1-\tau_j)\Big(1 - \mathbb{E}\delta_{j,t}\Big)\left[1 + \Phi_{j,t}\left(\frac{L_{j,t+1}}{\overline{K}}\right)\right]. \tag{11}$$

Given the end-of-period wealth held by entrepreneurs, $\mathcal{A}_{1,t}$ and $\mathcal{A}_{1,t}$, and aggregate productivities $A_{1,t}$ and $A_{2,t}$, we can solve for $q_{1,t}$, $q_{2,t}$, $B_{11,t}$, $B_{12,t}$, $B_{21,t}$, $B_{22,t}$, $L_{1,t}$, $L_{2,t}$ using equations (8)-(11) plus two of the first order conditions for entrepreneurs.

Proposition 2.2 *Suppose that $A_{j,t}$ is constant and the debt is always repaid (no default), that is, $\delta_{j,t} = 1$, $\tilde{B}_{j,t} = B_{j,t}$ and $\tilde{L}_{j,t} = L_{j,t}$. The economy converges to a steady state where $q > 1/R = \beta$ and households borrow from entrepreneurs.*

Proof 2.2 *See Appendix D*

The reason entrepreneurs are willing to hold the debt issue by households even if the price is higher than β is because entrepreneurs face uninsurable risks and bonds provide consumption insurance. If $q = \beta$, entrepreneurs would continue to accumulate bonds without limit. In the steady state without default the difference between the price of bonds and the intertemporal discount factor is determined by the intermediation cost τ.

When households can default and the aggregate productivity is stochastic, the economy may not reach a steady state but displays stochastic dynamics in response to the realizations of $\varepsilon_{j,t}$ and $A_{j,t}$.

2.5 Discussion and remarks

Before proceeding, it would be helpful to clarify the importance of some modeling assumptions and the associated properties.

The equilibrium is characterized by producers (entrepreneurs) that are net savers and households net borrowers. This equilibrium structure differs from other models proposed in the literature where, typically, producers are net borrowers. Although having producers with positive net financial wealth might appear counterfactual at first, it is not inconsistent with the recent changes in the financial structure of US corporations. It is well known that during the last two and half decades, US corporations have increased their holdings of financial assets. This suggests that the proportion of financially dependent firms has declined significantly over time, consistent with the empirical findings of Shourideh and Zetlin-Jones (2012) and ? (?).

The large accumulation of financial assets by firms (often referred to 'cash') is related to the significance of business savings. ? (?) document the share of savings done by firms both in advanced and emerging countries and present evidence that in Latin America this share is even larger than in industrialized economies. The importance of business savings is also documented in ? (?). Using data for 47 countries over 19952013 they show that the contribution of businesses to national savings is on average more than 50%. The model developed here captures the growing importance of firms that are not very dependent on external financing.

The second remark is that the equilibrium property for which firms are net lenders does not rely on the assumption that households are risk neutral. What is crucial for the model to generate this property is that only entrepreneurs are exposed to uninsurable idiosyncratic risks. As long as entrepreneurs face more risk than households, entrepreneurs would continue to be net lenders in equilibrium even if households were risk averse.

The third remark relates to the assumption that the idiosyncratic risk faced by entrepreneurs cannot be insured away fully (market incompleteness). Since households are risk neutral, it would be optimal to offer wages that are contingent on the output of the firm. However, Appendix A shows that the idiosyncratic shock considered here is the residual risk that cannot be insured away because of agency problems. The micro-foundation provided in the appendix also explains why wages cannot be state-contingent.

3 Quantitative analysis

In this section I calibrate the model to study the quantitative impact of the growth of emerging countries on financial and macroeconomic stability. The calibration uses data for the period 1991-2013 under the assumption that country 1 is representative of industrialized economies and country 2 is representative of emerging economies. Starting in 1991, I simulate the model until 2013. The list of industrialized and emerging countries is provided in Figure 1.

3.1 Calibration

The model is calibrated annually. Changes in the economic size of the two countries are generated by variations in productivities $A_{1,t}$ and $A_{2,t}$.

Total production is the sum of entrepreneurial output, $A_{j,t}H_{j,t}$, and housing services, $A_{j,t}\overline{K}$. Thus, aggregate output in country j is $Y_{j,t} = A_{j,t}(H_{j,t} + \overline{K})$. Because in the model there is no capital accumulation, the empirical counterpart of aggregate output is Gross Domestic Product minus Investment.

The productivities $A_{1,t}$ and $A_{2,t}$ are chosen to replicate the size of the two groups of countries over the period 1991-2013 measured at nominal exchange rates, not PPP. This is consistent with the main goal of the quantitative exercise which is to study how the change in the 'relative' size of the two countries affects the world demand for financial assets. Since movements in nominal exchange rates affect the purchasing power of a country in the acquisition of foreign assets, the relative productivity $A_{2,t}/A_{1,t}$ should also reflect these movements. Another factor that contributes to generate differences in the overall economic size of the two countries is population growth. Since population differences are not explicitly modelled, $A_{1,t}$ and $A_{2,t}$ should also reflect changes in population.

Define the nominal output of country j as

$$P_{j,t}Y_{j,t} \; = \; P_{j,t}\hat{A}_{j,t}(H_{j,t} + \overline{K})N_{j,t},$$

where $\hat{A}_{j,t}$ is actual productivity, $H_{j,t}$ is per-capita employment, $\overline{K}$ is the per-capita endowment of houses, $N_{j,t}$ is population, and $P_{j,t}$ is the nominal price of country j expressed in the same currency units for all countries. For example, using US dollars as the common denominator, prices are calculated by multiplying local currency units by the dollar exchange rate. Notice that the above definition of output assumes that the endowment of houses increases with population. This is necessary to preserve balanced growth.

Aggregate productivity in the model corresponds to

$$\begin{aligned} A_{1,t} &= \hat{A}_{1,t} N_{1,t}, \\ A_{2,t} &= \frac{P_{2,t} \hat{A}_{2,t} N_{2,t}}{P_{1,t}}. \end{aligned}$$

This shows that the relative productivity in the model, $A_{2,t}/A_{1,t}$, also reflects cross-country differences in population and prices. The empirical series are then constructed using the equations

$$A_{1,t} = \frac{Y_{1,t}}{H_{1,t} + \overline{K}}, \tag{12}$$

$$A_{2,t} = \frac{P_{2,t} Y_{2,t}/P_{1,t}}{H_{2,t} + \overline{K}}. \tag{13}$$

The numerator is the real, net (of investment) GDP, deflated by nominal prices in industrialized countries. In this way, if prices in emerging countries grow more than prices in industrialized countries, this will be reflected in higher relative productivity in emerging countries. Although this does not increase (relative) labor productivity in emerging countries, it raises their ability to purchase assets in industrialized countries, which is the main focus of this paper. Also notice that the change in relative prices could simply be the result of movements in the nominal exchange rates. Still, when the currencies of emerging countries appreciate, the acquisition of foreign assets become cheaper for these countries.

Before I can use equations (12) and (13), I need to pin down the value of $\overline{K}$. This is done using the share of housing services in net GDP (net of investment), which in the model is equal to $\overline{K}/(H_{j,t} + \overline{K})$. Unfortunately, data for the share of housing services is not available for many countries. To obviate this problem, I impose that all countries have the same share of housing services in output (GDP minus investment in the data) and use the US share as the calibration target for both countries. Using data from NIPA, the average share of housing services in net GDP over the period 1991-2013 is 12.2%. Thus, I calibrate $\overline{K}$ using the condition

$$\frac{\overline{K}}{\overline{H} + \overline{K}} = 0.122.$$

The value of $\overline{H}$ is set to the average employment-to-population ratio over the period 1991-2013 for all countries (emerging and industrialized). Using data from the World Development Indicators (WDI) I then set $\overline{H} = 0.449$.

Given the value of $\overline{K}$, I compute the sequence of $A_{2,t}$ and $A_{1,t}$ using equations (12) and (13). The variables $Y_{1,t}Y_{1,t}$ and $P_{2,t}Y_{2,t}$ are measured in the data as GDP minus investment in constant US dollars from the WDI. These variables are then both deflated with the GDP deflator of industrialized countries, that is, $P_{1,t}$. The variable $H_{j,t}$ is measured as the ratio of employment over total population also from the WDI. The resulting 'relative' productivity, $A_{2,t}/A_{1,t}$, is plotted in Figure 2.

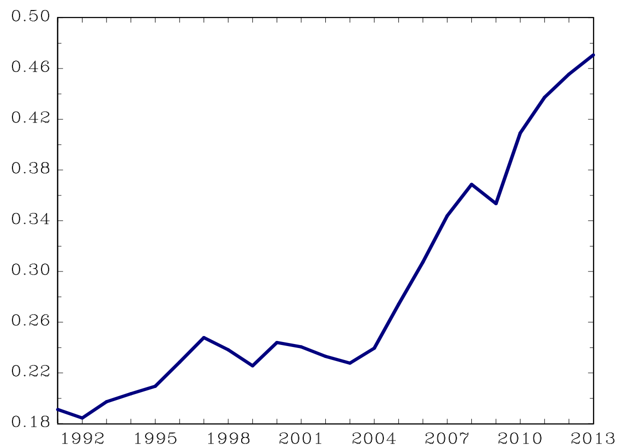

Figure 2: Relative productivity of emerging vs. industrialized countries, 1990-2013.

For the simulation of the model I also need to specify the stochastic processes for productivity. I assume that $A_{j,t}$ follows the process

$$\ln(A_{j,t}) = \rho + \ln(A_{j,t-1}) + \epsilon_{j,t},$$

where $\epsilon_{j,t}$ is a shock that is independently and identically distributed across countries and over time. Notice that the expected growth rate ρ does not have the country subscript j. Thus, the two countries have the same expected growth. Even if emerging and industrialized countries have experienced very different growth rates during the last two decades, this is not the case when we look at a longer horizon. Furthermore, it is not obvious that the growth differential experienced by the two groups of countries during the last two decades was anticipated. I further assume that $\epsilon_{1,t}$ and $\epsilon_{2,t}$ are independently drawn from a normal distribution with zero mean and same standard deviation σ_ϵ. I set σ_ϵ to the average standard deviation of GDP growth for emerging and industrialized countries over the period 1970-2013 (which is the period for which I have data from the WDI).

Remaining parameters The discount factor is set to $\beta = 0.95$, implying an annual intertemporal discount rate of about 5%. The intermediation cost is set to 1%, that is, $\tau = 0.01$. The probability of a negative sunspot shock, $\varepsilon = 0$, is set to $\lambda = 0.02$. Thus, provided that leverage is sufficiently high, crises are very low probability events. On average, once every fifty years. Similar numbers have been used in the literature (see for example **??**).

The stochastic process for the uninsurable idiosyncratic productivity π follows a truncated normal distribution with zero mean and standard deviation σ_π. The standard deviation σ_π determines the 'demand' of assets (in the spirit of Mendoza et al. (2009)). Higher values of σ_π increase the demand for the liabilities (bonds) issued by the household sector. The parameters κ_1 and κ_2, instead, determine the recovery value of loans when the housing market freezes. This in turns determines the incentive of households to borrow and, therefore, the ability of a country to create financial assets (in the spirit of Caballero et al. (2008)). Cross-country differences in κ will then capture differences in financial development between industrialized and emerging economies and, as a measure of financial development I use the ratio of domestic credit to net GDP, which in the model corresponds to $L_{j,t+1}/Y_{j,t}$. But in equilibrium, this ratio is the result of both demand and supply forces. Therefore, I calibrate the parameters σ_π, κ_1 and κ_2 jointly to match the following three targets: (i) Private Domestic Credit in industrialized countries over Net GDP in 1991; (ii) Private Domestic Credit in emerging countries over Net GDP in 1991; (iii) households' debt in 1991 is slightly above the threshold that would trigger a crisis in the event of a negative sunspot shock, that is, $L_{j,t}$ is slightly bigger than $\underline{p}_{j,t} = \kappa_j A_t$.

The targets are for year 1991 because this is the first year of the empirical sample and the first year of the simulation exercise. The ratio of domestic private credit over Net GDP in 1991 for industrialized countries was 145.7 and for emerging countries was 49.6. However, in the data, only some of the domestic liabilities are held by businesses. Some of the liabilities are held by other households. This implies that the 'net' debt for the whole household sector is smaller than the whole domestic private credit. As a compromise, I impose that $L_{1,t}/Y_{1,t}$ and $L_{1,t}/Y_{1,t}$ are half the values of domestic credit in the data.

3.2 Quantitative results

I simulate the model for 123 years using a random sequence of draws of the sunspot shock ($\varepsilon = 0$ with probability $\lambda = 0.02$ and $\varepsilon = 1$ with probability $1 - \lambda = 0.98$). During the first 100 periods the detrended aggregate productivities of the two countries stay constant at their 1991 levels. Therefore, the relative productivity does not change. The goal of the first 100 simulated periods is to eliminate the impact of initial conditions. Starting in period 101, corresponding to year 1991, the productivities of the two countries follow the actual series constructed from the data for the period 1991-2013 (with the relative productivity of emerging countries shown in Figure 2).

In absence of sunspot shocks, the dynamics of the economy would be solely driven by changes in productivity. The presence of sunspot shocks adds another source of fluctuation. The simulated dynamics would then depend on the actual realizations of these shocks. To better illustrate how the sunspot shocks affect the stochastic properties of the model, I repeat the simulation 1,000 times, with each simulation over 100+23 years.

Simulation results Figure 3 plots the average as well as the 5th and 95th percentiles of the 1,000 repeated simulations. The range of variation between the 5th and 95th percentiles indicates the potential volatility at any point in time (for given productivity).

The first panel shows the relative productivity $A_{2,t}/A_{1,t}$ constructed from the data as described earlier (and previously plotted in Figure 2). The next three panels plot the risk-free rate and the debt to output ratio of households. The last two panels plot the employment in the two countries.

Following the increase in the 'relative' productivity of emerging countries, the interval delimited by the 5th and 95th percentiles for the repeated simulations widens significantly. This means that financial and macroeconomic volatility increases substantially as we move to the 2000s. In this particular simulation the probability of a crisis is always positive, even before the structural break in 1991 when the relative productivity of emerging countries accelerated. However, after the structural break, the consequence of a

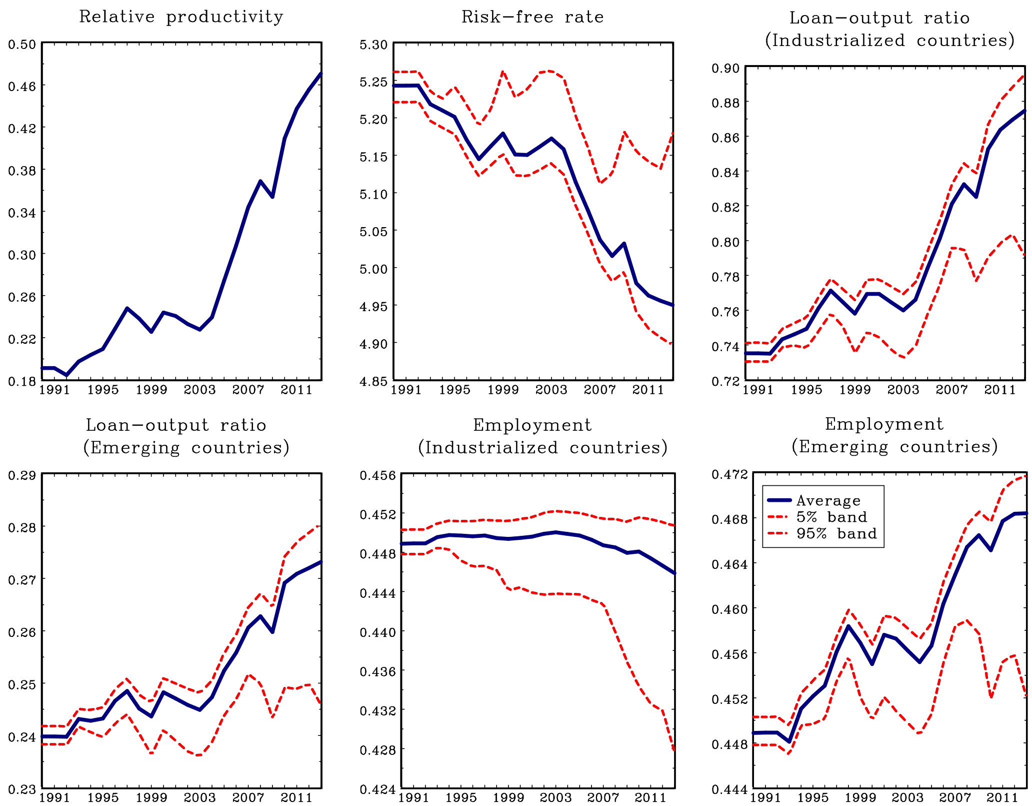

Figure 3: Change in productivity of emerging countries relatively to industrialized countries, 1992-2013. Responses of 1,000 repeated simulations.

bank crisis could be much bigger since the distance between the 5th and 95th percentiles widens. This is especially true in the second half of 2000s.

Notice that, without the growth of emerging countries (relatively to industrialized countries), the 5th and 95th percentile band would not change after 1991. Therefore, the comparison of the band before and after 1991 shows how the growth of emerging countries contributed to increasing financial and macroeconomic volatility in both groups of countries.

Besides the increase in financial and macroeconomic volatility, Figure 3 reveals other interesting patterns. First, as the relative size of emerging countries increases, households become more leveraged while the interest rate declines.

Figure 3 also shows that labor declines on average. This is because, as the share of emerging countries in the world economy increases, the global demand for bonds increases. Households respond by borrowing more (and therefore, by supplying more bonds) but not enough to compensate the increase in demand. Thus, entrepreneurs in both countries hold less financial assets relatively to the scale of production. This implies lower insurance and, therefore, less demand for labor.

Central mechanism The dynamics shown by the simulation exercise follow from the increase in the demand for bonds from entrepreneurs 'relatively' to the issuance of liabilities from households (supply of bonds). It is important to stress the 'relative' qualification. As emerging countries become bigger, their demand for financial assets increases in absolute value. But also the issuance of household liabilities increases in emerging countries. Therefore, in order to generate a decline in the interest rate and higher leverages, the demand for financial assets from entrepreneurs in emerging countries must rise more than the supply from households.

This point can be illustrated more precisely using the equilibrium condition in financial markets,

$$B_{11,t} + B_{21,t} + B_{12,t} + B_{22,t} = L_{1,t} + L_{2,t}.$$

Suppose that country 2 (the emerging economies) experience growth. Keeping for the moment the interest rate unchanged, this increases the demand of financial assets in country 2, $B_{12,t} + B_{22,t}$, but also the supply in country 2, $L_{2,t}$. If the absolute increase in the demand is not different from the supply, the above equilibrium condition would not change and, therefore, the interest rate would stay the same.

Now suppose that productivity in country 2 grows by g_{t+1} between t and $t+1$. Also suppose that, if the (risk-free) interest rate does not change, this induces the same rate of growth in the demand and supply of financial assets in country 2. Under the assumption that the (risk-free) interest rate does not change, the demand and supply of financial assets in country 1 does not change. Therefore, the equilibrium must satisfy

$$B_{11,t} + B_{21,t} + (B_{12,t} + B_{22,t})g_{t+1} = L_{1,t} + L_{2,t}g_{t+1}.$$

Since country 2 has a positive net foreign asset position before experiencing growth, that is, $B_{12,t}+B_{22,t} > L_{1,t}$, the absolute increase in demand is bigger than the absolute increase in supply, that is, $(B_{12,t}+B_{22,t})g_{t+1} > L_{2,t}g_{t+1}$.

Therefore, the above equilibrium condition will not be satisfied. To re-establish equilibrium the interest rate has to drop in order to induce households in both countries to borrow more.

The intuition provided with the above example relies on the assumption that the growth in productivity induces the same growth in the demand and supply of financial assets. On the household sector, a higher $A_{2,t}$ increases the liquidation value of houses and generates higher households' borrowing because, effectively, it increases the collateral value of houses. On the production sector, a higher $A_{2,t}$ increases the profits and wealth of entrepreneurs, which in turn increases their demand of financial assets. However, if the increase in profits is not large, the increases in demand for financial assets from entrepreneurs is smaller than the increase in households' debt, placing upward pressure on the interest rate (contrary to what obtained in the simulation). The assumption that aggregate productivity is observed with delay plays a crucial role in generating a sufficiently large increase in demand of bonds.

Since $A_{2,t}$ is still unknown when workers are hired and wages clear the labor market, an unexpected growth in productivity generates an unexpected increase in entrepreneurial profits. Since entrepreneurs save a fraction of their end-of-period wealth, higher profits imply higher savings, that is, higher value of $B_{12,t+1} + B_{22,t+1}$. If the increase in g_t was anticipated, instead, the higher productivity would generate an immediate increase in wages with only a small effect on profits. In this case $B_{12,t+1} + B_{22,t+1}$ increases only marginally compared to $L_{2,t}$. The lagged observation of productivity is also important for generating a positive correlation between the growth of a country and its current account balance. This point will be explained shortly after showing the dynamics of the current account.

Simulation for a particular sequence of shocks Although the model predicts that financial and macroeconomic volatility has increased in both industrialized and emerging countries, it is difficult to detect from the empirical data. This is because crises are very low probability events: in the model a crisis could materialize when the draw of the sunspot shock is low, an event that has been calibrated to arise on average every 50 years. Thus, the macroeconomic dynamics observed prior to 2008-09 would appear quite stable even if the underlying volatility has increased. In fact, under the 2% calibrated probability of a negative sunspot shock, the probability that only positive shocks are drown during the period 1991 to 2008 is about 70 percent.

To illustrate the impact of the 2008-09 crisis, I simulate the model for a particular sequence of sunspot shocks. Starting in 1991, I assume that the economy experiences a sequence of positive sunspot draws $\varepsilon = 1$ until 2008. Then, in 2009, the draw of the sunspot becomes $\varepsilon = 0$ and reverts back to $\varepsilon = 1$ afterwards. This particular sequence of sunspot shocks captures the idea that expectations may have turned pessimistic in the fourth quarter of 2008. Since the model is calibrated annually, the negative sunspot shock is assumed to arise in 2009 even if in the data the crisis materialized toward the end of 2008. The simulated variables are plotted in Figure 4.

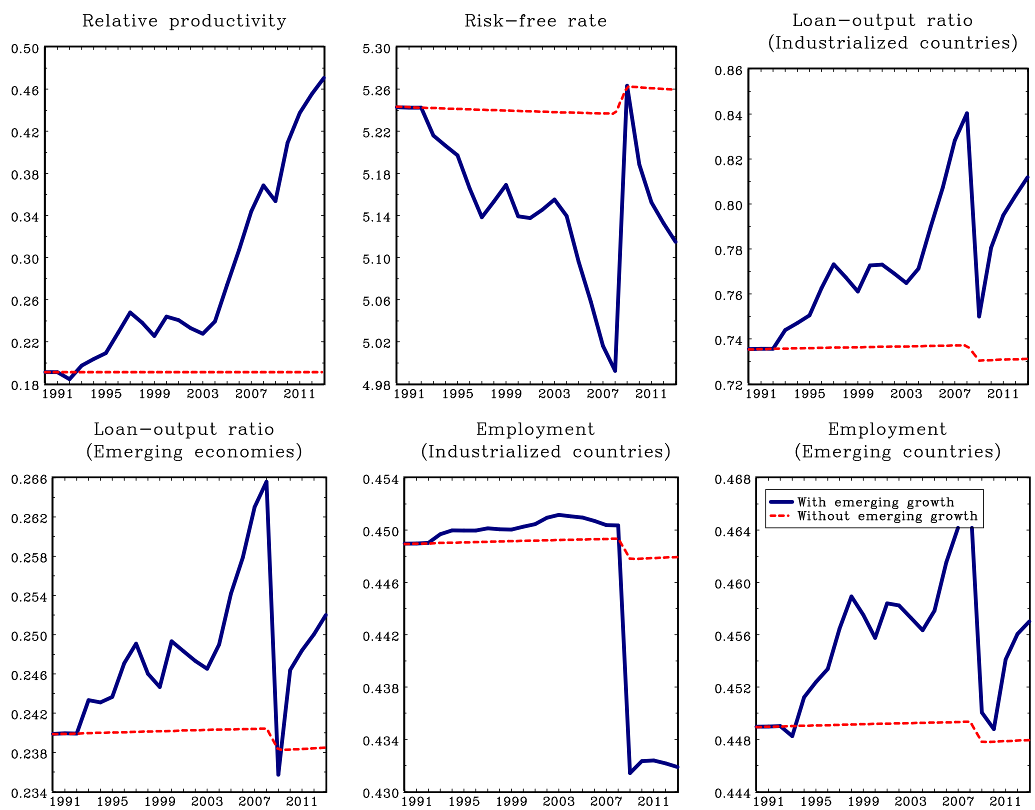

Figure 4: Change in productivity of emerging countries relatively to industrialized countries, 1991-2013. Responses of 1,000 repeated simulations with same draws of positive sunspot shocks ($\varepsilon = 1$) with the exception of 2009 ($\varepsilon = 0$).

Looking at the continuous lines, as long as the draws of the sunspot shock are $\varepsilon = 1$, the risk-free interest rate declines and households debt increases. Employment remains relatively stable in industrialized countries and increases in emerging economies. The dynamics of employment in emerging economies is driven by the growth of financial assets accumulated by entrepreneurs thanks to productivity growth. However, a single realization of $\varepsilon = 0$ triggers a reversal in the dynamics of households' borrowing and interest rate and a large decline in employment in both countries. Furthermore, even if the negative shock is only for one period and there are no crises afterwards, the recovery in the labor market is slow. This is because the crisis generates a large decline in the financial wealth of entrepreneurs, which takes a long time to be rebuilt through savings.

Another way of showing the importance of growth in emerging countries, is through the following counterfactual exercise. I repeat the simulation under the assumption that the 'relative' productivity of emerging countries does not grow but remains at the 1991 level for the whole simulation period. Essentially, emerging countries experience the same growth rate as industrialized countries. This counterfactual exercise tells us how the macroeconomic dynamics would have changed in response to the same sequence of sunspot shocks if emerging countries had not experienced higher growth than industrialized countries. The resulting simulation is shown in Figure 4 by the dashed line.

Without the growth of emerging countries, the same sequence of sunspot shocks would have generated a smaller financial expansion before 2009 as well as a much smaller contraction in 2009. Therefore, the increase in demand for financial assets could have contributed to the observed expansion of the financial sector but it also created the conditions for greater financial and macroeconomic fragility. However, the fragility became evident only after the crisis materialized.

Global imbalances As showed in Figure 1, the 2000s are also characterized by large imbalances between industrialized and emerging countries. Starting in 2000, industrialized countries have experienced current account deficits while the current account of emerging countries has been in surplus. The surplus of emerging countries was especially large in the 2003-2007 period, only partially corrected by the crisis. Figure 5 shows that, during the same period, the simulated model predicts large current account surpluses for emerging countries.

The current account balance of country j is equal to the change in its

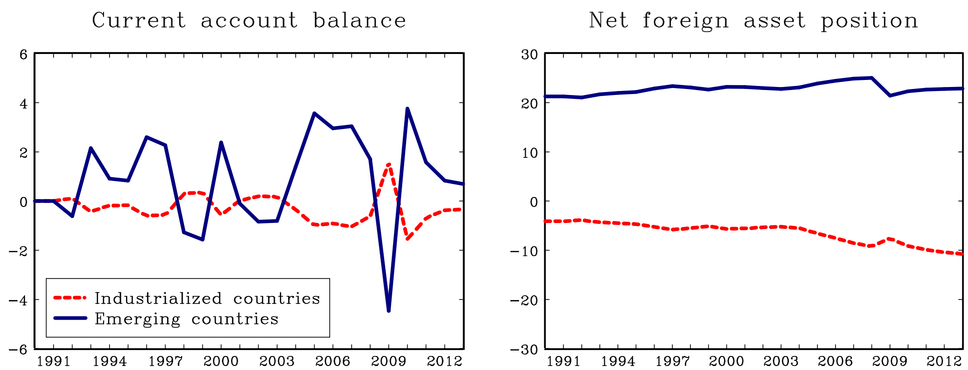

Figure 5: Current account balance and net foreign asset position as a percentage of net output. Responses of 1,000 repeated simulations with draws of positive sunspot shocks starting in 1992 and negative draw in 2009.

foreign asset position, that is,

$$CA_{j,t} = NFA_{j,t+1} - NFA_{j,t}.$$

The net foreign asset positions at the end of period t is equal to the value of assets held abroad minus the value of assets that foreigners hold in the country, that is,

$$\begin{aligned} NFA_{1,t+1} &= q_{2,t}B_{21,t+1} - q_{1,t}B_{12,t+1} \\ NFA_{2,t+1} &= q_{1,t}B_{12,t+1} - q_{2,t}B_{21,t+1} \end{aligned}$$

The current account balance of emerging countries generated by the simulation is more volatile than in the data. However, it is positive on average and this leads to an increase in net foreign asset positions of emerging countries (as shown in the right panel of Figure 5). The model also generates a widening surplus prior to the crisis and the contraction after the crisis. The current account balance of industrialized countries displays the same pattern but with the reversed sign.

The fact that fast growing countries tend to have current account surpluses while countries with moderate growth tend to experience current account deficits has been shown in ? (?). This paper also shows that this empirical fact is inconsistent with the predictions of many macro models where higher growth is associated with higher net foreign borrowing. The model developed in this paper, instead, is capable of generating a positive correlation between growth and accumulation of foreign assets by emerging countries. In order for the model to generate this pattern it is important that productivity is observed after the employment decision. With this assumption higher growth in emerging countries generates higher entrepreneurial profits (since wages do not respond immediately) which in turns allows for higher entrepreneurial savings ($b_{12,t+1} + b_{22,t+1}$) in excess of the increase in household borrowing ($L_{2,t}$). When the savings of emerging countries exceed borrowing, the current account of these countries becomes positive as shown in Figure 5.

4 Discussion and conclusion

An implication of the sustained high growth of emerging countries and their larger share in the world economy, is that the economic performance of these countries has become more important for the economies of industrialized countries. The view that emerging countries are a collection of small open economies whose dynamics is negligible for industrialized countries is no longer a valid approximation.

There are many channels through which emerging countries could affect the industrialized world. In this paper I emphasized one of these channels: the increased demand for financial assets traded in globalized capital markets. In particular, I have shown that the worldwide increase in the demand for financial assets raises the incentives to leverage. On the one hand, this allows for the expansion of the financial sector with positive effects on real macroeconomic activity. On the other, it increases the fragility of the financial system, raising the probability and/or the consequences of a crisis.

An important feature of the model is that the expansion of the financial structure improves allocation efficiency. This is because the issuance of bank liabilities provides insurance instruments for producers, encouraging them to hire labor. Effectively, the increase in the supply of financial assets that can be used for insurance purposes reduces the wedge in the demand for labor. However, the creation of more financial assets is often associated with higher leverage, making the financial system more vulnerable to crises. From a policy perspective there is a trade-off: the benefit of an expanded financial system versus the potential cost of deeper crises. A similar mechanism also arises in models with asset price bubbles and borrowing constraints as in Miao and Wang (2011). I leave the study of optimal policies for future research.

Appendix

A Limited enforcement and transformed problem

The micro-foundation for the lack of insurance is based on the assumption that entrepreneurs have the ability to divert part of their revenues. The diverted revenues are observable but cannot be verified legally. If an entrepreneur diverts x_t, he/she retains $(1-\zeta)x_t$ and the remaining part, ζx_t, will be lost. Therefore, ζ parameterizes the cost of diversion.

Entrepreneurs can purchase financial claims $n^i_{j,t}(z^i_{j,t})$ that are contingent on the realization of productivity in a competitive market. Because the counterparts of these claims are households who are risk-neutral, the prices for the claims are the probabilities associated with the realizations of $z^i_{j,t}$. The probabilities are denoted by $G_{j,t}(z)$. Notice that $z^i_{j,t} = A_{j,t}\pi^i_{j,t}$ includes both aggregate and idiosyncratic productivities. While the limited verifiability of the idiosyncratic component is a plausible assumption, the same cannot be said for the aggregate component. However, as will become clear below, if I assume that the minimum value of the idiosyncratic shock is zero, that is, $\underline{\pi} = 0$, then the results obtained here are also valid under the assumption that the aggregate productivity $A_{j,t}$ is verifiable. Therefore, in the rest of this section I assume that $\underline{\pi} = 0$. Below I will also discuss what would change if $\underline{\pi} \neq 0$.

Financial contracts are not exclusive, meaning that agents can always switch to another supplier of these claims in the subsequent period. The financial contract must be incentive-compatible.

For notational simplicity, in the analysis that follows I will ignore the agent superscript i and the country subscript j. After the realization of z_t the entrepreneur could divert part of the revenue. By claiming that the realization of productivity is the lowest value, $\underline{z} = 0$, the entrepreneur would divert $(z_t - \underline{z})h_t$. Because part of the diverted revenue is lost, the entrepreneur retains $(1-\zeta)(z_t - \underline{z})h_t$ and, from the financial contract, he/she receives $n_t(\underline{z})$. The net worth after diversion is then

$$b_t + (\underline{z} - w_t)h_t + (1-\zeta)(z_t - \underline{z})h_t + n_t(\underline{z}) \quad = \quad a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t.$$

Denoting by $\tilde{\Omega}_t(a_t(z_t))$ the value function at the end of the period before consumption when the the net worth is $a_t(z_t)$, the value of diversion is $\tilde{\Omega}_t\Big(a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t\Big)$. Incentive-compatibility requires

$$\tilde{\Omega}_t\Big(a_t(z_t)\Big) \geq \tilde{\Omega}_t\Big(a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t\Big),$$

which must hold for all z_t.

The entrepreneur's problem can be written as

$$\begin{aligned}
\Omega_t(b_t) &= \max_{h_t, n(z_t)} \mathbb{E}_t \tilde{\Omega}_t(a_t(z_t)) \qquad (14)\\
&\quad \text{subject to}\\
&\quad a_t(z_t) = \tilde{b}_t + (z_t - w_t)h_t + n_t(z_t)\\
&\quad \tilde{b}_t = (1-\delta_t)b_t\\
&\quad \int_{z_t} n_t(z_t)G_t(z_t) = 0\\
&\quad \tilde{\Omega}_t\Big(a_t(z_t)\Big) \geq \tilde{\Omega}_t\Big(a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t\Big)
\end{aligned}$$

$$\begin{aligned}
\tilde{\Omega}_t(a_t(z_t)) &= \max_{b_{t+1}} \Big\{ \ln(c_t) + \beta \mathbb{E}_t \Omega_{t+1}(b_{t+1}) \Big\} \qquad (15)\\
&\quad \text{subject to}\\
&\quad c_t = a_t - q_t b_{t+1}
\end{aligned}$$

The optimization problem has been divided in two sub-problems because the information set changes from the beginning of the period to the end of the period. In sub-problem (14) the entrepreneur chooses the input of labor and the contingent claims before knowing the productivity z_t. Remember that, even if the entrepreneur starts the period with financial wealth b_t, he/she may incur some financial losses that brings the residual wealth to $\tilde{b}_t$. The losses are captured by the variable δ_t. This is an aggregate endogenous variable that will be derived in the general equilibrium. For the characterization of the individual problem, however, we can take it as an exogenous stochastic variable since it cannot be affected by an individual (atomistic) entrepreneur.

The last constraint on Problem (14) is the cost to purchase the contingent claims. Imposing that the total cost is equal to zero is a normalization. In sub-problem (15) the entrepreneur allocates the end of period wealth in consumption and savings.

It is important to emphasize that the contractual party knows whether the entrepreneur is diverting. However, there is no legal procedure that can be used to enforce the payment because it is not possible to legally verify the diverted funds. The assumption that financial contracts are not exclusive and entrepreneurs can switch to other intermediaries from one period to the other is important because it limits the punishment for diversion. Notice that, although the new level of wealth after diversion is verifiable when a new contract is signed, this does not allow for the verification of diversion because the additional resources could derive from lower consumption in previous periods, which is not verifiable. The fraction of revenue lost, ζ, can be interpreted as the cost for hiding (making non-verifiable) the diverted revenue and for hiding consumption.

Using standard arguments for recursive problems, we can prove that the solution is unique and the functions Ω_t and $\tilde{\Omega}_t$ are strictly increasing and concave. The strict monotonicity of the value functions implies that the incentive-compatibility constraint can be written as

$$a_t(z_t) \geq a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t.$$

The concavity of $\tilde{V}_t$ implies that it is optimal for the entrepreneur to choose the contingent claims so that the above inequality is always satisfied with equality. What this says is that the entrepreneur will choose as much insurance as possible. Since $a_t(z_t) = \tilde{b}_t + (z_t - w_t)h_t + n_t(z_t)$, we have

$$\tilde{b}_t + (z_t - w_t)h_t + n_t(z_t) = a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t,$$

which we can solve for $n_t(z_t)$,

$$n_t(z_t) = a_t(\underline{z}) + (1-\zeta)\cdot(z_t - \underline{z})h_t - (z_t - w_t)h_t - \tilde{b}_t. \tag{16}$$

Multiplying both sides by the probabilities $G_t(z_t)$ and integrating over z_t we obtain

$$\int_{z_t} n_t(z_t)G_t(z_t) = a_t(\underline{z}) + (1-\zeta)\cdot(\mathbb{E}z_t - \underline{z})h_t - (\mathbb{E}z_t - w_t)h_t - \tilde{b}_t. \tag{17}$$

Subtracting (17) to (16) and taking into account that $\int_{z_t} n_t(z_t)\Gamma(z_t) = 0$, we obtain

$$n_t(z_t) = -\zeta(z_t - \mathbb{E}z_t)h_t.$$

Substituting in the law of motion for end-of-period assets we have

$$a_t(z_t) = \tilde{b}_t + \Big[\mathbb{E}z_t + (1-\zeta)(z_t - \mathbb{E}z_t) - w_t\Big]h_t.$$

Therefore, if we define $\tilde{z}_t = \mathbb{E}z_t + (1-\zeta)(z_t - \mathbb{E}z_t)$, we would have the same problem as the one without contingent claims but with the transformed productivity $\tilde{z}_t$. When $\zeta = 1$, which corresponds to perfect enforcement, the volatility of $\tilde{z}_t$ becomes zero. Thus, entrepreneurs can perfectly insure the production risk. When $\zeta = 0$, any insurance of the production risk is unfeasible.

The assumption $\underline{\pi} \neq 0$ implies that the minimum value of revenues is always zero independently of the realization of the aggregate shock. This is because $\underline{z} = A_t\underline{\pi} = 0$ whatever the value of A_t. If $\underline{\pi} \neq 0$, however, the minimum value of z_t will depend on aggregate productivity A_t and, to the extent that A_t is verifiable, the entrepreneur would be able to insure some of the volatility associated with aggregate productivity. Still, the risk associated with the idiosyncratic productivity cannot be fully insured and, therefore, the transformed model would have a similar structure with regards to the idiosyncratic productivity shock.

B Proof of Lemma 2.1

To be written.

C First order conditions for households

To be written.

D Proof of Proposition 2.2

To be written.

E First order conditions for problem (??)

To be written.

F Proof of Lemma ??

To be written.

G Proof of Proposition 2.1

To be written.

H Numerical solution

To be written.

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