The Global Financial Resource Curse

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Abstract

Since the second half of the 1990s, the United States have received large capital flows from developing countries and experienced a productivity growth slowdown. Motivated by these facts, we provide a model connecting international financial integration and global productivity growth. The key feature is that the tradable sector is the engine of growth of the economy. Capital flows from developing countries to the United States boost demand for U.S. non-tradable goods. This induces a reallocation of U.S. economic activity from the tradable sector to the non-tradable one. In turn, lower profits in the tradable sector lead firms to cut back investment in innovation. Since innovation in the United States determines the evolution of the world technological frontier, the result is a drop in global productivity growth. We dub this effect the global financial resource curse. The model thus offers a new perspective on the consequences of financial globalization, and on the appropriate policy interventions to manage it.

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1 Introduction

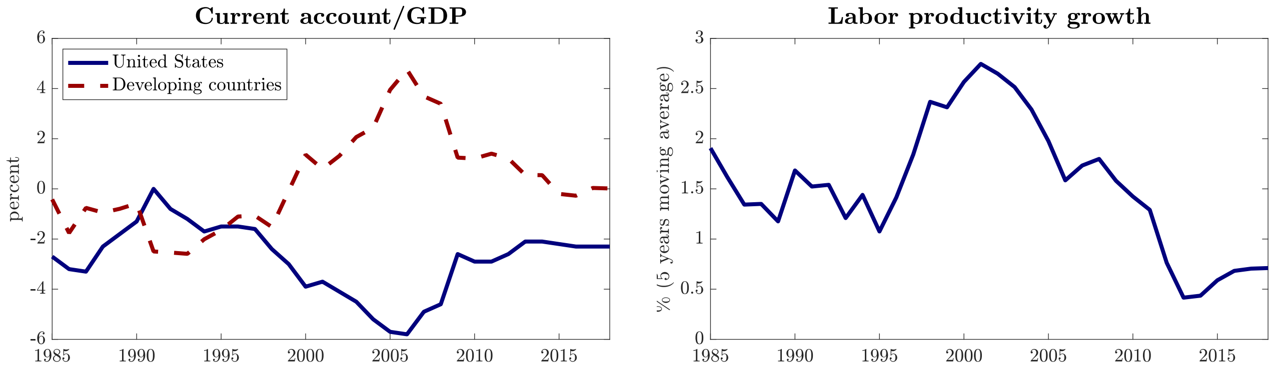
Since the late 1990s, the global economy has experienced two spectacular trends. First, there has been a surge of capital flows from developing countries - mainly China and other Asian countries - toward the United States (Figure 1a). Second, productivity growth in the United States has declined dramatically (Figure 1b). Both facts have been the centre of academic and policy debates, but have so far been considered independently. In this paper, instead, we argue that these two phenomena might be intimately connected. In particular, we show that the integration of developing countries in international financial markets might generate a slowdown in global productivity growth, by triggering an effect that we dub the *global financial resource curse*.

To make our point, we develop a framework to study the impact of financial integration on global productivity growth. Our model is composed of two regions: the United States and a group of developing countries. As in standard models of technology diffusion (Grossman and Helpman, 1991a), innovation activities in the United States determine the evolution of the world technological frontier. Developing countries, in contrast, experience productivity growth by absorbing knowledge originating from the United States. Therefore, investment by firms in developing countries determines their proximity to the technological frontier.

Compared to standard frameworks, our model has two novel features. The first one is that sectors producing tradable goods are the engine of growth in our economy. That is, in both regions productivity growth is the result of investment by firms operating in the tradable sector. The non-tradable sector, instead, is a traditional sector with stagnant productivity growth. As we explain in more detail below, this assumption captures - in a stark way - the notion that sectors producing tradable goods, such as manufacturing, have more scope for productivity improvements compared to sectors producing non-tradables, for instance construction. The second important feature is that agents in developing countries have a higher propensity to save compared to U.S. ones. Again as we discuss below, the literature has highlighted a host of factors which can generate high saving rates in developing countries, such as demography, lack of insurance or government interventions aiming at sustaining national savings.

Against this background, we consider a global economy moving from a regime of financial autarky to international financial integration. Due to the heterogeneity in propensities to save across the two regions, once financial integration occurs the United States receive capital inflows from developing countries. Capital inflows, in turn, allow U.S. agents to finance an increase in consumption. Higher consumption of tradables is achieved by increasing imports of tradable goods from developing countries, so that the United States end up running persistent trade deficits. But non-tradable consumption goods have to be produced domestically. In order to increase non-tradable consumption, therefore, factors of production migrate from the tradable sector toward the non-tradable one. This produces a drop in the profits earned by firms in the tradable sector, reducing their incentives to invest in innovation. The result is a drop in U.S. productivity growth.

To some extent, developing countries experience symmetric dynamics compared to the United



(a) Capital flows. **(b) Productivity growth.**

Figure 1: Motivating facts.

States. Financial integration, in fact, leads developing countries to run persistent trade surpluses. This stimulates economic activity in the tradable sector, at the expenses of the non-tradable one. In turn, higher profits in the tradable sector induce firms in developing countries to increase their efforts in absorbing knowledge from the frontier. As a result, the proximity of developing countries to the technological frontier rises. But this does not necessarily mean that financial integration benefits productivity growth in developing countries. The drop in U.S. productivity growth, the reason is, reduces the productivity gains that developing countries can obtain by absorbing knowledge from the frontier. Hence, it might very well be that after financial integration productivity growth slows down in developing countries too. In this case, the process of financial integration generates a fall in global productivity growth.

In our model, therefore, inflows of foreign capital depress productivity growth in the recipient country, because they lead to a drop in economic activity in the tradable sector. In Benigno and Fornaro (2014) we have dubbed this effect the *financial resource curse*, due to its similarities with the notion of natural resource curse. Here, however, there is one fundamental difference. Innovation activities in the country affected by the financial resource curse, that is the United States, determine the evolution of the world technological frontier. Capital inflows toward the United States thus produce a fall in global productivity growth, giving rise to a *global financial resource curse*.

Our model also helps to rationalize the sharp decline in global rates observed over the last three decades. It has been argued that the integration of high-saving developing countries in global credit markets has contributed to the drop in interest rates (Bernanke, 2005). This effect is also present in our framework, but in a magnified form. In standard models, after two regions integrate financially, the equilibrium interest rate lies somewhere between the two autarky rates. In our model, instead, financial integration induces a drop in the equilibrium interest rate below both autarky rates. The reason is that the slowdown in global productivity growth stimulates the global supply of savings, exerting downward pressure on interest rates. Because of this effect, financial integration can lead to a regime of superlow global rates.

This paper unifies two strands of the literature that have been traditionally separated. First, there is a vast literature on the impact of globalization on productivity growth. One part of this literature has argued that globalization increases global productivity growth by facilitating the flow of ideas across countries (Howitt, 2000). Another body of work has focused on the impact of trade globalization on productivity (Grossman and Helpman, 1991a; Rivera-Batiz and Romer, 1991; Akcigit et al., 2018; Cuñat and Zymek, 2019). We complement this literature by studying the impact of *financial globalization* on productivity growth.

Second, there is a literature studying the macroeconomic consequences of financial globalization, and in particular of the integration of high-saving developing countries in the international financial markets. For instance, Caballero et al. (2008) and Mendoza et al. (2009) provide models in which the integration of developing countries in global credit markets leads to an increase in the global supply of savings and a fall in global rates. Caballero et al. (2015) and Eggertsson et al. (2016) show that in a world characterized by deficient demand financial integration can lead to a fall in global output. This paper contributes to this literature by studying the impact of financial integration on global productivity growth.

The paper is also related to a third literature, which connects capital flows to productivity. In Ates and Saffie (2016), Benigno and Fornaro (2012) and Queralto (2019) sudden stops in capital inflows depress productivity growth. In Gopinath et al. (2017) and Cingano and Hassan (2019) capital flows affect productivity by changing the allocation of capital across heterogeneous firms. Finally, Benigno and Fornaro (2012, 2014) and Brunnermeier et al. (2018) study single small open economies and show that capital inflows might negatively affect productivity by reducing innovation activities in the tradable sector. Our paper builds on this insight, but takes a global perspective. In particular, due their impact on the world technological frontier, in our model capital flows out of developing countries can induce a drop in global productivity growth.

The rest of the paper is structured as follows. We start by discussing the key assumptions underpinning our theory. Section 2 introduces the model. Section 3 provides our main results through a steady state analysis. Section 4 considers transitional dynamics. Section 5 derives some policy implications. Section 6 concludes. The Appendix collects all the proofs to the propositions.

Discussion of key elements. Our theory rests on two key elements: the special role of sectors producing tradable goods in the growth process, and the impact of capital flows on the sectoral allocation of productive resources. Here we discuss the empirical evidence that underpins these notions.

We study an economy in which the tradable sector is the engine of growth. Empirically, tradable sectors are characterized by higher productivity growth compared to sectors producing non-tradable goods. For instance, Duarte and Restuccia (2010) study productivity growth at the sectoral level, using data from 29 OECD and developing countries over the period 1956-2004. They find that productivity grows faster in manufacturing and agriculture - two sectors traditionally associated with production of traded goods - compared to services, the sector producing the bulk of non-traded goods. Hlatshwayo and Spence (2014) reach the same conclusion using U.S. data for the period 1990-2013, even after accounting for the fact that some services can be traded. In our model, we capture this asymmetry by assuming that productivity growth is fully concentrated in the tradable sector. Our main results, however, would still be present as long as non-tradable sectors were characterized by a smaller scope for productivity improvements compared to tradable ones.

In our model the tradable sector also represents the source of knowledge spillovers from advanced to developing countries. Grossman and Helpman (1991a) provide an early theoretical treatment of knowledge flows across countries, while Klenow and Rodriguez-Clare (2005) show that international knowledge spillovers are necessary in order to account for the cross-countries growth patterns observed in the data. Several empirical studies point toward the importance of trade in facilitating technology transmission from advanced to developing countries. Just to cite a few examples, Coe et al. (1997), Keller (2004) and Amiti and Konings (2007) highlight the importance of imports as a source of knowledge transmission, while Blalock and Gertler (2004), Park et al. (2010) and Bustos (2011) provide evidence in favor of exports as a source of productivity growth. Rodrik (2012) considers cross-country convergence in productivity at the industry level and finds that this is restricted to the manufacturing sector. This finding lends support to our assumption that knowledge spillovers are concentrated in sectors producing tradable goods.

A crucial aspect of our framework is that capital inflows, and the associated credit booms, induce a shift of productive resources out of tradable sectors and toward non-tradable ones. Benigno et al. (2015) study 155 episodes of large capital inflows occurring in a sample of 70 middle- and high-income countries during the period 1975-2010. They find that these episodes are characterized by a shift of labor and capital out of the manufacturing sector. Pierce and Schott (2016) document a sharp drop in U.S. employment in manufacturing starting from the early 2000s, and thus coinciding with the surge in capital inflows from developing countries. More broadly, Mian et al. (2019) show that increases in credit supply tend to boost employment in non-tradable sectors at the expenses of tradable ones. As an example, they document that the deregulation of financial markets taking place in the United States during the 1980s lead to a credit boom and a shift of employment from tradable to non-tradable sectors.

Lastly, in our framework financial integration triggers capital flows out of developing countries and toward the United States. This feature of the model captures the direction of capital flows observed in the data from the late 1990s (see Figure 1a). The literature has proposed several explanations for this fact. In Caballero et al. (2008) developing countries export capital to the U.S. because they are unable to produce enough stores of value to satisfy local demand, due to the underdevelopment of their financial markets. Mendoza et al. (2009) argue that lack of insurance against idiosyncratic shocks contributes to the high saving rates observed in several developing countries. Gourinchas and Jeanne (2013) and Alfaro et al. (2014) show that policy interventions by governments in developing countries - aiming at fostering national savings - explain an important part of the capital outflows toward the United States. As we will see, for our results we do not need to take a stance on the precise source of high saving rates in developing countries. Our model is thus consistent with all these possible explanations.

2 Model

Consider a world composed of two regions: the United States and a group of developing countries.[1] As we will see, the two regions are symmetric except for two aspects. First, developing countries have a higher propensity to save compared to the United States. Second, innovation in the United States determines the evolution of the world technological frontier. Developing countries, instead, experience productivity growth by adopting discoveries originating from the United States. In what follows, we will refer to the United States as region u and to developing countries as region d. For simplicity, we will focus on a perfect-foresight economy. Time is discrete and indexed by $t \in \{0, 1, ...\}$.

2.1 Households

Each region is inhabited by a measure one of identical households. The lifetime utility of the representative household in region i is

$$\sum_{t=0}^{\infty} \beta^t \log(C_{i,t}), \tag{1}$$

where $C_{i,t}$ denotes consumption and $0 < \beta < 1$ is the subjective discount factor. Consumption is a Cobb-Douglas aggregate of a tradable good $C_{i,t}^T$ and a non-tradable good $C_{i,t}^N$, so that $C_{i,t} = (C_{i,t}^T)^{\omega}(C_{i,t}^N)^{1-\omega}$ where $0 < \omega < 1$. Each household is endowed with $\bar{L}$ units of labor, and there is no disutility from working.

Households can trade in one-period riskless bonds. Bonds are denominated in units of the tradable consumption good and pay the gross interest rate $R_{i,t}$. Moreover, investment in bonds is subject to a subsidy $\tau_{i,t}$. This subsidy is meant to capture a variety of factors, for instance such as demography or policy-induced distortions, affecting households' propensity to save. This feature of the model will allow us to generate, in a stylized but simple way, heterogeneity in saving rates across the two regions. In particular, we are interested in a scenario in which developing countries have a higher propensity to save compared to the United States. We will thus normalize $\tau_{u,t} = 0$ and assume that $\tau_{d,t} = \tau > 0$.

The household budget constraint in terms of the tradable good is

$$C_{i,t}^T + P_{i,t}^N C_{i,t}^N + \frac{B_{i,t+1}}{R_{i,t}(1+\tau_{i,t})} = W_{i,t}\bar{L} + \Pi_{i,t} - T_{i,t} + B_{i,t}. \tag{2}$$

The left-hand side of this expression represents the household's expenditure. $P_{i,t}^N$ denotes the price of a unit of non-tradable good in terms of tradable. Hence, $C_{i,t}^T + P_{i,t}^N C_{i,t}^N$ is the total expenditure in

[1] There is no need to specify the number of developing countries. For instance, our results apply to the case of a single large developing country, or to a setting in which there is a continuum of measure one of small open developing countries.

consumption. $B_{i,t+1}$ denotes the purchase of bonds made by the household at time t. If $B_{i,t+1} < 0$ the household is holding a debt.

The right-hand side captures the household's income. $W_{i,t}$ denotes the nominal wage, and hence $W_{i,t}\bar{L}$ is the household's labor income. Labor is immobile across regions and so wages are region-specific. Firms are fully owned by domestic agents, and $\Pi_{i,t}$ denotes the profits that households receive from the ownership of firms. $T_{i,t}$ is a tax paid to the domestic government. We assume that governments run a balanced budget and so $T_{i,t} = \tau_{i,t}B_{i,t+1}/(R_{i,t}(1+\tau_{i,t}))$. Finally, $B_{i,t}$ represents the gross return on investment in bonds made at time $t-1$.

There is a limit to the amount of debt that a household can take. In particular, the end-of-period bond position has to satisfy

$$B_{i,t+1} \geq -\kappa_{i,t}, \tag{3}$$

where $\kappa_{i,t} \geq 0$. In words, the maximum amount of debt that a household can take is equal to $\kappa_{i,t}$ units of tradable goods.

The household's optimization problem consists in choosing a sequence $\{C^T_{i,t}, C^N_{i,t},\ B_{i,t+1}\}_t$ to maximize lifetime utility (1), subject to the budget constraint (2) and the borrowing limit (3), taking initial wealth $B_{i,0}$, a sequence for income $\{W_{i,t}\bar{L}+\Pi_{i,t}-T_{i,t}\}_t$, and prices $\{R_{i,t}(1+\tau_{i,t}), P^N_{i,t}\}_t$ as given. The household's first-order conditions can be written as

$$\frac{\omega}{C^T_{i,t}} = R_{i,t}(1+\tau_{i,t})\left(\frac{\beta\omega}{C^T_{i,t+1}} + \mu_{i,t}\right) \tag{4}$$

$$B_{i,t+1} \geq -\kappa_{i,t} \quad \text{with equality if} \quad \mu_{i,t} > 0 \tag{5}$$

$$C^N_{i,t} = \frac{1-\omega}{\omega}\frac{C^T_{i,t}}{P^N_{i,t}}, \tag{6}$$

where $\mu_{i,t}$ is the nonnegative Lagrange multiplier associated with the borrowing constraint. Equation (4) is the Euler equations for bonds. Equation (5) is the complementary slackness condition associated with the borrowing constraint. Equation (6) determines the optimal allocation of consumption expenditure between tradable and non-tradable goods. Naturally, demand for non-tradables is decreasing in their relative price $P^N_{i,t}$. Moreover, demand for non-tradables is increasing in $C^T_{i,t}$, due to households' desire to consume a balanced basket between tradable and non-tradable goods.

2.2 Non-tradable good production

The non-tradable sector represents a traditional sector with limited scope for productivity improvements. The non-tradable good is produced by a large number of competitive firms using labor, according to the production function $Y^N_{i,t} = L^N_{i,t}$. $Y^N_{i,t}$ is the output of the non-tradable good, while $L^N_{i,t}$ is the amount of labor employed by the non-tradable sector. The zero profit condition thus requires that $P^N_{i,t} = W_{i,t}$.

2.3 Tradable good production

The tradable good is produced by competitive firms using labor and a continuum of measure one of intermediate inputs x^j, indexed by $j \in [0, 1]$. Intermediate inputs cannot be traded across the two regions.[2] Denoting by $Y_{i,t}^T$ the output of tradable good, the production function is

$$Y_{i,t}^T = \left(L_{i,t}^T\right)^{1-\alpha} \int_0^1 \left(A_{i,t}^j\right)^{1-\alpha} \left(x_{i,t}^j\right)^{\alpha} dj, \tag{7}$$

where $0 < \alpha < 1$, and $A_{i,t}^j$ is the productivity, or quality, of input j.[3]

Profit maximization implies the demand functions

$$(1-\alpha) \left(L_{i,t}^T\right)^{-\alpha} \int_0^1 \left(A_{i,t}^j\right)^{1-\alpha} \left(x_{i,t}^j\right)^{\alpha} dj = W_{i,t} \tag{8}$$

$$\alpha \left(L_{i,t}^T\right)^{1-\alpha} \left(A_{i,t}^j\right)^{1-\alpha} \left(x_{i,t}^j\right)^{\alpha-1} = P_{i,t}^j, \tag{9}$$

where $P_{i,t}^j$ is the price in terms of the tradable good of intermediate input j. Due to perfect competition, firms producing the tradable good do not make any profit in equilibrium.

2.4 Intermediate goods production and profits

Every intermediate good is produced by a single monopolist. One unit of tradable output is needed to manufacture one unit of intermediate good, regardless of quality. In order to maximize profits, each monopolist sets the price of its good according to

$$P_{i,t}^j = \frac{1}{\alpha} > 1. \tag{10}$$

This expression implies that each monopolist charges a constant markup $1/\alpha$ over its marginal cost.

Equations (9) and (10) imply that the quantity produced of a generic intermediate good j is

$$x_{i,t}^j = \alpha^{\frac{2}{1-\alpha}} A_{i,t}^j L_{i,t}^T. \tag{11}$$

Combining equations (7) and (11) gives:

$$Y_{i,t}^T = \alpha^{\frac{2\alpha}{1-\alpha}} A_{i,t} L_{i,t}^T, \tag{12}$$

[2]In the case of a single large developing country, this is equivalent to assuming that intermediate goods are non-tradables. If several developing countries are present, instead, we are effectively assuming that intermediate inputs can be perfectly traded among developing countries. We make this assumption purely to simplify the exposition, and our results would hold also if trade of intermediate goods across developing countries was not possible.

[3]More precisely, for every good j, $A_{i,t}^j$ represents the highest quality available. In principle, firms could produce using a lower quality of good j. However, as in Aghion and Howitt (1992) and Grossman and Helpman (1991b), the structure of the economy is such that in equilibrium only the highest quality version of each good is used in production.

where $A_{i,t} \equiv \int_0^1 A_{i,t}^j dj$ is an index of average productivity of the intermediate inputs. Hence, production of the tradable good is increasing in the average productivity of intermediate goods and in the amount of labor employed in the tradable sector. Moreover, the profits earned by the monopolist in sector j are given by

$$P_{i,t}^j x_{it}^j - x_{i,t}^j = \varpi A_{i,t}^j L_{i,t}^T,$$

where $\varpi \equiv (1/\alpha - 1)\alpha^{2/(1-\alpha)}$. According to this expression, the profits earned by a monopolist are increasing in the productivity of its intermediate input and on employment in the tradable sector. The dependence of profits from employment is due to the presence of a market size effect. Intuitively, high employment in the tradable sector is associated with high production of the tradable good and high demand for intermediate inputs, leading to high profits in the intermediate sector.

2.5 Innovation in the United States

In the United States, firms operating in the intermediate sector can invest in innovation in order to improve the quality of their products. In particular, a U.S. firm that employs in innovation $L_{u,t}^j$ units of labor sees its productivity evolve according to

$$A_{u,t+1}^j = A_{u,t}^j + \chi A_{u,t} L_{u,t}^j, \tag{13}$$

where $\chi > 0$ determines the productivity of research. This expression embeds the assumption, often made in the endogenous growth literature, that innovators can build on the existing stock of knowledge $A_{u,t}$. This assumption captures an environment in which existing knowledge is non-excludable, so that inventors cannot prevent others from drawing on their ideas to innovate.[4]

Defining firms' profits net of expenditure in research as $\Pi_{u,t}^j \equiv \varpi A_{u,t}^j L_{u,t}^T - W_{u,t} L_{u,t}^j$, firms producing intermediate goods choose investment in innovation to maximize their discounted stream of profits

$$\sum_{t=0}^{\infty} \frac{\omega \beta^t}{C_{u,t}^T} \Pi_{u,t}^j,$$

subject to (13). Since firms are fully owned by domestic households, they discount profits using the households' discount factor $\beta^t / C_{u,t}^T$. We will focus on interior equilibria, in which every U.S. firm performs some research activity in every period. In this case, optimal investment in research requires

$$\frac{W_{u,t}}{\chi A_{u,t}} = \frac{\beta C_{u,t}^T}{C_{u,t+1}^T} \left(\varpi L_{u,t+1}^T + \frac{W_{u,t+1}}{\chi A_{u,t+1}} \right). \tag{14}$$

Intuitively, in an interior equilibrium firms equalize the marginal cost from performing research

[4] This assumption, however, is not crucial for our results. In fact, we could equally assume that knowledge is a private good with respect to U.S. firms. In this case their productivity would follow the process $A_{u,t+1}^j = A_{u,t}^j + \chi A_{u,t}^j L_{u,t}^j$. None of our results would be affected by this alternative assumption.

$W_{u,t}/(\chi A_{u,t})$, to its marginal benefit discounted using the households' discount factor. The marginal benefit is given by the increase in profits next period $\varpi L^T_{u,t+1}$ plus the savings on future research costs $W_{u,t+1}/(\chi A_{u,t+1})$.

As it will become clear later on, a crucial aspect of the model is that the return from innovation is increasing in the size of the U.S. tradable sector, as captured by $L^T_{u,t+1}$. This happens because higher economic activity in the tradable sector boosts the profits that firms producing intermediate goods enjoy from improving the quality of their products. In this sense, the tradable sector is the engine of growth in our model.

2.6 Technology adoption by developing countries

Also in developing countries, productivity growth is the outcome of investment by firms producing intermediate goods. However, in developing countries firms improve the quality of their products by adopting technological advances originating from the United States. This assumption captures the idea that, due to their institutional setting, the ability of developing countries to innovate is limited compared to the U.S. one.[5]

Formally, following the literature on cross-country technology diffusion, we capture this notion by assuming that firms in developing countries can draw on the U.S. stock of knowledge when performing research. In particular, productivity in developing countries evolve according to

$$A^j_{d,t+1} = A^j_{d,t} + \xi A^{\phi}_{u,t} A^{1-\phi}_{d,t} L^j_{d,t}, \tag{15}$$

where $\xi > 0$ captures the productivity of research in developing countries, and $0 < \phi < 1$ determines the extent to which developing countries firm benefit from the U.S. stock of knowledge. These assumptions, as we will see, tie long-run productivity growth in developing countries to innovation activities in the United States. This feature of the model introduces a force toward, at least partial, convergence in productivity across the two regions.

Firms producing intermediate goods in developing countries choose investment in research to maximize their stream of profits, net of research costs, subject to (15). Again focusing on equilibria in which some research is performed by every firm in every period, optimal investment in innovation requires

$$\frac{W_{d,t}}{\xi A^{\phi}_{u,t} A^{1-\phi}_{d,t}} = \frac{\beta C^T_{d,t}}{C^T_{d,t+1}} \left(\varpi L^T_{d,t+1} + \frac{W_{d,t+1}}{\xi A^{\phi}_{u,t+1} A^{1-\phi}_{d,t+1}} \right). \tag{16}$$

As it was the case for the U.S., optimal investment in research equates the marginal cost from investing to its marginal benefit.[6] The difference is that for developing countries the marginal cost

[5] In our baseline model, we assume that developing countries base their productivity growth on technology adoption from advanced economies even in the long run. This would happen, for instance, if due to poor institutions the productivity of research aimed at innovating was sufficiently low in developing countries compared to the United States. In Section 4.2, we consider a case in which developing countries start innovating once their distance to the frontier becomes small enough.

[6] Notice that we are assuming that profits are discounted at rate $\omega\beta^t/C^T_{d,t}$. This corresponds to a case in which the subsidy on savings is restricted to investment in bonds only. Alternatively, we could have assumed that the subsidy on savings applies also to investment in research. In this case firms' profits would be discounted at rate

of performing research is decreasing in their distance from the technological frontier, as captured by the term $A_{u,t}/A_{d,t}$. This force will push toward convergence in productivity between the two regions. Moreover, as it was the case for the U.S., the benefit from investing in research is increasing in the size of the tradable sector ($L^T_{d,t+1}$). Hence, also in developing countries the tradable sector is the source of productivity growth.

2.7 Aggregation and market clearing

Value added in the tradable sector is just equal to total production of tradable goods net of the amount spent in producing intermediate goods. Using equations (11) and (12) we can write value added in the tradable sector as:

$$Y^T_{i,t} - \int_0^1 x^j_{i,t} dj = \Psi A_{i,t} L^T_{i,t}, \tag{17}$$

where $\Psi \equiv \alpha^{2\alpha/(1-\alpha)} \left(1 - \alpha^2\right)$.

Market clearing for the non-tradable good requires that in every region consumption is equal to production, so that

$$C^N_{i,t} = Y^N_{i,t} = L^N_{i,t}. \tag{18}$$

The market clearing condition for the tradable good can be instead written as

$$C^T_{i,t} + \frac{B_{i,t+1}}{R_{i,t}} = \Psi A_{i,t} L^T_{i,t} + B_{i,t}. \tag{19}$$

To derive this expression, we have used the facts that domestic households receive all the income from production, and that governments run a balance budget every period. Moreover, global asset market clearing requires that

$$B_{u,t} = -B_{d,t}. \tag{20}$$

Finally, in every region the labor market must clear

$$\bar{L} = L^N_{i,t} + L^T_{i,t} + L^R_{i,t}. \tag{21}$$

In this expression, we have defined $L^R_{i,t} = \int_0^1 L^j_{i,t} dj$ as the total amount of labor devoted to research in region i.

2.8 Equilibrium

In the balanced growth path of the economy some variables remain constant, while other grow at the same rate as $A_{u,t}$. In order to write down the equilibrium in stationary form, we normalize this second group of variables by $A_{u,t}$. To streamline notation, for a generic variable $X_{i,t}$ we define $x_{i,t} = X_{i,t}/A_{u,t}$. We also denote the growth rate of the technological frontier as $g_t \equiv A_{u,t}/A_{u,t-1}$,

$\omega\beta^t/((1+\tau)^t C^T_{d,t})$. All of our main results would extend to this case.

and the proximity of a region to the frontier by $a_{i,t} \equiv A_{i,t}/A_{u,t}$ (of course, $a_{u,t} = 1$).

The model can be narrowed down to three sets of equations or "blocks". The first block describes the path of tradable consumption and capital flows. Using the notation spelled out above, the households' Euler equation becomes

$$\frac{\omega}{c_{i,t}^T} = R_{i,t}(1+\tau_{i,t})\left(\frac{\beta\omega}{g_{t+1}c_{i,t+1}^T} + \tilde{\mu}_{i,t}\right), \tag{22}$$

where $\tilde{\mu}_{i,t} \equiv A_{u,t}\mu_{i,t}$. To ensure the existence of a balanced growth path, we assume that the borrowing limit of each region is proportional to productivity ($\kappa_{i,t} = \kappa A_{i,t+1} > 0$). Condition (5) can thus be written as

$$b_{i,t+1} \geq -\kappa a_{i,t+1} \quad \text{with equality if} \quad \tilde{\mu}_{i,t} > 0. \tag{23}$$

Finally, the market clearing conditions for the tradable good and for bonds become

$$c_{i,t}^T + \frac{g_{t+1}b_{i,t+1}}{R_{i,t}} = \Psi a_{i,t}L_{i,t}^T + b_{i,t} \tag{24}$$

$$b_{u,t} = -b_{d,t}. \tag{25}$$

These equations define the path of $c_{i,t}^T$, $b_{i,t}$ and $R_{i,t}$ given a path for productivity and tradable output. In particular, in a financially integrated world, these equations determine the behavior of capital flows across the two regions.

The second block of the model determines the behavior of productivity. Throughout, we will focus on interior equilibria in which $L_{i,t}^T > 0$ for every i and t. In this case, as it is easy to verify, $W_{i,t} = (1-\alpha)\alpha^{2\alpha/(1-\alpha)}A_{i,t}$. In equilibrium, equation (14) then becomes

$$g_{t+1} = \frac{\beta c_{u,t}^T}{c_{u,t+1}^T}\left(\chi\alpha L_{u,t+1}^T + 1\right). \tag{26}$$

This equation captures the optimal investment in research by U.S. firms, and implies a positive relationship between productivity growth and expected future employment in the tradable sector. Intuitively, a rise in production of tradable goods is associated with higher monopoly profits. In turn, higher expected profits induce entrepreneurs to invest more in research, leading to a positive impact on the growth rate of productivity. This is the classic market size effect emphasized by the endogenous growth literature, with a twist. The twist is that the allocation of labor across the two sectors matter for productivity growth.

Following similar steps, we can use (16) to obtain an expression describing the evolution of productivity in developing countries

$$a_{d,t}^{\phi} = \frac{\beta c_{d,t}^T}{g_{t+1}c_{d,t+1}^T}\left(\xi\alpha L_{d,t+1}^T + a_{d,t+1}^{\phi}\right). \tag{27}$$

This equation describes how the proximity of developing countries to the technological frontier evolves in response to firms' investment in research. As it was the case for the U.S., a larger tradable sector induces more investment in research by developing countries and thus leads to a closer proximity to the frontier.

The last block describes the use of productive resources, that is how labor is allocated across the production of the two consumption goods and research. To derive an expression for $L^N_{i,t}$, we can use $Y^N_{i,t} = L^N_{i,t}$ and $W_{i,t} = P^N_{i,t}$ to write equation (6) as

$$L^N_{i,t} = \frac{1-\omega}{\omega(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}} \frac{c^T_{i,t}}{a_{i,t}} \equiv \Gamma \frac{c^T_{i,t}}{a_{i,t}}.$$

The interesting aspect of this equation is that production of non-tradable goods is positively related to consumption of tradables, because of households' desire to balance their consumption across the two goods. Hence, as tradable consumption rises more labor is allocated to the non-tradable sector. As we will see, this effect plays a key role in mediating the impact of capital flows on productivity growth.

Expressions for $L^R_{i,t}$ can be derived by writing equations (13) and (15) as

$$L^R_{u,t} = \frac{g_{t+1}-1}{\chi}$$

$$L^R_{d,t} = \frac{g_{t+1}a_{d,t+1} - a_{d,t}}{\xi a^{1-\phi}_{d,t}}.$$

As it is intuitive, faster productivity growth or a closer proximity to the frontier requires larger innovation effort, and hence more labor allocated to research.

Plugging these expressions in the market clearing condition for labor then gives

$$L^T_{u,t} = \bar{L} - \Gamma c^T_{u,t} - \frac{g_{t+1}-1}{\chi} \tag{28}$$

$$L^T_{d,t} = \bar{L} - \Gamma \frac{c^T_{d,t}}{a_{d,t}} - \frac{g_{t+1}a_{d,t+1} - a_{d,t}}{\xi a^{1-\phi}_{d,t}}. \tag{29}$$

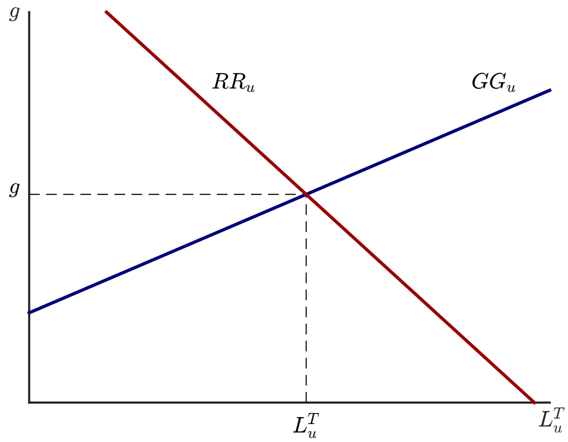
These equations can be interpreted as the resource constraints of the economy.

We collect these observations in the following lemma.

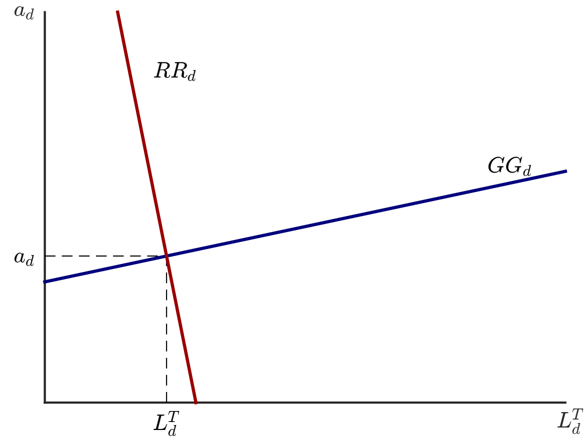
Lemma 1 *In a competitive equilibrium the path of real allocations* $\{c^T_{i,t}, b_{i,t+1}, \tilde{\mu}_{i,t}, a_{i,t+1}, L^T_{i,t}\}_{i,t}$*, interest rates* $\{R_{i,t}\}_{i,t}$ *and growth rate of the world technological frontier* $\{g_{t+1}\}_t$*, satisfy* (22)*,* (23)*,* (24)*,* (25)*,* (26)*,* (27)*,* (28) *and* (29) *given initial conditions* $\{b_{i,0}, a_{i,0}\}_i$*.*

3 Financial integration and global productivity growth

In this section we characterize the balanced growth path - or steady state - of the model. Focusing on steady states, and thus on the long-run behaviour of the economy, allows us to derive analytically



(a) United States.



(b) Developing countries.

Figure 2: Steady state equilibria.

our key results about the impact of financial integration on global productivity. We consider transitional - or medium-run - dynamics later on, in Section 4.1.

Steady state equilibria can be represented using two simple diagrams. The first diagram connects global productivity growth to the size of the tradable sector in the United States. Start by considering that in steady state $c_{i,t}^T$, $L_{i,t}^T$ and g_{t+1} are all constant. We can then write equation (26) as

$$g = \beta \left(\chi \alpha L_u^T + 1 \right), \tag{GG_u}$$

where the absence of a time subscript denotes the steady state value of a variable. The GG_u schedule captures the incentives to innovate for U.S. firms. Due to the market size effect described above, optimal investment in innovation in the U.S. gives rise to in a positive relationship between g and L_u^T. A second relationship between g and L_u^T can be obtained by writing equation (28) as

$$L_u^T = \bar{L} - \Gamma c_u^T - \frac{g-1}{\chi}. \tag{RR_u}$$

The RR_u schedule captures the resource constraint of the U.S. economy. Faster productivity growth requires more research effort, leaving less labor to be allocated to production. This explains why the RR_u describes a negative relationship between g and L_u^T. Together, these two schedules determine the equilibrium in the United States for a given value of c_u^T (Figure 2a).

A similar approach can be used to describe the equilibrium in developing countries. Recall that we are focusing on equilibria in which investment in research by developing countries is always positive. This implies that n steady state productivity in developing countries grows at rate g, and so their proximity to the technological frontier is constant. Hence, in steady state (27) reduces to

$$a_d^{\phi} = \frac{\beta \xi \alpha L_d^T}{g - \beta}. \tag{GG_d}$$

The GG_d schedule captures firms' incentive to adopt technologies from the frontier in developing countries. As production of tradables by developing countries increases, the return to increasing productivity rises, leading to higher investment in research and a closer proximity to the frontier. Instead, the steady state counterpart of (29) is

$$L_d^T = \bar{L} - \Gamma \frac{c_d^T}{a_d} - \frac{(g-1)a_d^{\phi}}{\xi}. \tag{RR_d}$$

Intuitively, maintaining a closer proximity to the frontier requires more research labor, leaving less labor to production of tradable goods. This explains the negative relationship between a and L_d^T implied by the RR_d schedule. Given a value of c_d^T, the intersection of these two schedules gives the equilibrium value of a_d and L_d^T (Figure 2b). To fully determine the equilibrium we need to specify a financial regime. We turn to this task next.

3.1 Financial autarky

Under financial autarky, financial flows across the two regions are not allowed. Hence, since households inside every region are symmetric, $b_{u,t} = b_{d,t} = 0$. This implies that tradable consumption is given by $c_{i,t}^T = a_{i,t} \Psi L_{i,t}^T$. It is then a matter of simple algebra to solve for the steady state values of g, a_d and L_i^T. Combining the GG_u and RR_u equations one gets that

$$g_a = \beta \left(\frac{\alpha \left(\chi \bar{L} + 1 - \beta \right)}{1 + \Gamma \Psi + \alpha \beta} + 1 \right), \tag{30}$$

where the subscript a denotes the value of a variable under financial autarky. As it is intuitive, a higher productivity of research in the U.S. (i.e. a higher χ) leads to faster growth in the world technological frontier. Moreover, as the tradable sector share of value added rises (i.e. as ω increases, and so Γ falls), more resources are devoted to innovation leading to faster productivity growth.[7]

To solve for the equilibrium in developing countries we can combine the equilibrium values of g and $L_{u,a}^T$ with equations GG_d and RR_d to obtain

$$a_{d,a}^{\phi} = \frac{\beta \xi \alpha \bar{L}}{(g_a - \beta)(1 + \Gamma \Psi) + (g_a - 1)\alpha \beta}. \tag{31}$$

Naturally, a higher ξ is associated with a more efficient process of technology adoption in developing countries, and thus to a closer proximity to the frontier in steady state.[8] Moreover, a larger size of the tradable sector (i.e. a lower Γ) is associated with a closer proximity to the frontier, because

[7] To clarify, what matters for our main results is that productivity growth is increasing in the share of labor allocated to the tradable sector. This means that our key results would also apply to a setting in which scale effects related to population size were not present. For instance, in the spirit of Young (1998), these scale effects could be removed by assuming that the number of intermediate inputs available inside a country are proportional to population size.

[8] $a_{d,a}$, instead, is decreasing with the growth rate of the technological frontier g_a. This happens because a faster pace of innovation in the U.S. requires more resources devoted to research by developing countries in order to maintain a constant proximity to the frontier.

technology adoption is the result of research efforts by firms in the tradable sector.

Moreover, under financial autarky the two regions feature different interest rates. Recalling that $\tau_{u,t} = 0$, using U.S. households' Euler equation gives

$$R_{u,a} = \frac{g_a}{\beta}.$$

Instead, since $\tau_{d,t} = \tau > 0$, the households' Euler equation in developing countries implies that

$$R_{d,a} = \frac{g_a}{\beta(1+\tau)} < R_{u,a}.$$

Hence, in the long run developing countries feature a lower interest rate compared to the United States. This is just the outcome of the higher propensity to save characterizing households in developing countries compared to U.S. ones.

Proposition 1 *Suppose that*

$$\frac{\beta\xi\alpha\bar{L}}{(g_a-\beta)(1+\Gamma\Psi)+(g_a-1)\alpha\beta} < \frac{1}{\beta} < \frac{\alpha\left(\chi\bar{L}+1-\beta\right)}{1+\Gamma\Psi+\alpha\beta}+1, \tag{32}$$

where g_a is given by (30). Then under financial autarky there is a unique steady state in which productivity in both regions grows at rate $g_a > 1$, given by (30), and developing countries' proximity to the frontier is equal to $a_{d,a} < 1$, given by (31). Moreover, $R_{u,a} = g_a/\beta$ and $R_{d,a} = g_a/((1+\tau)\beta) < R_{u,a}$.

Proposition 1 summarizes the results derived so far. The role of condition 32 is to guarantee that in steady state productivity grows at a positive rate ($g_a > 1$), and that developing countries do not catch up fully with the technological frontier ($a_{d,a} < 1$). This condition holds, for instance, if research is sufficiently productive in the United States (i.e. χ is large enough), and if the ability of developing countries to adopt U.S. technologies is sufficiently small (i.e. if ξ is not too large compared to χ).

3.2 Financial integration

What is the impact of financial globalization on growth? To answer this question, we now turn to a scenario in which the two regions are financially integrated. Since capital flows freely across the two regions, interest rates must be equalized and so $R_{u,t} = R_{d,t}$.

Recall that households in developing countries have a higher propensity to save compared to U.S. ones. Naturally, U.S. households have thus a tendency to borrow from developing countries. In fact, as it is easy to show, in the long-run U.S. households borrow up to their limit, and so $b_{u,f} = -\kappa$, where the subscript f denotes the value of a variable in the steady state with financial integration. Conversely, households in developing countries have positive assets in the long run.

Their Euler equation thus implies that in steady state

$$R_f = \frac{g_f}{\beta(1+\tau)}, \tag{33}$$

where R_f denotes the steady state world interest rate under financial integration. We can then use equation (24) to write

$$c_{u,f}^T = \Psi L_{u,f}^T - \kappa\left(1 - \frac{g_f}{R_f}\right) = \Psi L_{u,f}^T + \kappa\left(\beta(1+\tau) - 1\right). \tag{34}$$

This equation highlights how the U.S. trade balance in steady state ($\Psi L_{u,f}^T - c_{u,f}^T$) crucially depends on the ratio g_f/R_f, which is in turn determined by $\beta(1+\tau)$.

We are interested in a scenario in which financial integration leads the U.S. to run persistent trade deficits. In this section, we will thus assume that $g_f > R_f$, which is the case if $\beta(1+\tau) > 1$. In words, we are assuming that the steady state interest rate is lower than the growth rate of the economy. Empirically, at least if one interprets R_f as the return on U.S. government bonds, this assumption is in line with the experience of the United States since the mid-1990s. We defer a discussion of the case $g_f < R_f$ to Section 4.1, where we will show that our key insights also apply to this alternative scenario.

Perhaps the best way to understand the impact of financial integration on productivity growth is to employ the diagrams presented in Figure 3. Let us start from the United States. In a financially integrated world, as we have just discussed, the U.S. end up running trade deficits in the long run. Trade deficits, in turn, sustain consumption of tradable goods, which rises above production ($c_{u,f}^T > \Psi L_{u,f}^T$). But higher consumption of tradable goods pushes up demand for non-tradables. In order to satisfy this increase in demand, labor migrates from the tradable sector toward the non-tradable one. The result is a drop in L_u^T. Graphically, this is captured by the leftward shift of the RR_u curve. This is not, however, the end of the story. As the tradable sector shrinks, firms' incentives to innovate fall - because the profits appropriated by successful innovators are now smaller. The result is a drop in productivity growth in the United States.

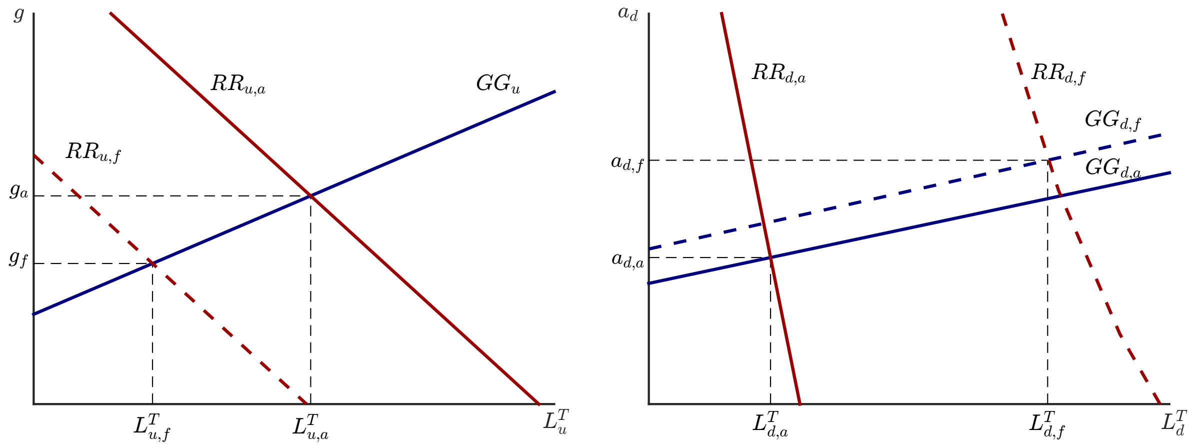
These results can also be derived analytically, by combining the GG_u and RR_u equations with (34) to obtain

$$g_f = g_a - \frac{\alpha\beta\chi\Gamma}{1+\Gamma\Psi+\alpha\beta}\kappa\left(\beta(1+\tau) - 1\right). \tag{35}$$

This expression shows that, as long as $\beta(1+\tau) > 1$, financial integration depresses g below its value under financial autarky. Moreover, this effect is stronger the larger the capital inflows toward the U.S., here captured by a higher value of the parameter κ.

In some respects, the impact of financial integration on developing countries is the mirror image of the U.S. one. In fact, after financial integration developing countries end up running trade surpluses in steady state, and their tradable consumption is given by

$$c_{d,f}^T = \Psi a_{d,f} L_{d,f}^T - \kappa\left(\beta(1+\tau) - 1\right). \tag{36}$$



(a) United States. **(b) Developing countries.**

Figure 3: Impact of financial integration.

Naturally, to finance trade surpluses consumption of tradables has to fall below production ($c^T_{d,f} < \Psi a_{d,f} L^T_{d,f}$). This causes a drop in demand for non-tradable goods, which induces labor to shift out of the non-tradable sector toward the tradable one. Graphically, this effect corresponds to a rightward shift of the RR_d curve.[9] Moreover, as the tradable sector grows larger, firms in developing countries increase their spending in research. They do so in order to appropriate the now larger profits derived from upgrading their productivity. As illustrated by Figure 3*b* this process pushes developing countries closer to the technological frontier.

More precisely, by combining the GG_a and RR_a equations with (36) one finds that

$$a^{\phi}_{d,f} = \frac{\alpha\beta\xi\left(\bar{L} + \Gamma\frac{\kappa(\beta(1+\tau)-1)}{a_{d,f}}\right)}{(g_f - \beta)(1+\Gamma\Psi) + (g_f - 1)\alpha\beta}. \tag{37}$$

Comparing this expression with (31) shows that, since $\beta(1+\tau) > 1$ and $g_f < g_a$, financial integration increases developing countries' proximity to the frontier. Again, this effect is stronger the larger the capital flows out of developing countries, i.e. the higher κ.

In spite of the increase in a_d, however, it is far from clear that financial integration is associated with long run productivity improvements in developing countries. The reason, of course, is that developing countries absorb technological advances originating from the United States. Therefore, the drop in U.S. productivity growth translates into lower long run productivity growth in developing countries too. Hence, the process of financial integration generates a fall in global productivity growth.

Taking stock, in our model inflows of foreign capital can depress productivity growth in the recipient country, due to their impact on the sectoral allocation of resources. In Benigno and Fornaro (2014) we have dubbed this effect the *financial resource curse*, due to its similarities with the notion of natural resource curse. Here, however, there is one fundamental difference.

[9] The shift in the GG_d curve, instead, is due to the impact of financial integration on U.S. productivity growth.

Innovation activities in the country affected by the financial resource curse, that is the United States, determine the evolution of the world technological frontier. Capital inflows toward the United States thus lead to a fall in global productivity growth, giving rise to a *global financial resource curse*.

Proposition 2 *Suppose that* $\beta(1+\tau) > 1$ *and that*

$$\frac{\alpha\xi\left(\bar{L}+\Gamma\kappa\left(\beta(1+\tau)-1\right)\right)}{(g_f-\beta)(1+\Gamma\Psi)+(g_f-1)\alpha\beta} < \frac{1}{\beta} < \frac{\alpha\left(\chi\left(\bar{L}+\Gamma\kappa\left(\beta(1+\tau)-1\right)\right)+1-\beta\right)}{1+\Gamma\Psi+\alpha\beta}+1, \tag{38}$$

where g_f *is given by* (35)*. Then under financial integration there is a unique steady state in which productivity in both regions grows at rate* g_f*, given by* (35)*, satisfying* $1 < g_f < g_a$*. Developing countries' proximity to the frontier is equal to* $a_{d,f}$*, given by* (37)*, with* $a_{d,a} < a_{d,f} < 1$*. Both regions share the same interest rate given by* $R_f = g_f/((1+\tau)\beta)$*.*

Proposition 2 summarizes our observations about the impact of financial integration on productivity. As it was the case under financial autarky, the role of condition 38 is to guarantee that in steady state productivity grows at a positive rate ($g_f > 1$), and that developing countries do not catch up fully with the technological frontier ($a_{d,f} < 1$).

Before closing this section, it is useful to spend some words on the impact of financial integration on interest rates. In standard models, after two regions integrate financially the equilibrium interest rate lies in between the two autarky rates (Caballero et al., 2008). This is not the case here. In fact, it is easy to see that the interest rate under financial integration lies below both autarky rates ($R_f < R_{d,a} < R_{u,a}$). This happens because financial integration depresses the rate of global productivity growth. Lower global productivity boosts households' supply of savings, and drives down the world interest rate below its values observed under financial autarky.

Corollary 1 *Suppose that* (32) *and* (38) *hold and that* $\beta(1+\tau) > 1$*. Then the world interest rate under financial integration is lower than the two autarky rates (*$R_f < R_{d,a} < R_{u,a}$*).*

Several commentators have argued that the integration in the international financial markets of developing countries, characterized by high saving rates, had a large negative impact on global rates (Bernanke, 2005). In our model this effect is present, but in a magnified form. The reason, once again, is that financial integration depresses global growth, putting further downward pressure on global rates.

4 Medium-run dynamics

4.1 Transitional dynamics

4.2 Innovation by developing countries

5 Policy implications

5.1 Growing-by-exporting in developing countries

5.2 Capital account policies in the United States

6 Conclusion

Appendix

A Proofs

B Lab equipment model

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