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Abstract

Since the late 1990s, the United States has 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.

Key words: global productivity growth, international financial integration, capital flows, U.S. productivity growth slowdown, low global interest rates, Bretton Woods II, export-led growth

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1 Introduction

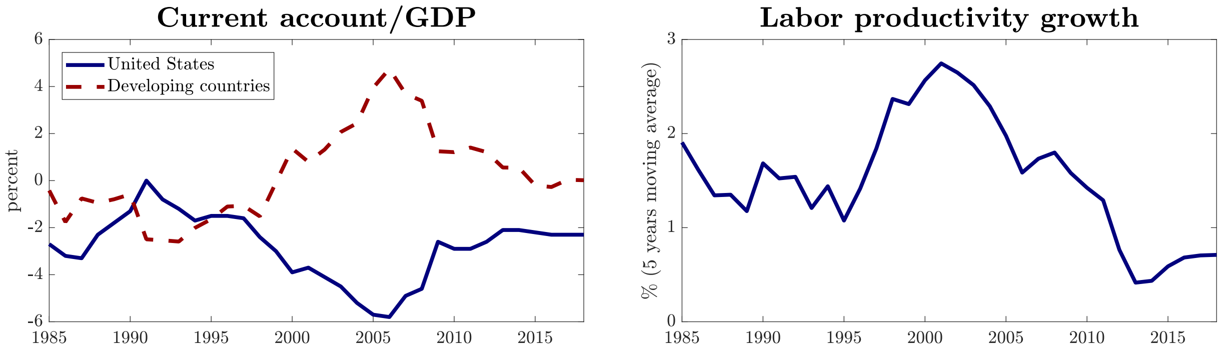
Since the late 1990s, the global economy has experienced two spectacular trends. First, there has been a surge of capital flows from developing countries - mainly China and other Asian countries - toward the United States (Figure 1a). Second, productivity growth in the United States has declined dramatically (Figure 1b). Both facts have been the center 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, 1991), innovation activities by the technological leader, i.e. 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 characterized by stagnant productivity growth. As we explain in more detail below, this assumption captures 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 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, 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 fall in U.S. productivity growth.

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



(a) Capital flows. **(b) U.S. productivity growth.**

Figure 1: Motivating facts. Notes: The left panel shows the large current account deficits experienced by the United States since the late 1990s, accompanied by current account surpluses from developing countries. The right panel illustrates the productivity growth slowdown affecting the United States since the early 2000s. See Appendix C for the procedure used to construct these figures.

States. Financial integration 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 investment in technology adoption. The proximity of developing countries to the technological frontier thus rises. But this does not necessarily mean that financial integration benefits productivity growth in developing countries. Following financial integration, indeed, productivity growth in developing countries initially accelerates, but then it slows down below its value under financial autarky. This happens because the drop in innovation activities in the U.S. reduces the productivity gains that developing countries can obtain by absorbing knowledge from the frontier. In the long run, therefore, the process of financial integration generates a fall in global productivity growth.

Perhaps paradoxically, in our framework cheap access to foreign capital by the world technological leader depresses global productivity growth. The reason is that capital inflows lead to a contraction in economic activity in tradable sectors, which are the engine of growth in our economies. In this respect, our model is connected to the idea of natural resource curse (Van der Ploeg, 2011). However, our mechanism is based on financial - rather than natural - resources. Moreover, the forces that we emphasize are global in nature. In fact, lower innovation by the technological leader drives down productivity growth also in the rest of the world, including in those countries experiencing capital outflows and an expansion of their tradable sectors. Therefore, we refer to the link between capital flows toward the world technological leader and weak global growth as the *global financial resource curse.*

Relatedly, it has been argued that the U.S. enjoy an exorbitant privilege, because they issue the world's dominant currency and are thus able to borrow cheaply from the rest of the world (Gopinath and Stein, 2018; Gourinchas et al., 2019). But in our model the exorbitant privilege carries an exorbitant duty, since capital inflows generate a growth slowdown in the country issuing the dominant currency.[1] Moreover, given that the U.S. represent the world's technological leader, this exorbitant duty spreads to the rest of the world as well. To the best of our knowledge, we are the first to emphasize this connection between the central role played by the United States in the international monetary and technological system.

Our model also helps to rationalize the sharp decline in global rates observed over the last three decades. Some commentators have claimed that the integration of high-saving developing countries in global credit markets has contributed to depress interest rates around the world (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. This happens because lower global growth leads agents to increase their saving supply, exerting downward pressure on interest rates. Because of this effect, financial integration can lead to a regime of superlow global rates.

In the last part of the paper, we use the model to revisit two growth strategies that are often debated in academic and policy circles. We start by considering export-led growth by developing countries, that is the idea that technology adoption can be fostered by policies that stimulate trade balance surpluses and capital outflows (Dooley et al., 2004). We show that export-led growth might be successful at raising productivity growth in developing countries in the medium run. However, this comes at the expenses of a fall in innovation activities in the United States, which eventually produces a drop in global productivity growth. We then consider policies that limit capital inflows, or equivalently trade balance deficits, in the United States. These interventions increase economic activity in the U.S. tradable sector, and thus foster innovation by the world technological leader. Therefore, policies that reduce capital inflows to the U.S. have a positive impact on global growth in the long run. In the medium run, however, restrictions on capital inflows toward the United States hurt growth in developing countries, and generate a sharp drop in global interest rates.

The rest of the paper is structured as follows. We start by discussing the related literature and 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 proofs to all the propositions are collected in the Appendix.

Related literature. 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, 1991; 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.

[1] Gourinchas et al. (2010) coined the term exorbitant duty, to describe the fact that the United States tend to make losses on their foreign asset position during times of global stress.

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), Eggertsson et al. (2016) and Fornaro and Romei (2019) 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. 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.[2] Our paper builds on this insight, but takes a global perspective. In particular, due to their impact on the world technological frontier, in our model capital flows out of developing countries can induce a drop in global productivity growth.

Finally, this paper contributes to the recent literature exploring the causes of the U.S. productivity growth slowdown. This literature has focused on different possibilities, such as rising costs from discovering new ideas (Bloom et al., 2020), slower technology diffusion from frontier to laggard firms (Akcigit and Ates, 2020), low competition due to rising firms' entry costs (Aghion et al., 2019) or falling interest rates (Liu et al., 2019), and weak aggregate demand leading to low profits from innovating (Anzoategui et al., 2019; Benigno and Fornaro, 2018). Our paper provides a complementary explanation, based on the interaction of capital flows and the sectoral allocation of production.

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

[2]The notion of financial resource curse, defined as the joint occurrence of large capital inflows and weak productivity growth, was introduced in Benigno and Fornaro (2014) by a subset of the authors of this paper. There are, however, stark differences between this paper and Benigno and Fornaro (2014). Benigno and Fornaro (2014) focus on a single small open economy, receiving an exogenous inflow of foreign capital. Instead, here we take a global perspective, and study the impact on the global economy of capital flows from developing countries to the technological leader. We show that in this case also those countries experiencing capital outflows, which should grow faster according to the logic of Benigno and Fornaro (2014), will eventually see their productivity growth slowing down. Moreover, in the current framework we consider the implications for global interest rates, which were taken as exogenous in Benigno and Fornaro (2014), and study the global impact of export-led growth by developing countries and of restrictions on capital inflows by the United States. Another difference is that in Benigno and Fornaro (2014) growth was the unintentional byproduct of learning by doing. Here, as in the modern endogenous growth literature, productivity growth is the result of investment in innovation by profit-maximizing firms.

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 (1991) 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. 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.[3] 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 U.S. 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 U.S. 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, 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 $\tau_{d,t} = \tau > 0$.

[3] 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.

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 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 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 $\kappa_{i,t} \geq 0$. This constraint captures in a simple form a case in which a household cannot credibly commit in period t to repay more than $\kappa_{i,t}$ units of the tradable good to its creditors in period $t+1$.

The household's optimization problem consists in choosing a sequence $\{C_{i,t}^T, C_{i,t}^N,\ B_{i,t+1}\}_t$ 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 $\{R_{i,t}(1+\tau_{i,t}), P_{i,t}^N\}_t$ as given. The household's first-order conditions can be written as

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

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

$$C_{i,t}^N = \frac{1-\omega}{\omega}\frac{C_{i,t}^T}{P_{i,t}^N}, \tag{6}$$

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 $P_{i,t}^N$. Moreover, demand for non-tradables is increasing in $C_{i,t}^T$, 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 $Y_{i,t}^N = L_{i,t}^N$. $Y_{i,t}^N$ is the output of the non-tradable good, while $L_{i,t}^N$ is the amount of labor employed by the non-tradable sector. The zero profit condition thus requires that $P_{i,t}^N = W_{i,t}$.

2.3 Tradable good production

The tradable good is produced by competitive firms using labor and a continuum of measure one of intermediate inputs $x_{i,t}^j$, indexed by $j \in [0,1]$. Intermediate inputs cannot be traded across the two regions.[4] 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.[5]

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 the 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.

[4] 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.

[5] 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), the structure of the economy is such that in equilibrium only the highest quality version of each good is used in production.

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:

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

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 in employment in the tradable sector. The dependence of profits on 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[6]

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

where $\chi>0$ determines the productivity of research. This expression embeds the assumption, often made in the endogenous growth literature, that innovators 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.[7]

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

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

[6] In Appendix B we demonstrate that all our results are robust toward assuming that investment in innovation is done in terms of the tradable final good, rather than in terms of labor.

[7] 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.

subject to (13). Since firms are fully owned by domestic households, they discount profits using the households' discount factor $\omega\beta^t/C^T_{u,t}$.

From now on, we assume that firms are symmetric and so $A^j_{u,t} = A_{u,t}$. Moreover, we focus on equilibria in which investment in innovation by U.S. firms is always positive. Optimal investment in research then requires

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

Intuitively, firms equalize the marginal cost from performing research $W_{u,t}/(\chi A_{u,t})$, to its marginal benefit discounted using the households' discount factor. The marginal benefit is given by the increase in next period profits ($\varpi L^T_{u,t+1}$) 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

In developing countries, firms producing intermediate goods improve the quality of their products by adopting technological advances originating from the United States.[8] Following the literature on international technology diffusion (Barro and Sala-i Martin, 1997), we formalize this notion by assuming that firms in developing countries draw on the U.S. stock of knowledge when performing research. Productivity of a generic intermediate input j thus evolves 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 $0 < \phi \leq 1$ determines the extent to which developing countries' firms benefit from the U.S. stock of knowledge. Since we think of the United States as the technological leader and developing countries as the followers, we will focus on scenarios in which $A_{u,t} > A_{d,t}$ for all t.

Firms producing intermediate goods in developing countries choose investment in research to maximize their stream of profits, net of research costs, subject to (15). We restrict attention to equilibria in which firms in developing countries are symmetric ($A^j_{d,t} = A_{d,t}$), and their investment in technology adoption is always positive. Optimal investment in research then requires

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

[8] This assumption captures the idea that, due to institutional features, the United States enjoy a strong comparative advantage in conducting innovation activities compared to developing countries.

As it was the case for the U.S., optimal investment in research equates the marginal cost from investing to its marginal benefit.[9] The difference is that for developing countries the marginal cost 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 pushes 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 ($L^T_{d,t+1}$). Also in developing countries, therefore, 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 balanced 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.

[9] 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 τ is restricted to investment in bonds only. Alternatively, we could have assumed that the subsidy on savings applies also to investment in research. Our main insights would also apply to this alternative setting. The only wrinkle is that then we would have to assume, as in Benigno and Fornaro (2018), that every firm has a constant probability of loosing its stream of monopoly profits (perhaps because its technology is copied by another firm, or for some other shock that leads to the firm's death). This would be needed to maintain firms' value finite, even in environments in which the interest rate is persistently lower than the growth rate of the economy.

2.8 Equilibrium

In the balanced growth path of the economy some variables remain constant, while others 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 $x_{i,t} \equiv X_{i,t}/A_{u,t}$. We also denote the growth rate of the technological frontier as $g_t \equiv A_{u,t}/A_{u,t-1}$, 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 ($\kappa_{i,t} = \kappa_t A_{i,t+1} > 0$), where κ_t is a time-varying parameter with steady state value $\kappa > 0$. Condition (5) can thus be written as

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

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 $L_{i,t}^N$, we can use $Y_{i,t}^N = L_{i,t}^N$ and $W_{i,t} = P_{i,t}^N$ to write equation (6) as

$$L_{i,t}^N = \frac{1-\omega}{\omega(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}}} \frac{c_{i,t}^T}{a_{i,t}} \equiv \Gamma \frac{c_{i,t}^T}{a_{i,t}}.$$

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 $L_{i,t}^R$ can be derived by writing equations (13) and (15) as

$$L_{u,t}^R = \frac{g_{t+1} - 1}{\chi}$$

$$L_{d,t}^R = \frac{g_{t+1} a_{d,t+1} - a_{d,t}}{\xi a_{d,t}^{1-\phi}}.$$

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

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

$$L_{d,t}^T = \bar{L} - \Gamma \frac{c_{d,t}^T}{a_{d,t}} - \frac{g_{t+1} a_{d,t+1} - a_{d,t}}{\xi a_{d,t}^{1-\phi}}. \tag{29}$$

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

We collect these observations in the following lemma.

Lemma 1 *In an equilibrium the path of real allocations* $\{c_{i,t}^T, b_{i,t+1}, \tilde{\mu}_{i,t}, a_{i,t+1}, L_{i,t}^T\}_{i,t}$*, interest rates* $\{R_{i,t}\}_{i,t}$ *and growth rate of the technological frontier* $\{g_{t+1}\}_t$*, satisfy* (22), (23)*,* (24)*,* (25)*,* (26)*,* (27), (28) *and* (29) *given a path for the borrowing limit* $\{\kappa_t\}_t$ *and 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 our key results about the impact of financial integration on global productivity growth. We consider transitional - or medium-run - dynamics later on, in Section 4.

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 $c^T_{i,t}$, $L^T_{i,t}$ and g_{t+1} are all constant. We can then write equation (26) as

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

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 United States gives rise to a positive relationship between g and L^T_u. A second relationship between g and L^T_u can be obtained by writing equation (28) as

$$L^T_u = \bar{L} - \Gamma c^T_u - \frac{g-1}{\chi}. \tag{RR_u}$$

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 schedule describes a negative relationship between g and L^T_u. Together, these two schedules determine the equilibrium in the United States for a given value of c^T_u (Figure 2a).

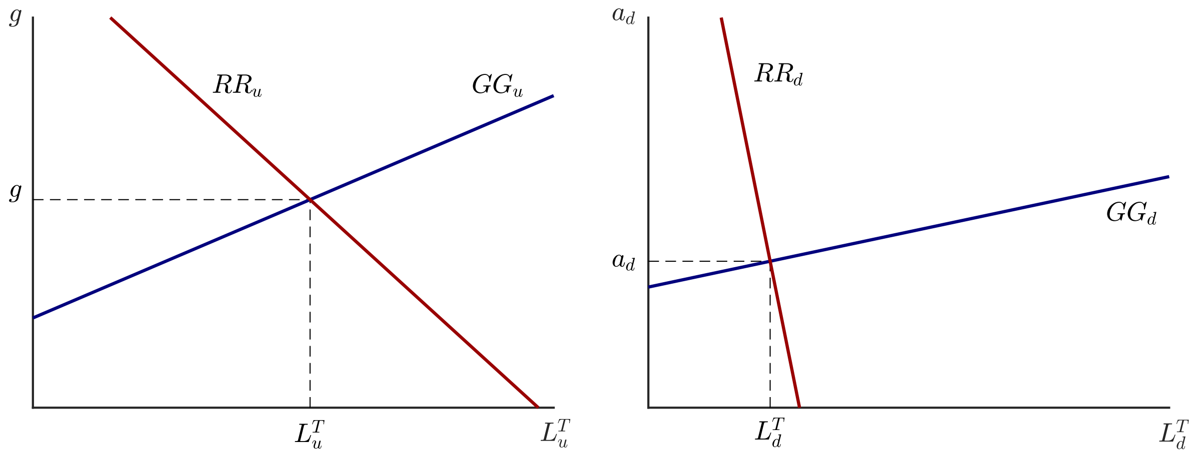
A similar approach can be used to describe the equilibrium in developing countries. Recall that we are focusing on equilibria in which investment in research by developing countries is always positive. This implies that in steady state productivity in developing countries grows at rate g, and so their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

$$a^\phi_d = \frac{\beta \xi \alpha L^T_d}{g - \beta}. \tag{GG_d}$$

The GG_d schedule captures the incentives of firms in developing countries to adopt technologies from the frontier. 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

$$L^T_d = \bar{L} - \Gamma \frac{c^T_d}{a_d} - \frac{(g-1)a^\phi_d}{\xi}. \tag{RR_d}$$

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



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

Figure 2: Steady state equilibria.

L_d^T implied by the RR_d schedule. Given a value of c_d^T, the intersection of these two schedules determines the equilibrium value of a_d and L_d^T (Figure 2b). To fully characterize 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. Since households inside every region are symmetric, it must then be that $b_{u,t} = b_{d,t} = 0$. We can thus define an equilibrium under financial autarky as follows.

Definition 1 *An equilibrium under financial autarky satisfies the conditions stated in Lemma 1 and* $b_{i,t} = 0$ *for all* i *and* t*.*

In each region consumption of tradable goods must be equal to output, and so $c_{i,t}^T = a_{i,t}\Psi L_{i,t}^T$. It is then a matter of simple algebra to solve for the steady state values of g and a_d. 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. According to this expression, 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.[10]

[10]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) and Howitt (1999), these

To solve for the equilibrium in developing countries we can combine equations GG_d and RR_d to obtain

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

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.[11] Moreover, a larger size of the tradable sector (i.e. a lower Γ) is associated with a closer proximity to the frontier, because technology adoption is the result of research efforts by firms in the tradable sector.

Finally, 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*

$$i)\quad \beta\left(\frac{\alpha\left(\chi\bar{L}+1-\beta\right)}{1+\Gamma\Psi+\alpha\beta}+1\right)>1 \quad \text{and} \quad ii)\quad \xi<\chi. \tag{32}$$

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 second condition is satisfied if the ability of developing countries to adopt U.S. technologies is sufficiently small compared to the productivity of research in the United States.

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

scale effects could be removed by assuming that the number of intermediate inputs available inside a country is proportional to population size.

[11] $a_{d,a}$, 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.

two regions, interest rates must be equalized and so $R_{u,t} = R_{d,t}$. We are now ready to define an equilibrium under financial integration.

Definition 2 *An equilibrium under financial integration satisfies the conditions stated in Lemma 1 and $R_{u,t} = R_{d,t}$ for all t.*

Recall that households in developing countries have a higher propensity to save compared to U.S. ones. In the long-run U.S. households thus borrow up to their limit and $b_{u,f} = -\kappa$, 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

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

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 $\beta(1+\tau)$.

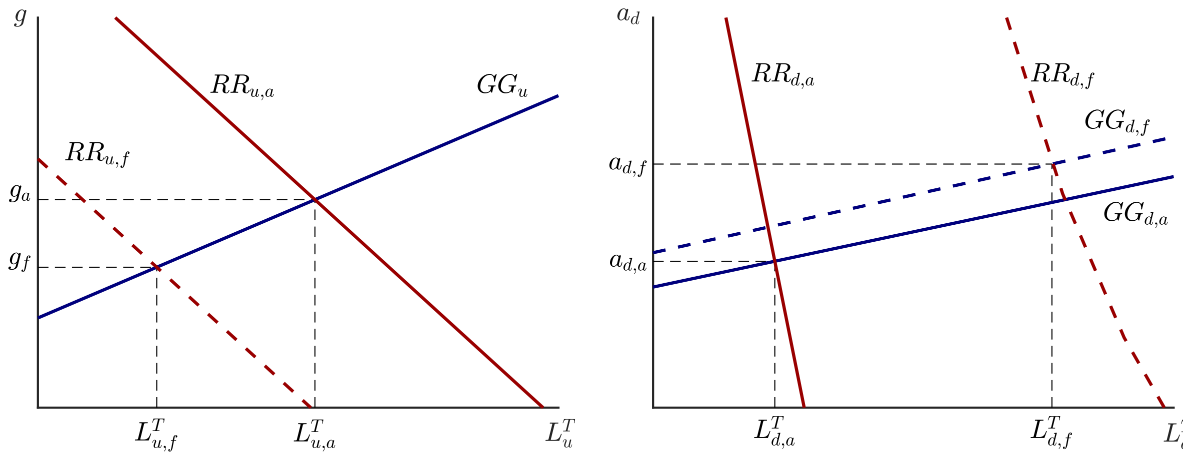
We are interested in a scenario in which the United States run persistent trade deficits. This happens if $g_f > R_f$, that is if the steady state interest rate is lower than the growth rate of the economy. Empirically, at least if one interprets R_f as the return on U.S. government bonds, this condition is in line with the experience of the United States since the mid-1990s.[12] Moreover, the U.S. have indeed been running persistent trade deficits - despite being a net debtor - during this period. From now on, therefore, we will focus on the case $g_f > R_f$ by assuming that $\beta(1+\tau) > 1$.

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, since $\beta(1+\tau) > 1$, the United States end up running trade deficits in the long run. In turn, trade deficits sustain consumption of tradable goods, which rises above production $(c_{u,f}^T > \Psi L_{u,f}^T)$. 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, and so L_u^T falls. 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.

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

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

[12] More broadly, as shown by Mehrotra and Sergeyev (2019), the rate of return on U.S. government bonds has been lower than the growth rate of the U.S. economy for most of the post-WWII period.



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

Figure 3: Impact of financial integration.

This expression shows that financial integration depresses g below its value under financial autarky.[13] Moreover, this effect is stronger the larger the capital inflows toward the United States, 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

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

Naturally, to finance trade surpluses consumption of tradables has to fall below production ($c^T_{d,f} < \Psi a_{d,f} L^T_{d,f}$).[14] 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.[15] As the tradable sector grows larger, firms in developing countries increase their spending in research. They do so in order to appropriate the now higher profits derived from upgrading their productivity. As illustrated by Figure 3b, this process pushes developing countries closer to the technological frontier.

More precisely, by combining the GG_d and RR_d 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

[13] Recall that we are assuming $\beta(1+\tau) > 1$.

[14] We restrict the analysis to values of κ small enough so that tradable consumption in developing countries is always positive.

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

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 generates long run productivity improvements in developing countries. The reason is that developing countries absorb technological advances originating from the United States. Therefore, lower innovation activities in the United States translate into a drop in the steady state rate of productivity growth in developing countries. Hence, at least in the long run, the process of financial integration generates a fall in global productivity growth.

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

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

where g_a is given by (30). 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 ($a_{d,f} < 1$). Because financial integration reduces g_f and raises $a_{d,f}$ relative to their values under financial autarky, this amounts to assuming that cross-border capital flows, as captured by the variable $\kappa(\beta(1+\tau)-1)$, are not too large.

Our framework also gives a new perspective on the impact of financial integration on interest rates. In standard models, after two regions integrate financially, the equilibrium interest rate lies somewhere in between the two autarky rates. 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 productivity growth boosts households' supply of savings, and drives down the world interest rate below the values observed under financial autarky.

Corollary 1 *Suppose that (38) holds 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 it is magnified by the drop in global productivity growth associated with financial globalization. Hence, here financial integration leads to a regime of superlow global rates.

Before concluding this section, two remarks are in order. First, in our model inflows of foreign capital depress productivity growth in the recipient country because they reduce economic activity in the tradable sector. Due to its similarities with the notion of natural resource curse, in Benigno and Fornaro (2014) we have dubbed this effect the *financial resource curse*. Here, however, the implications are much more dramatic. In fact, one could naively think that countries experiencing capital outflows - and so an expansion of their tradable sector - would enjoy faster productivity growth. But, as we have just shown, this conclusion is not correct. In our model the slowdown in productivity growth affects capital-exporting countries too, giving rise to a *global financial resource curse*.

Second, there is a literature emphasizing how capital flows from developing countries to the United States are driven by the role of the dollar as the world's dominant currency (Gopinath and Stein, 2018). In fact, the United States' ability to issue reserve assets highly demanded by developing countries has been referred to as an exorbitant privilege (Gourinchas et al., 2019). A distinctive feature of our model is that the country issuing the dominant currency is also the world technological leader. But this might transform the exorbitant privilege in an exorbitant duty, since capital flows can generate a growth slowdown in the country issuing the dominant currency.[16] Worse yet, the exorbitant duty spreads to the countries whose growth depends on technology adoption from the frontier. To the best of our knowledge, we are the first to emphasize this connection between the central role played by the United States in the international monetary and technological system.

4 Capital flows and productivity growth in the medium run

So far, we have focused our analysis on steady states, that is on the long run behavior of the economy. In this section, instead, we focus on the medium run, that is on the transition from a regime of financial autarky to financial integration. To anticipate our main finding, during the transition developing countries can experience an acceleration in productivity growth, as they push themselves closer to the technological frontier.[17] Therefore, when developing countries start joining the international credit markets, global productivity growth might accelerate. But this growth acceleration might only be temporary and, due to the logic of the global financial resource curse, global productivity growth might eventually slow down in the long run.

To illustrate the transitional dynamics of the model, we resort to some simple numerical simulations.[18] To be clear, the objective of this exercise is not to provide a careful quantitative evaluation of our mechanism. This would require a much richer framework. Rather, our aim is to show how the transitional dynamics of the model look for reasonable values of the parameters.

We perform the following experiment. The economy is in the financial autarky steady state

[16] Gourinchas et al. (2010) coined the term exorbitant duty, to describe the fact that the United States tend to make losses on their foreign asset position during times of global stress.

[17] This is consistent with the experience of several developing countries, in which capital outflows were coupled with fast productivity growth (Gourinchas and Jeanne, 2013).

[18] All dynamics are computed using the Levenberg-Marquardt mixed complementarity algorithm (lmmcp) implemented in Dynare. This algorithm solves for full non-linear perfect foresight paths of the economy without relying on linearization, and can additionally handle occasionally binding constraints. See Adjemian et al. (2011) for details.

in period $t = 0$. In period $t = 1$ international credit markets open up, and the economy transits toward the steady state with financial integration. We model the opening of the international credit markets as a gradual increase in the borrowing limit κ_t, which follows the path

$$\kappa_t = \frac{1}{1+\rho}\kappa_{t-1} + \frac{\rho}{1+\rho}\kappa, \tag{39}$$

where $\kappa > 0$ continues to denote the steady state value of the borrowing limit, and $\kappa_0 = 0$.[19] The parameter ρ determines the speed with which restrictions on cross-border capital flows are lifted.

4.1 Parameters

We choose the length of a period to correspond to a year. In line with the international macroeconomic literature, we set the discount factor to $\beta = 0.99^4 = 0.96$, and the share of tradable goods in consumption expenditure to $\omega = 0.25$. The total amount of labor is normalized to unity, so that $\bar{L} = 1$.

To choose the parameters determining the growth process, we target some moments of the steady state under financial autarky. We set the labor share in gross tradable output to $1-\alpha = 0.53$, so that under financial autarky the United States spend 2.5% of GDP in innovation activities.[20] The productivity of research in the United States is set to $\chi = 0.74$. This implies that productivity growth in the autarky steady state is equal to 2%. Choosing values for the parameters determining knowledge absorption in developing countries is a challenging task, since the literature offers little guidance about it. We then fix $\phi = 1$,[21] and set ξ by targeting developing countries' distance from the frontier in the autarky steady state. From Figure 1a, current account imbalances across the United States and developing countries have opened up after 1995, and we thus assume that developing countries were in their financial autarky steady state in that year. Using data provided by Klenow and Rodriguez-Clare (2005), we compute an estimate of the distance from the frontier for a sample of developing countries in 1995, which gives us $a_{d,a} = 0.44$ (Appendix C describes the procedure used to derive this estimate). We then set $\xi = 0.32$ to match this statistic.

We are left to choose values for κ, τ and ρ, the parameters governing the behavior of capital flows and foreign assets. We set $\kappa = 0.06$, so that in the final steady state the United States have a net foreign asset-to-GDP position equal to -40%, similar to the value observed over the last few years. Given this value for κ, we set $\tau = 0.09$ so that in the final steady state the United States have a trade balance deficit equal to 2% of GDP, again close to its empirical counterpart in recent years. Finally, we set $\rho = 0.15$ so that the transition lasts about 25 years. This assumption guarantees that the global economy experiences a protracted period of sizable current account imbalances, in line with the pattern of capital flows shown in Figure 1a.

[19] Financial integration is modeled as an unexpected shock, in the sense that in periods $t < 1$ agents expect the world to remain in financial autarky forever. From period $t = 1$ on agents have perfect foresight.

[20] For comparison, according to data from the OECD, between 1981 and 2017 the average R&D spending-to-GDP ratio in the United States has been 2.58%.

[21] Setting ϕ to a lower value does not affect much our results, but does lead to a somewhat slower transition.

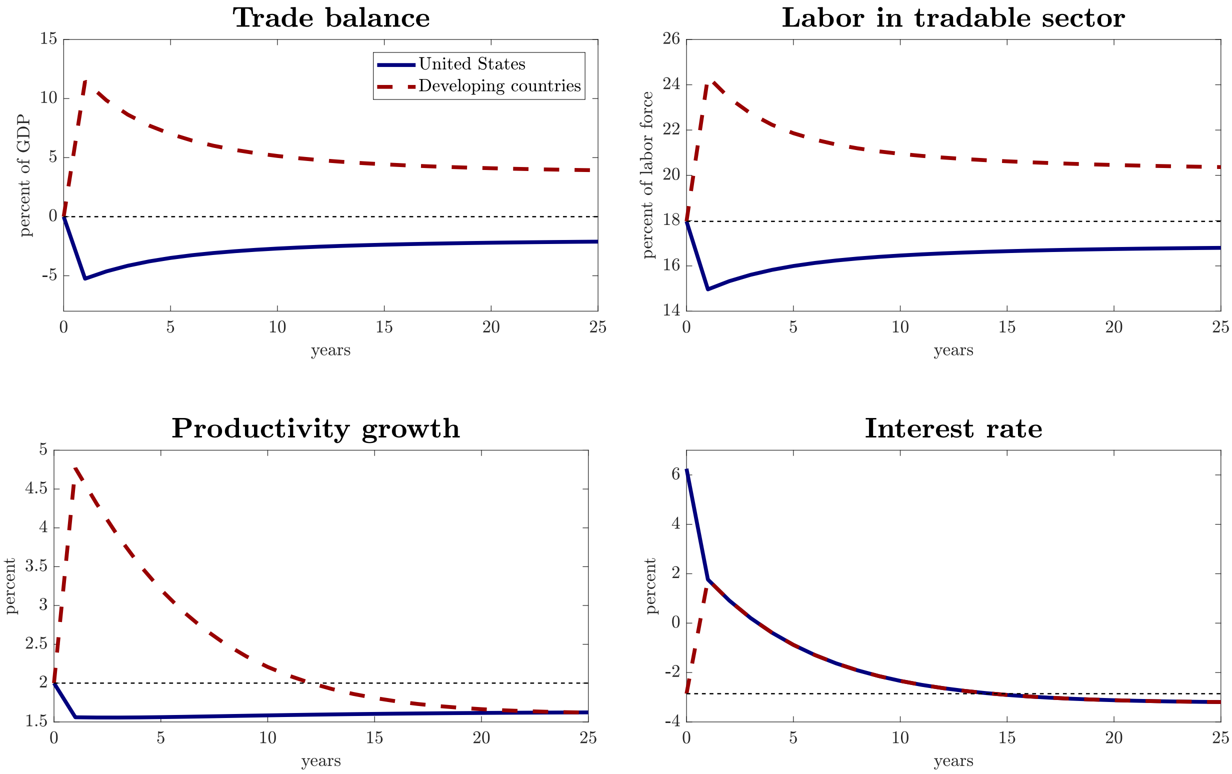


Figure 4: Transition from autarky to financial integration. Notes: the process of financial integration is captured by a gradual rise in κ_t, which is governed by (39). Financial integration is not anticipated by agents in periods $t < 1$. From period $t = 1$ on agents have perfect foresight.

4.2 Results

Figure 4 displays the economy's transitional dynamics, following the opening of international credit markets to developing countries. The top-left panel shows that the process of financial integration is characterized by large capital flows out of developing countries and toward the United States. As a result, the United States experience a persistent spell of sizable trade balance deficits. In turn, as explained above, the deficits in the trade balance induce a reallocation of labor in the United States toward the non-tradable sector, at the expense of the tradable one (top-right panel). As economic activity in the tradable sector falls, U.S. firms cut back their investment in innovation, resulting in a drop in the U.S. rate of productivity growth. These dynamics are all in line with the steady state analysis discussed in Section 3.

Turning to developing countries, financial integration is associated with large trade balance surpluses, and thus with an increase in economic activity in the tradable sector. Higher profits in the tradable sector lead firms in developing countries to increase their investment in technology adoption. Initially, this effect generates an acceleration in productivity growth in developing countries, which pushes them closer to the technological frontier. Hence, in the medium run, the model reproduces the positive correlation between productivity growth and capital outflows documented for developing countries by Gourinchas and Jeanne (2013). Eventually, however, productivity growth in developing countries slows down falling below the growth rate in the initial autarky steady state. The reason, of course, is that low productivity growth in the United States reduces the scope for technology adoption in developing countries. The model thus qualifies the view that developing countries can boost technology adoption and productivity growth by running trade balance surpluses, that is the Bretton Woods II view popularized by Dooley et al. (2004). We will go back to this point in Section 5.1.

The bottom-right panel of Figure 4 shows the path of interest rates. Financial globalization leads to interest rate equalization between the United States and developing countries. As standard frameworks would predict, on impact the world interest rate lies between the two autarky rates. This means that the United States experience a fall in their interest rate, while the interest rate in developing countries increases above its autarky value. This situation, however, is only temporary. As global growth slows down the world interest rate keeps falling. After a few years since the start of financial globalization, in fact, the world interest rate falls below both autarky rates. Therefore, in the long run the world enters a state of superlow interest rates, in which both the United States and developing countries experience a drop in their interest rate below the autarky values.

5 Policy implications

Governments often implement policies with the objective of fostering productivity growth. But what is the impact of these interventions in an integrated global economy, characterized by international mobility of capital and ideas? We now tackle this question with the help of our framework.[22] We start by considering interventions by governments in developing countries, and then turn to the United States.

5.1 Export-led growth by developing countries

A widespread belief, especially in policy circles, is that productivity growth in developing countries can be fostered by policies that stimulate trade surpluses. For instance, Dooley et al. (2004) put this notion at the centre of their Bretton Woods II perspective on the international monetary system. They argue that governments in East Asian countries have based their development strategy on export-led growth, supported by policies - such as capital controls and accumulation of foreign reserve assets - encouraging capital outflows toward the United States.[23]

Perhaps surprisingly, little research has been devoted to assess the viability of this growth strategy, especially when implemented on a global scale. In this section, we revisit this question through the lens of our framework. To do so, we will trace the impact on the global economy of an

[22]To be clear, the analysis in this section represents just a first pass in understanding the impact of different policies on the global economy. For instance, here we take a purely positive perspective, consisting in tracing the impact of policy interventions on global macroeconomic variables. We instead refrain from performing normative analyses and deriving optimal policy interventions. This is an interesting exercise, but it is beyond the scope of this paper.

[23]Consistent with this hypothesis, Alfaro et al. (2014) show that the positive correlation between capital outflows and productivity growth observed in developing countries is driven by public flows - especially in the form of large foreign reserve accumulation by the public sector of fast-growing East Asian economies.

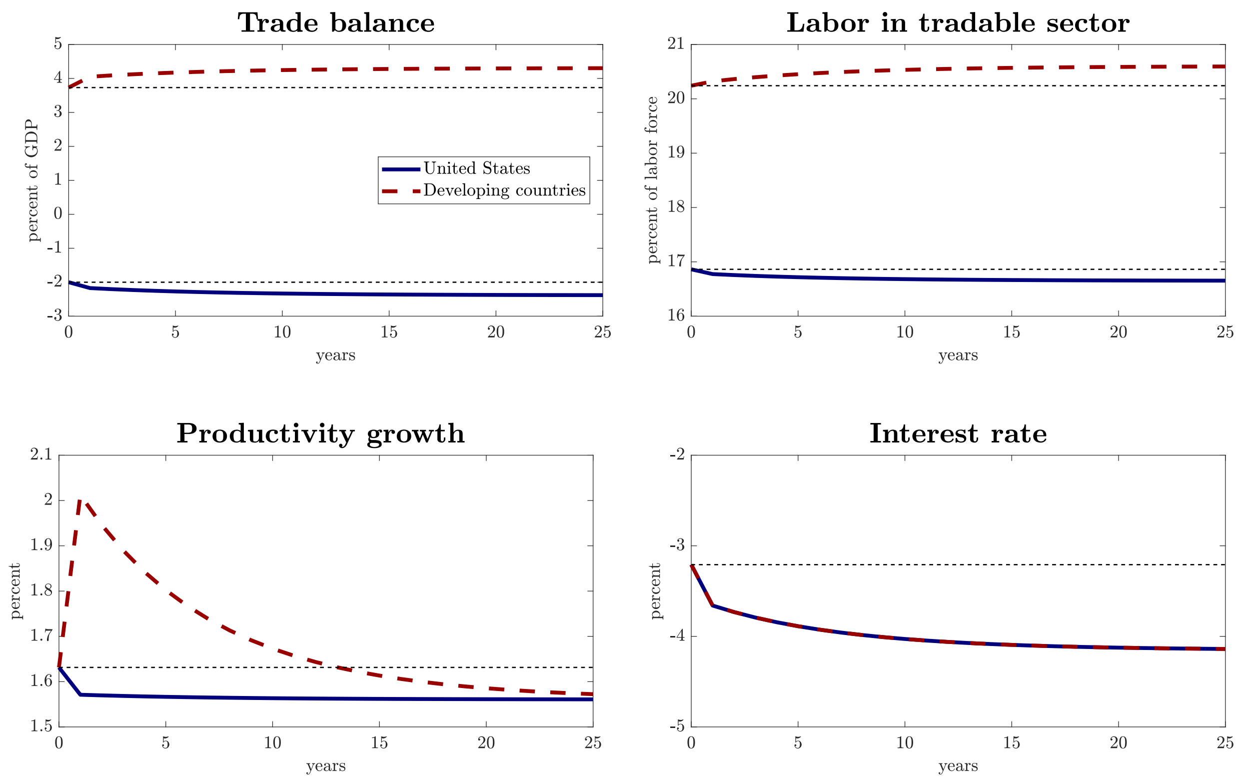


Figure 5: Export-led growth by developing countries. Notes: Response to a 1% permanent rise in τ, starting from the initial financial integration steady state. The rise in τ is not anticipated by agents in periods $t < 1$. From period $t = 1$ on agents have perfect foresight.

increase in τ. A rise in τ, the reason is, can be interpreted as an increase in the subsidy imposed by governments in developing countries on capital outflows.

Let us start by focusing on the steady state. Combining (35) and (37) gives

$$a_{d,f}^{\phi} = \frac{\xi\left(\bar{L} + \frac{\Gamma\kappa(\beta(1+\tau)-1)}{a_{d,f}}\right)}{\chi(\bar{L} - \Gamma\kappa(\beta(1+\tau)-1))}. \tag{40}$$

It is then easy to see that a rise in τ increases developing countries' proximity to the technological frontier. This result squares well with the notion of export-led growth. By subsidizing capital outflows, governments in developing countries increase economic activity in the tradable sector. This generates a rise in investment in technology adoption, which reduces the gap with the technological frontier.

The story, however, does not stop here. From equation (35), it is immediate to see that a rise in τ lowers the rate of productivity growth in the United States. As capital flows toward the United States, the U.S. tradable sector shrinks, inducing a drop in investment in innovation by U.S. firms. Through this effect, the export-led growth strategy pursued by developing countries depresses productivity growth in the United States. But innovation by the United States determines the world technological frontier, and thus the scope for technology adoption by developing countries. Hence, a rise in τ ends up depressing long-run productivity growth in developing countries, too.

Figure 5 shows the dynamic impact of a permanent rise in τ. Initially, developing countries experience a growth acceleration, as they narrow the gap with the technological frontier. In the long run, however, productivity growth in developing countries declines, and eventually converges to the U.S. one. The model thus suggests that an export-led growth strategy might be successful in raising productivity growth in the medium run. In the long run, however, this strategy might backfire and cause a drop in global productivity growth. This result sounds a note of caution on the use of export-led growth as a development strategy. These policies, in fact, can aggravate the global financial resource curse.

To conclude, let us note that the negative effects of export-led growth arise when this strategy is implemented on a global scale. To see this point, imagine that the developing countries region is composed of a continuum of small open economies. Then, an increase in the subsidy to capital outflows by a single country does not affect the rest of the world at all. Capital outflows from a single small open economy, in fact, are not large enough to affect economic activity in the United States. But this suggests that developing countries can fall in a coordination trap. A single small country, in fact, does not internalize the impact of its policies on the growth rate of the world technological frontier.[24] Therefore, avoiding the negative side effects triggered by export-led growth might require coordination among developing countries. Designing an optimal export-led growth strategy for developing countries is beyond the scope of this paper, but represents a promising area for future research.

5.2 Capital account policies in the United States

In response to the recent productivity growth slowdown, a host of policies have been proposed to revive growth in the United States. An obvious candidate is represented by policies, such as subsidies to R&D investment, directly aiming at fostering firms' innovation activities. These policies have been considered by a large literature, e.g. Akcigit et al. (2018) and Benigno and Fornaro (2018), and we will not pursue them here. We will instead focus on another proposal, which has received less attention by the academic literature, that consists in stimulating growth by reducing the trade deficits that the United States run against the rest of the world.

Ultimately, in order to achieve smaller trade deficits, net capital inflows toward the United States have to fall. To achieve this objective, the U.S. government could impose barriers to capital inflows, for instance in the form of capital controls or financial regulation. In our framework, the impact of these policies can be studied by considering a tightening in the U.S. borrowing limit, that is a drop in κ.[25]

Let us begin by considering the steady state. Using equation (35), it is easy to see that a drop in κ leads to an acceleration in U.S. productivity growth in the long run. A lower κ, the reason is,

[24] Even the government of a country, large enough to internalize the impact of its policies on the world technological frontier, would have no incentives to take into account how its actions affect welfare in the rest of the world. Hence, also large developing countries might gain from coordinating their policy interventions.

[25] For instance, the U.S. government could achieve a drop in κ by imposing on its citizens a borrowing limit tighter than the market one.

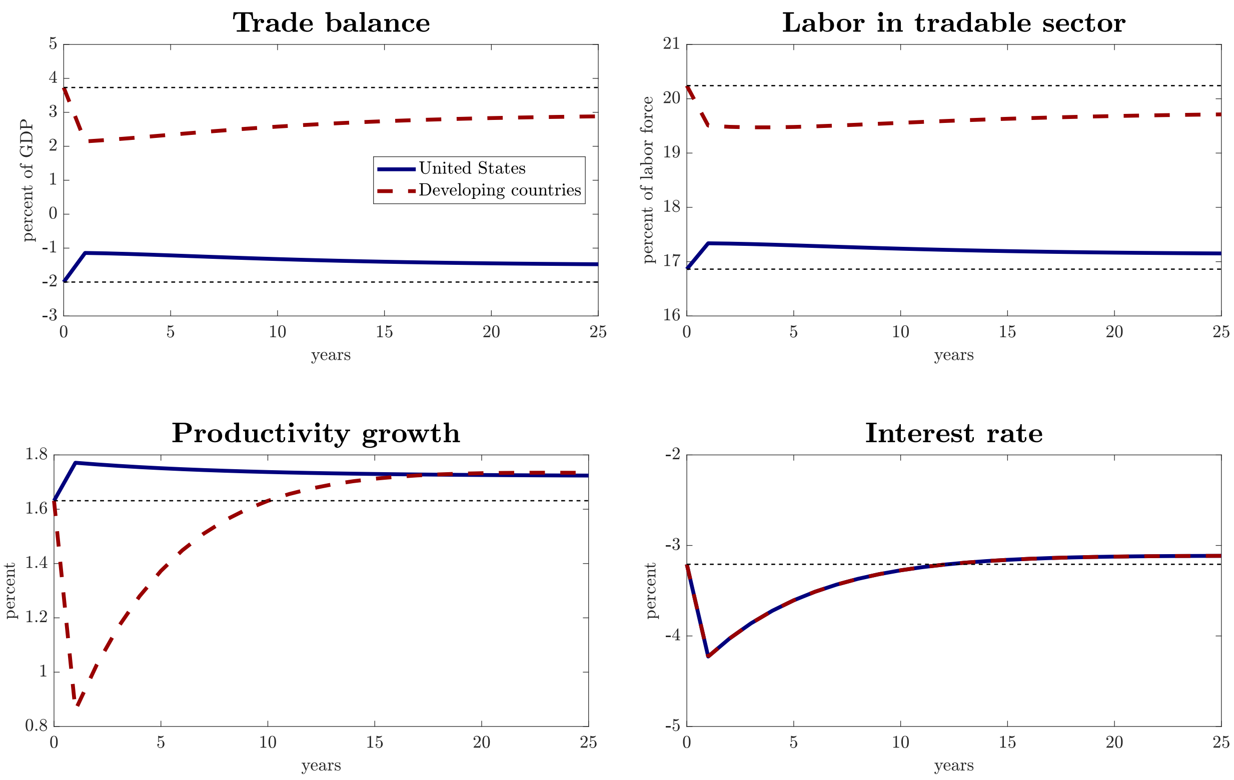


Figure 6: Barriers to capital inflows in the United States. Notes: Response to a decline in κ generating a 10% long-run drop in the U.S. foreign debt-to-GDP ratio, relative to the initial financial integration steady state. In the medium run, the process for κ_t is governed by (39). The drop in κ is not anticipated by agents in periods $t < 1$. From period $t = 1$ on agents have perfect foresight.

reduces the U.S. trade deficit. Lower trade deficits, in turn, are associated with lower consumption of non-tradable goods by U.S. households. The result is an increase in economic activity in the U.S. tradable sector, at the expenses of the non-tradable one. This induces U.S. firms to increase their investment in innovation, which fosters productivity growth. Hence, a policy-induced reduction in U.S. trade deficits leads to faster productivity growth in the long run.

Of course, developing countries are going to be affected, too. Equation (40), in fact, implies that a lower κ reduces developing countries' proximity to the frontier. As it should be clear by now, lower capital outflows from developing countries depress economic activity in their tradable sector, which slows down the process of technology adoption. In spite of this, in the long run developing countries enjoy faster productivity growth, due to the rise in innovation activities in the United States. These contrasting effects are illustrated by Figure 6, which shows the dynamic impact of an increase in the barriers to capital inflows in the United States. Initially, productivity growth in developing countries experiences a sharp slowdown. It is then easy to imagine that policymakers in developing economies might have a negative view on these policies. In the long run, however, the growth acceleration in the United States spreads to developing countries, which experience a pickup in productivity growth.

Another interesting result illustrated by Figure 6 concerns the response of global rates. On impact, an increase in the barriers to capital inflows in the U.S. produces a sharp fall in global rates. This is not surprising, since these policy interventions are effectively restricting the global supply of assets. In the long run, however, faster productivity growth lifts interest rates, which rise above their initial value.[26] These results suggest that the response of interest rates to restrictions on capital flows toward the United States might be complex, and depend on the time horizon considered.

6 Conclusion

In this paper, we have presented a model to study the impact of financial integration on global productivity growth. We have shown that capital flows from developing countries to the United States can generate a global productivity growth slowdown, by triggering a fall in economic activity in the U.S. tradable sectors. We have dubbed this effect the global financial resource curse.

This paper represents just a first step in a broader research agenda. For instance, here we have just touched on the issue of policy interventions. But the world that we describe is ripe with externalities and international spillovers. It would then be interesting to use our model to design optimal policies to manage financial globalization. Moreover, in this paper we have abstracted from the impact of demand factors on aggregate employment and output. However, low interest rates are a key feature of our narrative. If equilibrium interest rates are too low, monetary policy might be unable to maintain full employment because of the zero lower bound constraint on nominal rates. To study these effects one should integrate nominal rigidities in this framework, in the spirit of the Keynesian growth model developed by Benigno and Fornaro (2018). This represents a promising area for future research.

Appendix

A Proofs

This Appendix contains the proofs of all propositions.

A.1 Proof of Proposition 1

Proof. We start by proving uniqueness. First, consider that (RR_u) and (GG_u), once $c^T_{u,a}$ is substituted out, imply respectively a positive and negative relationship between $L^T_{u,a}$ and g_a. This means that there can be at most one value for $L^T_{u,a}$ and g_a consistent with equilibrium. Likewise, (RR_d) and (GG_d), once $c^T_{d,a}$ is substituted out, imply respectively a positive and negative relationship between $L^T_{d,a}$ and $a_{d,a}$. Again, this means that the equilibrium values of $L^T_{d,f}$ and $a_{d,f}$ are uniquely pinned down.

[26]The undershooting result is typical of models of international deleveraging, such as Benigno and Romei (2014) and Fornaro (2018).

It is immediate to see that the first part of condition (32) implies $g_a > 1$, since the expression appearing in (32) equals exactly the equation for g_a in (30).

We now show that $\xi < \chi$ implies $a_{d,a} < 1$. Inserting g_a given by (30) into (31) yields

$$a^{\phi}_{d,a} = \frac{\beta\xi\alpha\bar{L}}{\frac{\alpha\beta(\chi\bar{L}+1-\beta)}{1+\Gamma\Psi+\alpha\beta}(1+\Gamma\Psi) + \alpha\beta\left(\frac{\alpha\beta(\chi\bar{L}+1-\beta)}{1+\Gamma\Psi+\alpha\beta} + \beta - 1\right)}.$$

Canceling $\alpha\beta$ and multiplying with $1 + \Gamma\Psi + \alpha\beta$, this can be written as

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

The denominator can be simplified to $\chi\bar{L}(1 + \Gamma\Psi + \alpha\beta)$. Canceling variables then leads to

$$a^{\phi}_{d,a} = \frac{\xi}{\chi}.$$

Since $\phi > 0$, then $\xi < \chi$ implies $a_{d,a} < 1$.

We are left with determining $R_{u,a}$ and $R_{d,a}$. Since households inside each region are symmetric and financial flows across regions are not allowed, it must be that $b_{i,t} = 0$. Credit market clearing inside each region then requires $\tilde{\mu}_{i,t} = 0$.[27] Using the households' Euler equations evaluated in steady state then gives $R_{u,a} = g_a/\beta$ and $R_{d,a} = g_a/(\beta(1+\tau))$. ■

A.2 Proof of Proposition 2

Proof. We start by showing that $R_f = g_f/((\beta(1+\tau))$. From the Euler equation in both regions (22), evaluated in steady state

$$\frac{\omega}{c^T_{u,f}} = R_f\left(\frac{\beta\omega}{g_f c^T_{u,f}} + \tilde{\mu}_{u,f}\right)$$
$$\frac{\omega}{c^T_{d,f}} = R_f(1+\tau)\left(\frac{\beta\omega}{g_f c^T_{d,f}} + \tilde{\mu}_{d,f}\right).$$

Since $\tau > 0$, it must be that $\tilde{\mu}_{u,f} > 0$ and $\tilde{\mu}_{d,f} = 0$ to ensure the credit markets clear.[28] U.S. households are therefore borrowing constrained in steady state, and so $b_{u,f} = -\kappa$. Moreover, developing countries' Euler equation implies

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

[27] Strictly speaking, if $\kappa = 0$ then $\tilde{\mu}_{i,t} = 0$ is not a necessary condition for credit markets to clear. This implies that with $\kappa = 0$ interest rates are not uniquely pinned down in equilibrium. This source of multiplicity, however, disappears as soon as $\kappa > 0$. We therefore impose the equilibrium refinement condition $\tilde{\mu}_{i,t} = 0$ also for the case $\kappa = 0$.

[28] More precisely, if $\kappa = 0$ then $\tilde{\mu}_{d,f} = 0$ is not a necessary condition for credit markets to clear. This implies that with $\kappa = 0$ interest rates are not uniquely pinned down in equilibrium. This source of multiplicity, however, disappears as soon as $\kappa > 0$. We therefore impose the equilibrium refinement condition $\tilde{\mu}_{d,f} = 0$ also for the case $\kappa = 0$.

Since $b_{u,f} = -\kappa = -b_{d,f}$, tradable consumption in both regions is

$$c^T_{u,f} = \Psi L^T_{u,f} - \kappa\left(1 - \frac{g_f}{R_f}\right) = \Psi L^T_{u,f} + \kappa\left(\beta(1+\tau) - 1\right)$$
$$c^T_{d,f} = \Psi a_{d,f} L^T_{d,f} + \kappa\left(1 - \frac{g_f}{R_f}\right) = \Psi a_{d,f} L^T_{u,f} - \kappa\left(\beta(1+\tau) - 1\right),$$

where we have used (33).

Proving that the steady state is unique is easy. First, consider that (RR_u) and (GG_u), once $c^T_{u,f}$ is substituted out, imply respectively a positive and negative relationship between $L^T_{u,f}$ and g_f. This means that there can be at most one value for $L^T_{u,f}$ and g_f consistent with equilibrium. Likewise, (RR_d) and (GG_d), once $c^T_{d,f}$ is substituted out, imply respectively a positive and negative relationship between $L^T_{d,f}$ and $a_{d,f}$. Again, this means that the equilibrium values of $L^T_{d,f}$ and $a_{d,f}$ are uniquely pinned down.

We now turn to the condition (38) stated in Proposition 2. From combining (GG_u) and (RR_u) the growth rate under financial integration is given by

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

which corresponds to (35) in the main text after inserting (30). Therefore, the first part of condition (38) guarantees that $g_f > 1$. Moreover, it is easy to check that if $g_f > 1$ then it must be that $L^T_{u,f} > 0$.

We are left to prove that $a_{d,f} < 1$. Start by combining (GG_d) and (RR_d) to derive an equation for $a_{d,f}$

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

which corresponds to (37) from the main text. Inserting g_f using (35) and taking identical steps as in Appendix A.1 this can be written as

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

The left-hand side of this expression is increasing in $a_{d,f}$, while the right-hand side is decreasing in it. Hence, $a_{d,f} < 1$ if and only if

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

which, after rearranging, corresponds to the second part of condition (38). ■

B Lab equipment model

In this Appendix we consider a lab equipment model, in which investment in R&D requires units of the final tradable good, rather than labor. To anticipate our main result, this version of the model preserves all the insights of the one in the main text.

B.1 Changes to economic environment

The only change, with respect to the model in the main text, is that here investment in innovation requires units of the traded final good. In particular, the law of motion for productivity of a generic U.S. firm j now becomes

$$A^j_{u,t+1} = A^j_{u,t} + \chi I^j_{u,t},$$

where $I^j_{u,t}$ captures investment in research - in terms of the tradable final good - by intermediate goods firm j. This equation replaces (13) of the baseline model. Thus firms' profits net of expenditure in research become

$$\Pi^j_{u,t} = \varpi A^j_{u,t} L^j_{u,t} - I_{j,t}.$$

As in the main text, firms choose investment in innovation to maximize their discounted stream of profits

$$\sum_{t=0}^{\infty} \frac{\omega \beta^t}{C^T_{u,t}} \Pi^j_{u,t}.$$

In an interior optimum ($I^j_{u,t} > 0$), optimal investment requires

$$\frac{1}{\chi} = \frac{\beta C^T_{u,t}}{C^T_{u,t+1}} \left(\varpi L^T_{u,t+1} + \frac{1}{\chi} \right)$$

which replaces (16). Similarly, we replace (15) for developing countries with

$$A^j_{d,t+1} = A^j_{d,t} + \xi \left(\frac{A_{u,t}}{A_{d,t}} \right)^{\phi} I^j_{d,t}.$$

Profit maximization leads to the first order condition

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

Aggregation and market clearing works as follows. First, value added in the tradable sector is still given by (17). Market clearing for the non-tradable good is still given by (18). However, the market clearing condition for tradable goods is now given by

$$C_{i,t} + I_{i,t} + \frac{B_{i,t+1}}{R_{i,t}} = \Psi A_{i,t} L^T_{i,t} + B_{i,t},$$

where $I_{i,t} = \int_0^1 I^j_{i,t} dj$ is the total amount of tradable goods devoted to investment in region i. This equation replaces (19) in the main text. Finally, asset market clearing is still given by (20), whereas labor market clearing (21) is replaced by

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

B.2 Equilibrium

AS it was the case for the baseline model, the model can be cast in terms of three "blocks" . These blocks capture, in turn, the paths of tradable consumption and capital flows, the behavior of productivity, and the resource constraint.

First, the households' Euler equation becomes

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

where the borrowing limit is given by

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

and where the market clearing conditions for the tradable good and for bonds are

$$c^T_{i,t} + i_{i,t} + \frac{g_{t+1}b_{i,t+1}}{R_{i,t}} = \Psi a_{i,t} L^T_{i,t} + b_{i,t}$$

$$b_{u,t} = -b_{d,t}.$$

Second, optimal investment in innovation by U.S. firms implies

$$g_{t+1} = \frac{\beta c^T_{u,t}}{c^T_{u,t+1}}\left(\chi\varpi L^T_{u,t+1} + 1\right),$$

while optimal investment in technology adoption by firms in developing countries requires

$$a^{\phi}_{d,t} = \frac{\beta c^T_{d,t}}{g_{t+1}c^T_{d,t+1}}\left(\xi\varpi L^T_{d,t+1} + a^{\phi}_{d,t+1}\right).$$

The law of motion for productivity can be written as

$$g_{t+1} = 1 + \chi i_{u,t},$$

in the U.S., and as

$$g_{t+1}a_{d,t+1} = a_{d,t} + \xi a^{-\phi}_{d,t} i_{d,t},$$

in the developing countries.

Third and last, the labor market clearing condition can be written as

$$L_{u,t}^T = \bar{L} - \Gamma c_{u,t}^T$$

for the U.S., as well as

$$L_{d,t}^T = \bar{L} - \Gamma \frac{c_{d,t}^T}{a_{d,t}}$$

for the developing countries.

B.3 Results

We now provide a brief comparison of the steady states under financial autarky and financial integration. To do so, we next derive the analogues of the (GG_u), (RR_u) as well as (GG_d) and (RR_d) curves. Starting with the U.S., note that the (GG_u) curve is now given by

$$g = \beta(\chi \varpi L_u^T + 1), \qquad (GG_u)$$

and is thus almost identical as in the baseline model (the only difference being that α is replaced by the composite parameter ϖ).

In turn, the (RR_u) curve is now given by

$$L_u^T = \bar{L} - \Gamma\left(\Psi L_u^T + b_u\left(1 - \frac{g}{R}\right)\right) + \Gamma\frac{g-1}{\chi}, \qquad (RR_u)$$

the term $b_u(1 - g/R)$ capturing capital flows. Notice that $b_u = 0$ under financial autarky, but $b_u = -\kappa$ under international financial integration. Moreover, in the latter case $1 - g/R = \beta(1+\tau) - 1$.

Relative to the baseline model, a key difference of the current environment is that (RR_u) posits another positive relationship between L_u^T and g, i.e. both (GG_u) and (RR_u) are upward sloping lines in (L_u^T, g) space. However, the slope of (RR_u) is necessarily larger than the slope of (GG_u), since

$$\chi\frac{(1+\Gamma\Psi)}{\Gamma} = \chi\left(\Psi + \frac{1}{\Gamma}\right) = \chi\left(\frac{1+\alpha}{\alpha}\varpi + \frac{1}{\Gamma}\right) > \chi\beta\varpi,$$

which follows from $0 < \alpha < 1$, $\beta < 1$, $\chi > 0$, $\varpi > 0$ and $\Gamma > 0$.[29]

Therefore, the impact of financial integration is as in the baseline model: a shift of the (RR_u) curve to the left triggered by capital inflows reduces g and L_u^T. Formally,

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

under financial autarky (compare (30) from the main text), but

$$g_f = g_a - \frac{\varpi\beta\chi\Gamma}{1 + \Gamma(\Psi - \beta\varpi)}\kappa(\beta(1+\tau) - 1) < g_a$$

[29] Recall the definitions of $\Psi \equiv \alpha^{\frac{2\alpha}{1-\alpha}}(1-\alpha^2)$ and $\varpi \equiv \alpha^{\frac{2}{1-\alpha}}(1/\alpha - 1)$. Hence $\Psi/\varpi = (1+\alpha)/\alpha$.

under international financial integration (compare (35) from the main text). The last inequality follows again from $\Psi > \varpi$ (as argued above) and all parameters being positive.

The impact of financial integration on developing countries is also the same as in the baseline model. In fact, the (GG_d) curve is now given by

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

and is therefore almost identical as in the baseline model. In turn, the (RR_d) curve is given by

$$L_d = \bar{L} - \Gamma\left(\Psi L_d^T + \frac{b_d}{a_d}\left(1-\frac{g}{R}\right)\right) + \Gamma\frac{(g-1)a_d^\phi}{\xi}. \tag{RR_d}$$

Compared with the baseline model, the difference is (again) that (RR_d) in the current model posits a positive relationship between a_d^ϕ and L_d^T, with a slope coefficient strictly larger than that of (GG_d). Therefore, capital outflows which shift (RR_d) to the right necessarily raise both a_d and L_d^T - as in the baseline model. Formally,

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

under financial autarky (compare (31) from the main text), but

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

under financial integration (compare (37) from the main text). Hence, our qualitative results on the impact of financial integration on steady state productivity growth are robust to the assumption that investment in innovation is done in terms of the traded final good.

C Data Appendix

This Appendix contains further details on the data used in this paper.

C.1 Data used in Figure 1

To construct the current-account-to-GDP ratio of developing countries in Figure 1a, we draw on current account data from the World Economic Outlook (WEO) 2019. Specifically, we extract current-account-to-GDP data for all countries which WEO classifies as "analytical group: Emerging market and developing economies" (a total of 154 countries).

Thereafter, we use nominal GDP data of these countries to construct weights in each year, then construct an average current account ratio by using the formula

$$\left(\frac{CA}{GDP}\right)_{\text{Developing countries},t} \equiv \sum_{i\in\text{Developing countries}} \frac{GDP_{i,t}}{\sum_{i\in\text{Developing countries}} GDP_{i,t}} \left(\frac{CA}{GDP}\right)_{i,t}$$

for each year $t \in \{1985, ..., 2018\}$.

To construct the time series for labor productivity growth in the United States in Figure 1b, we use data from OECD (2020), "GDP per hour worked (Total, 2010=100)". We extract the data for the United States from 1980 to 2018. Thereafter, we take log-changes to compute growth rates. Finally, we smooth the resulting series by taking a 5-period moving average and plot the result from 1985-2018.

C.2 Data used in transition analysis

Here we provide further details on the construction of the initial proximity of developing countries to the frontier, $a_{d,a} = 0.44$, used in the transition analysis in Section 4.

Klenow and Rodriguez-Clare (2005) provide a TFP estimate for a sample of countries in the year 1995 (their Table 7 on page 848). Among this group of countries, we classify countries as "Developing countries" whenever they appear in "analytical group: Emerging market and developing economies" of the IMF (see Appendix C.1 for details). Thereafter, we take a GDP-weighted average of TFP among these developing countries. Finally, we divide this number by the TFP estimate for the US in the year 1995, also provided by Klenow and Rodriguez-Clare (2005). This yields $a_{d,a} = 6.74/15.47 = 0.44$.

References

Adjemian, Stéphane, Houtan Bastani, Michel Juillard, Fréderic Karamé, Junior Maih, Ferhat Mihoubi, George Perendia, Johannes Pfeifer, Marco Ratto, and Sébastien Villemot (2011) "Dynare: Reference Manual Version 4," Dynare Working Papers 1, CEPREMAP.

Aghion, Philippe, Antonin Bergeaud, Timo Boppart, Peter J Klenow, and Huiyu Li (2019) "A theory of falling growth and rising rents," NBER working paper.

Aghion, Philippe and Peter Howitt (1992) "A Model of Growth Through Creative Destruction," *Econometrica*, Vol. 60, No. 2, pp. 323–351.

Akcigit, Ufuk and Sina T Ates (2020) "Ten facts on declining business dynamism and lessons from endogenous growth theory," *American Economic Journal: Macroeconomics*.

Akcigit, Ufuk, Sina T Ates, and Giammario Impullitti (2018) "Innovation and trade policy in a globalized world," NBER Working Paper No. 24543.

Alfaro, Laura, Sebnem Kalemli-Ozcan, and Vadym Volosovych (2014) "Sovereigns, upstream capital flows, and global imbalances," *Journal of the European Economic Association*, Vol. 12, No. 5, pp. 1240–1284.

Amiti, Mary and Jozef Konings (2007) "Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia," *American Economic Review*, Vol. 97, No. 5, pp. 1611–1638.

Anzoategui, Diego, Diego Comin, Mark Gertler, and Joseba Martinez (2019) "Endogenous Technology Adoption and R&D as Sources of Business Cycle Persistence," *American Economic Journal: Macroeconomics*, Vol. 11, No. 3, pp. 67–110.

Ates, Sina and Felipe Saffie (2016) "Fewer but better: Sudden stops, firm entry, and financial selection," *FRB International Finance Discussion Paper*, No. 1187.

Barro, Robert and Xavier Sala-i Martin (1997) "Technology diffusion, convergence and growth," *Journal of Economic Growth*, Vol. 2, No. 1, pp. 1–25.

Benigno, Gianluca, Nathan Converse, and Luca Fornaro (2015) "Large capital inflows, sectoral allocation, and economic performance," *Journal of International Money and Finance*, Vol. 55, pp. 60–87.

Benigno, Gianluca and Luca Fornaro (2012) "Reserve accumulation, growth and financial crises," CEPR Discussion Paper No. DP9224.

——— (2014) "The financial resource curse," *Scandinavian Journal of Economics*, Vol. 116, No. 1, pp. 58–86.

——— (2018) "Stagnation traps," *Review of Economic Studies*, Vol. 85, No. 3, pp. 1425–1470.

Benigno, Pierpaolo and Federica Romei (2014) "Debt Deleveraging and the Exchange Rate," *Journal of International Economics*, Vol. 93, pp. 1–16.

Bernanke, Ben (2005) "The global saving glut and the US current account deficit," Remarks at the Sandridge Lecture, Virginia Association of Economics, Richmond, VA, March 10.

Blalock, Garrick and Paul J Gertler (2004) "Learning from exporting revisited in a less developed setting," *Journal of Development Economics*, Vol. 75, No. 2, pp. 397–416.

Bloom, Nicholas, Charles I Jones, John Van Reenen, and Michael Webb (2020) "Are Ideas Getting Harder to Find?" *American Economic Review*.

Brunnermeier, M., P. O. Gourinchas, and O. Itskhoki (2018) "Consumption-led Growth," Manuscript, Princeton University.

Bustos, Paula (2011) "Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms," *American Economic Review*, Vol. 101, No. 1, pp. 304–40.

Caballero, Ricardo J, Emmanuel Farhi, and Pierre-Olivier Gourinchas (2008) "An equilibrium model of global imbalances and low interest rates," *American Economic Review*, Vol. 98, No. 1, pp. 358–93.

——— (2015) "Global Imbalances and Currency Wars at the ZLB," NBER Working Paper No. 21670.

Cingano, F. and F. Hassan (2019) "International Financial Flows and Misallocation: Not So Harmful After All," Manuscript, Banca d'Italia.

Coe, D.T., E. Helpman, and A.W. Hoffmaister (1997) "North-South R & D Spillovers," *Economic Journal*, Vol. 107, pp. 134–149.

Cuñat, A. and R. Zymek (2019) "Shrinking World, Growing Incomes? Assessing the Contribution of Trade to Growth, 1990-2014," Manuscript, Vienna University.

Dooley, Michael P., David Folkerts-Landau, and Peter Garber (2004) "The revived Bretton Woods system," *International Journal of Finance & Economics*, Vol. 9, No. 4, pp. 307–313.

Duarte, Margarida and Diego Restuccia (2010) "The role of the structural transformation in aggregate productivity," *Quarterly Journal of Economics*, Vol. 125, No. 1, pp. 129–173.

Eggertsson, Gauti B, Neil R Mehrotra, Sanjay R Singh, and Lawrence H Summers (2016) "A contagious malady? Open economy dimensions of secular stagnation," *IMF Economic Review*, Vol. 64, No. 4, pp. 581–634.

Fornaro, Luca (2018) "International Debt Deleveraging," *Journal of the European Economic Association*, Vol. 16, No. 5, pp. 1394–1432.

Fornaro, Luca and Federica Romei (2019) "The paradox of global thrift," *American Economic Review*, Vol. 109, No. 11, pp. 3745–3779.

Gopinath, Gita, Şebnem Kalemli-Özcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez (2017) "Capital allocation and productivity in South Europe," *Quarterly Journal of Economics*, Vol. 132, No. 4, pp. 1915–1967.

Gopinath, Gita and Jeremy C Stein (2018) "Banking, trade, and the making of a dominant currency," NBER working paper.

Gourinchas, Pierre-Olivier and Olivier Jeanne (2013) "Capital flows to developing countries: The allocation puzzle," *Review of Economic Studies*, Vol. 80, No. 4, pp. 1484–1515.

Gourinchas, Pierre-Olivier, Helene Rey, and Nicolas Govillot (2010) "Exorbitant privilege and exorbitant duty," Manuscript, London Business School.

Gourinchas, Pierre-Olivier, Hélène Rey, and Maxime Sauzet (2019) "The international monetary and financial system," *Annual Review of Economics*, Vol. 11, pp. 859–893.

Grossman, Gene M and Elhanan Helpman (1991) *Innovation and growth in the global economy*: MIT press Cambridge, MA.

Hlatshwayo, Sandile and Michael Spence (2014) "Demand and defective growth patterns: The role of the tradable and non-tradable sectors in an open economy," *American Economic Review*, Vol. 104, No. 5, pp. 272–77.

Howitt, Peter (1999) "Steady endogenous growth with population and R. & D. inputs growing," *Journal of Political Economy*, Vol. 107, No. 4, pp. 715–730.

——— (2000) "Endogenous growth and cross-country income differences," *American Economic Review*, Vol. 90, No. 4, pp. 829–846.

Keller, W. (2004) "International Technology Diffusion," *Journal of Economic Literature*, Vol. 42, No. 3, pp. 752–782.

Klenow, Peter J and Andres Rodriguez-Clare (2005) "Externalities and growth," *Handbook of Economic Growth*, Vol. 1, pp. 817–861.

Liu, Ernest, Atif Mian, and Amir Sufi (2019) "Low interest rates, market power, and productivity growth," NBER working paper.

Mehrotra, Neil R and Dmitriy Sergeyev (2019) "Debt Sustainability in a Low Interest Rate World," Manuscript, New York Fed.

Mendoza, Enrique G, Vincenzo Quadrini, and Jose-Victor Rios-Rull (2009) "Financial integration, financial development, and global imbalances," *Journal of Political Economy*, Vol. 117, No. 3, pp. 371–416.

Mian, Atif R, Amir Sufi, and Emil Verner (2019) "How does credit supply expansion affect the real economy? The productive capacity and household demand channels," *Journal of Finance*.

Park, Albert, Dean Yang, Xinzheng Shi, and Yuan Jiang (2010) "Exporting and firm performance: Chinese exporters and the Asian financial crisis," *Review of Economics and Statistics*, Vol. 92, No. 4, pp. 822–842.

Pierce, Justin R and Peter K Schott (2016) "The surprisingly swift decline of US manufacturing employment," *American Economic Review*, Vol. 106, No. 7, pp. 1632–62.

Van der Ploeg, Frederick (2011) "Natural resources: curse or blessing?" *Journal of Economic literature*, Vol. 49, No. 2, pp. 366–420.

Queralto, Albert (2019) "A model of slow recoveries from financial crises," *Journal of Monetary Economics*.

Rivera-Batiz, Luis A and Paul M Romer (1991) "Economic integration and endogenous growth," *Quarterly Journal of Economics*, Vol. 106, No. 2, pp. 531–555.

Rodrik, Dani (2012) "Unconditional convergence in manufacturing," *Quarterly Journal of Economics*, Vol. 128, No. 1, pp. 165–204.

Young, Alwyn (1998) "Growth without scale effects," *Journal of Political Economy*, Vol. 106, No. 1, pp. 41–63.