

**Department of Economics & Finance**

# **Capital shares and the intergenerational consequences of international financial integration**

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# Capital shares and the intergenerational consequences of international financial integration

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## Abstract

We revisit the welfare consequences of international financial integration (IFI) in a two-country OLG model where countries differ in the capital share of national income. We establish four main results: (i) the country with the highest capital share is the net recipient of capital flows as its output per effective units of labour is lower in autarky (i.e. developing economy), consistently with empirical evidence; (ii) on aggregate, IFI brings a 10% increase in consumption for the developing economy; (iii) IFI has uneven effects across generations: the first generation in the developing (developed) economy incurs a welfare loss (gain), while the remaining generations gain (lose) from IFI; (iv) labour (capital) should be taxed in the developing (developed) country to ensure that IFI is Pareto superior to financial autarky.

*Keywords:* international financial integration, capital flows, capital shares, OLG models, neoclassical growth models

*JEL classification:* F21, F36, F41, F65, O47

## 1 Introduction

The issue of whether it is beneficial for a country to open its financial markets to the rest of the world is a central question for policy makers, especially in developing countries. International financial integration (IFI) is often seen as a way for developing countries to speed up their transition to the steady state of the economy given their condition of capital scarcity. However, in a neoclassical growth model, Gourinchas and Jeanne (2006)

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show that the gains from international financial integration are quantitatively small for a typical non-OECD country.

In this paper, we argue that the reason why the gains are found to be small in this class of models is that developing countries are assumed to be identical to developed ones except for their initial level of capital<sup>1</sup>. However, consider two countries which differ in some key parameters of the economy: if they remained financially isolated, the return on capital would not be the same in the long-run. Therefore, if the countries integrated their capital markets, capital would flow from one country to another not just during the transition, but also at the steady state of the economy. In this context, the conclusion that the welfare gains from opening domestic financial markets are elusive do no longer hold true<sup>2</sup>.

Our first contribution is to study the pattern of capital flows and assess their welfare consequences in two-country neoclassical growth model where countries are heterogeneous in the importance that capital has as a factor of production in the aggregate production function (capital share). This dimension of heterogeneity has been ignored by the literature on the basis of the idea, backed empirically by Gollin (2002), that differences in capital shares across countries are negligible. However, Feenstra, Inklaar and Timmer (2015) have recently shown that not only capital shares are not constant over time but cross-country differences are much wider than we previously thought<sup>3</sup>. As a consequence, they argued that the “one-size-fits-all labor share of 70 percent that is commonly assumed in the literature is a simplification that is not supported by the facts”. For instance, Table 1 shows that the average capital share in 2005 was much higher than 0.30 and there is a lot of cross-country variation. Moreover, non-OECD countries tend to have a much higher capital share than OECD-countries.

Given this evidence, in our model the two countries will differ along two main dimensions: the capital share and the initial level of capital, where only the second channel is usually considered in the literature<sup>4</sup>. The two-country aspect of the model will also allow

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<sup>1</sup>Hoxha, Kalemli-Ozcan and Vollrath (2013) show that the gains can be larger by assuming that capital goods are imperfect substitutes.

<sup>2</sup>In fact, the literature on global imbalances has emphasized that capital flows are explained by several dimensions of heterogeneity such as differences in financial markets development (Caballero, Gourinchas and Fahri, 2008; Mendoza, Quadrini and Ríos Rull, 2009; Coeurdacier, Guibaud and Jin, 2015), pension systems (Eugeni, 2015), demographics (Backus, Henriksen and Cooley, 2014).

<sup>3</sup>Their findings are based on new data which are now part of the Penn World Tables 8.1 database.

<sup>4</sup>As this is the first attempt to analyze the problem, we assume that capital shares are constant over time and abstract from the fact that capital shares have been rising in many countries. In our framework, time-varying capital shares would

Table 1: Capital shares in 2005.

	Mean	Standard deviation	Min	Max	Observations
All countries	0.48	0.13	0.15	0.78	109
OECD countries	0.42	0.08	0.25	0.62	33
non-OECD countries	0.51	0.14	0.15	0.78	76

*Notes.* The data are from the Penn World Tables 8.1.

us to investigate the spillover effect on a typical developed economy when a “not so small” emerging country such as China financially integrates.

Our second contribution is that we relax the assumption of intergenerational altruism by exploring the consequences of IFI in a two-country model with overlapping generations in the spirit of Diamond (1965). The reason behind this choice is two-fold. Firstly, it is well known that the steady state interest rate in the Ramsey model is only pinned down by the representative agent’s discount factor. Any other dimension of heterogeneity (such as capital shares) cannot give rise to capital flows among countries at the steady state of the economy, since the autarkic interest rates would be identical. For this reason, OLG models are quickly becoming a favourite tool for studying issues such as current account imbalances, which are often a permanent phenomenon<sup>5</sup>. Secondly, important reforms are typically undertaken from governments, which tend to respond to the people who currently alive, independently from whether they are elected or not. Even if a reform leading to the openness of capital markets has considerable benefits in the future, it might not be implemented by the government if it is known to have detrimental effects for the present generations. Hence, we believe that departing from the representative agent framework might be informative as to why e.g. many developing countries still use capital controls.

Firstly, we prove that the country with the highest capital share has a lower output per effective units of labor and a higher interest rate in autarky. As a consequence, once financial markets are integrated, the high-capital share country borrows from the rest of the world in the transition to the integrated steady state and in the long-run. While international financial integration reduces output differences between the two countries, there is never full convergence: a country with a high capital share is relatively poorer than a country with a low capital share, independently from the level of financial integration. We

imply that the steady state of the autarkic as well as the integrated economy shifts over time.

<sup>5</sup>See footnote 2.

then provide empirical evidence to support the finding that there is an inverse relationship between the capital share and output per effective units of labor. While Table 1 suggests that we should find such relationship, Caselli and Feyrer (2007) and Feenstra, Inklaar and Timmer (2015) had previously found no correlation between output per capita and capital shares. We find the same result in our sample, but this conclusion is overturned once we adjust output per capita by productivity, as suggested by the model. We also show that countries with high capital shares tend to have a negative FDI position, consistently with the model which predicts that they should be net recipients of capital flows.

Secondly, we show that the process of international financial integration has substantial welfare consequences. To start with, we focus on the intergenerational effects of IFI for the country with the highest capital share (the poor country). To compare with the literature, we calibrate the model as closely to Gourinchas and Jeanne (2006) as possible except for the capital share in the developing country: in our sample, the average capital share of non-OECD countries weighted by their share of world GDP is 0.49. In this context, we find that the welfare gains for the generations born at the integrated steady state of the economy amount to up a 82.8% welfare increase in equivalent consumption. In the transition to the steady state, the welfare gains are even higher and decline as the steady state approaches. However, not all generations gain from IFI. The first generation experiences a fall in their income in the second period of life (due to a drop in the interest rate), hence suffering a welfare loss of 18.5% in equivalent consumption. Therefore, our model suggests that if political power is in the hands of the young, then financial integration does not take place. Nonetheless, this would come at the expense of the subsequent generations who would be able to reap huge gains. This result can help to explain why, although the level of financial integration has increased over time, it is still low in developing countries<sup>6</sup>.

The above numbers are obtained considering that a developing country's typical contribution to the dynamics of the world interest rate is small. In fact, we calibrate the size of the developing country using the average share of world GDP of non-OECD countries. As this case is alike to a small open economy, the welfare impact on the developed country is negligible. The novelty of our framework with respect to Gourinchas and Jeanne (2006) is that our two-country structure allows us to study the impact on developed countries of the financial integration of a large emerging country such as China. In the developed coun-

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<sup>6</sup>See e.g. Chinn and Ito (2006).

try, we find that the initial generation would gain from the higher interest rate enjoyed on domestically-owned and foreign-owned capital. However, the subsequent generations can lose up to 5% in equivalent consumption. As the developed country reaches a lower steady state under financial openness, IFI implies a lower wage for each generation (hence, a lower lifetime income).

The uneven intergenerational effects of IFI do not imply that the reform is not beneficial from an aggregate perspective and for each country involved. In fact, we show that a social planner which takes into account the welfare of all generations has a higher utility under financial openness than under financial autarky in all the scenarios considered. A typical small developing economy gains 10% in equivalent consumption, while a large emerging economy such as China experiences a welfare gain of 4%. As we hinted above, the large welfare gains for the developing/emerging economy are due to the fact that the country can reach a higher steady state through capital flows, as countries are heterogeneous beyond their initial levels of capital. While the spillover effects on the developed country are negligible in the first case, the aggregate welfare gains for a developed economy if China opens its financial markets are not much larger as equal to 0.35%.

Although both countries would gain from financial openness, our results point out that IFI is not Pareto superior to autarky as there are winners and losers. However, as aggregate income within each country is higher under financial integration, there exist redistribution policies which make all generations better off. As we stressed above, since the loser from IFI in the developing country is the first generation, financial openness might never take place in the absence of intergenerational altruism. However, the first generation could be persuaded to agree to financial openness under the condition that the government commits to a redistribution policy. We show that this can be achieved through the following balanced budget policy: the government should tax the labour income of the second generation and redistribute it to the first generation when it becomes old to compensate it for the fall in the real interest rate arising from the process of IFI. A labour income tax of 20% is enough to ensure that IFI is Pareto superior to financial autarky. In the case of China's financial openness, redistribution policies in the developed country become relevant too because of the significant negative spillover effects on each generation (except the first). A successful redistribution policy would consist in taxing capital income and redistribute it to the workers in every period. Since the welfare losses from IFI increase over time, the capital income tax should be time-varying and reach the

value of 14% at the steady state of the economy.

Finally, this paper is related to the complementary strand of literature which sees international financial integration as a way to improve the degree of risk sharing across countries<sup>7</sup>. The scale of the benefits that international financial integration can bring to countries through risk sharing heavily depend on the model structure and calibration. Recently, Coeurdacier, Rey and Winant (2015) have proposed a model which feature both the risk sharing and the capital scarcity channels and have concluded that the welfare gains are no larger than a permanent increase in consumption of 0.5%. In common with this paper, Mendoza, Quadrini and Ríos-Rull (2007) and Antunes and Cavalcanti (2013) also explore the welfare consequences of IFI while departing from the representative agent framework. In their case, heterogeneity stems from differences in the initial levels of wealth and earning abilities, not by the absence of altruism across generations.

The paper is organised as follows. Section 2 presents the model and derives analytical results on the pattern of capital flows. Section 3 provides empirical evidence in support of our results. Section 4 investigates the intergenerational consequences of international financial integration, for a small developing economy and a large emerging economy. In section 5, we design fiscal redistribution policies within countries which make sure that all generations gain from IFI. All the proofs are in the Appendix.

## 2 A two-country model with heterogeneous capital shares

Our set-up is embedded in a standard two-country Diamond model (1965).

The distinctive feature of our model is that the two countries have access to different constant returns to scale technologies for the production of the consumption good. In particular, we assume the following:

**Assumption 1 (Production functions)** *Firms in country  $i$  produce according to the Cobb-Douglas production function  $Y_{i,t} = K_{i,t}^{\alpha_i} (Z_{i,t} L_{i,t})^{1-\alpha_i}$ , where  $\alpha_1 < \alpha_2$ .*

As a period lasts for around 30 years in a two-period OLG model, we assume that capital fully depreciates after one period:  $\delta = 1$ . Let us define  $\hat{k}_i \equiv \frac{K_i}{Z_i L_i}$  as country  $i$ 's capital stock per effective units of labor and  $k_i \equiv \frac{K_i}{L_i}$  as the capital stock per capita, so that the production function of country  $i$  per effective units of labor is:  $\hat{y}_{i,t} = \hat{k}_{i,t}^{\alpha_i}$ .

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<sup>7</sup>See e.g. Cole and Obstfeld (1991), van Wincoop (1994), Obstfeld (1994), Tesar (1995), Mendoza, Quadrini and Ríos-Rull (2007), Antunes and Cavalcanti (2013).

To keep the model tractable, we assume that the utility function is logarithmic:

$$U_{i,t} \equiv \log c_{i,t}^y + \beta \log c_{i,t+1}^o \quad (1)$$

Finally, population and technology grow at the same constant rate in the two countries:

$$L_{i,t} = (1+n)L_{i,t-1} \text{ and } Z_{i,t} = (1+g)Z_{i,t-1}.$$

## 2.1 Autarky

Firstly, we consider the two economies in autarky as this will be useful to analyze the integrated economy. For the moment being, both capital and labour are immobile. The firms' problem is to choose  $\hat{k}_{i,t}^{aut}$  that maximises the profit function:

$$\max_{\hat{k}_{i,t}^{aut}} \hat{k}_{i,t}^{aut^{\alpha_i}} - R_{i,t}^{aut} \hat{k}_{i,t}^{aut} - \hat{w}_{i,t}^{aut} \quad (2)$$

where  $\hat{w}_{i,t}^{aut} = \frac{w_{i,t}^{aut}}{Z_{i,t}}$  which implies that factor prices are:

$$R_{i,t}^{aut} = \alpha_i \hat{k}_{i,t}^{aut^{\alpha_i-1}} \quad (3)$$

$$\hat{w}_{i,t}^{aut} = (1 - \alpha_i) \hat{k}_{i,t}^{aut^{\alpha_i}} \quad (4)$$

The maximisation problem of consumers is also standard. Agents maximise (1) subject to:

$$c_{i,t}^{y aut} + s_{i,t}^{aut} = w_{i,t}^{aut} \quad (5)$$

$$c_{i,t+1}^o aut = s_{i,t}^{aut} (1 + r_{i,t+1}^{aut}) \quad (6)$$

which implies that the saving function is:

$$s_{i,t}^{aut} = \frac{\beta}{1 + \beta} w_{i,t}^{aut} \quad (7)$$

The capital market clears in every country:

$$K_{i,t+1}^{aut} = L_{i,t} s_{i,t}^{aut}$$

In equilibrium,  $R_{i,t}^{aut} = 1 + r_{i,t}^{aut}$ . Substituting the saving function and the price of labour from the first-order condition of the firms, we obtain:

$$K_{i,t+1}^{aut} = L_{i,t} \frac{\beta}{1 + \beta} Z_{i,t} (1 - \alpha_i) \hat{k}_{i,t}^{aut^{\alpha_i}} \quad (8)$$

which implies that the dynamics of the capital stock per effective units is characterized by the following equation:

$$(1+n)(1+g)\hat{k}_{i,t+1}^{aut} = \frac{\beta}{1 + \beta} (1 - \alpha_i) \hat{k}_{i,t}^{aut^{\alpha_i}} \quad (9)$$

It is well known that a unique and stable steady state exists under these assumptions on preferences and technology. The steady state capital stocks and interest rates in autarky are:

$$\hat{k}_i^{aut} = \left[ \frac{\beta(1 - \alpha_i)}{(1 + \beta)(1 + n)(1 + g)} \right]^{\frac{1}{1 - \alpha_i}} \quad (10)$$

$$R_i^{aut} = \frac{\alpha_i(1 + \beta)(1 + n)(1 + g)}{\beta(1 - \alpha_i)} \quad (11)$$

We can now prove the first result:

**Proposition 1 (Autarkic steady states)** *As  $\alpha_1 < \alpha_2$ , then  $\hat{k}_1^{aut} > \hat{k}_2^{aut}$  and  $R_1^{aut} < R_2^{aut}$ .*

**Corollary 1**  *$\hat{k}_1^{aut} > \hat{k}_2^{aut}$  implies that  $\hat{y}_1^{aut} > \hat{y}_2^{aut}$ .*

In this section, we have shown that the country with the highest capital share has a lower output per effective units of labor and a higher interest rate in autarky. Therefore, we will refer to country 1 (2) as the rich (poor) country.

## 2.2 International financial integration

As we are interested in the effects of financial markets' liberalization, we keep the assumption that firms can only hire domestic workers. Open economy variables are now marked by the superscript \*.

Since there is a common capital market and there are no frictions, all firms take the same interest rate as given. The demands for inputs in the two countries now satisfy:

$$R_t^* = \alpha_1 \hat{k}_{1,t}^{*\alpha_1 - 1} = \alpha_2 \hat{k}_{2,t}^{*\alpha_2 - 1} \quad (12)$$

$$\hat{w}_{i,t}^* = (1 - \alpha_i) \hat{k}_{i,t}^{*\alpha_i} \quad (13)$$

Although interest rates are equalized, capital stocks per effective units of labor are not equalized as the capital shares are not identical.

We can now write the equilibrium equation and analyze capital accumulation in the respective countries in the integrated economy. The (world) capital market is in equilibrium as long as (world) savings are equal to the sum of the domestic capital stocks:

$$\sum_i K_{i,t+1}^* = \sum_i L_{i,t} s_{i,t}^* = \frac{\beta}{1 + \beta} \sum_i L_{i,t} Z_{i,t} (1 - \alpha_i) \hat{k}_{i,t}^{*\alpha_i} \quad t \geq 0 \quad (14)$$

Dividing both sides of the equation by  $L_t Z_t$ :

$$(1+n)(1+g)(\rho_1 \hat{k}_{1,t+1}^* + \rho_2 \hat{k}_{2,t+1}^*) = \frac{\beta}{1+\beta} \left[ \rho_1 (1-\alpha_1) \hat{k}_{1,t}^{*\alpha_1} + \rho_2 (1-\alpha_2) \hat{k}_{2,t}^{*\alpha_2} \right] \quad (15)$$

where  $\rho_i$  is country  $i$ 's share of the world's effective units of labor (country size):  $\rho_i \equiv \frac{L_{i,t} Z_{i,t}}{L_t Z_t}$ .

### 2.2.1 Steady state

At a steady state of the world economy, the capital stocks of the two countries do not change over time:  $\hat{k}_{i,t}^* = \hat{k}_i^*$  for every  $i$ .

$$(1+n)(1+g)(\rho_1 \hat{k}_1^* + \rho_2 \hat{k}_2^*) = \frac{\beta}{1+\beta} \left[ \rho_1 (1-\alpha_1) \hat{k}_1^{*\alpha_1} + \rho_2 (1-\alpha_2) \hat{k}_2^{*\alpha_2} \right] \quad (16)$$

To prove the existence of a steady state, we rewrite the difference equation using the first-order conditions of the firms and show the existence of a steady state interest rate.

**Proposition 2 (Existence, uniqueness and stability of the steady state)** *For any given  $R_0$ , the (world) interest rate converges to a unique and stable steady state  $R^*$ .*

We can define the net foreign assets per effective units of labor of country  $i$  as follows:

**Definition 1 (Net foreign assets)**

$$\hat{a}_{i,t+1} \equiv \frac{\hat{s}_{i,t}}{(1+n)(1+g)} - \hat{k}_{i,t+1} \quad (17)$$

Let us now study the pattern of capital flows at the steady state.

**Proposition 3 (Net foreign assets (steady state))** *Country 1 (2) is the lender (borrower) country at the world interest rate  $R^*$ , which lies between the two autarkic interest rates:  $R_1^{aut} < R^* < R_2^{aut}$ .*

**Corollary 2** *Since  $R_1^{aut} < R^* < R_2^{aut}$ , then  $\hat{k}_2^* > \hat{k}_2^{aut}$  and  $\hat{k}_1^* < \hat{k}_1^{aut}$ . This implies that  $\hat{y}_2^* > \hat{y}_2^{aut}$  ( $\hat{y}_1^* < \hat{y}_1^{aut}$ ).*

As the world interest rate is lower than the autarkic interest rate, financial openness allows the poor country to reach a higher output as compared to the autarkic steady state. The opposite occurs for the developed country.

Nonetheless, the next Proposition shows that the poor country can never catch up with the level of output of the rich country.

**Proposition 4 (Lack of cross-country convergence)** *If  $\frac{(1+\beta)(1+n)(1+g)}{\beta(1-\alpha_1)} > \left(\frac{\alpha_2}{\alpha_1}\right)^{\frac{\alpha_2(1-\alpha_1)}{\alpha_2-\alpha_1}}$ , then  $\hat{y}_{1,t}^* > \hat{y}_{2,t}^*$  for all  $R_t^* \geq R^*$ .*

Although the rental rate of capital is equalized across countries, the level of capital that satisfies the first-order condition of the firms will vary according to the technology (equation (12)). Hence, we can never expect cross-country convergence as a result of international financial integration when the dimension of heterogeneity comes from the technological side of the economy.

Proposition 4 gives a sufficient condition under which the rich (poor) country stays rich (poor) under international financial integration. This condition is not very stringent. To make it even less binding, let us assume that  $n = g = 0$ . Let us also set the capital share of country 1 to 0.3, which is the value normally chosen for developed countries. Considering that a period corresponds to 30 years, a quarterly discount factor of 0.99 means that  $\beta = 0.299$ . We then verify numerically that the inequality holds for any value of  $\alpha_2$  between 0 and 1.

### 2.2.2 Dynamics

Before studying the dynamics, we establish the direction of capital flows when the financial markets of the two countries integrate. Suppose that the two countries open their financial markets at  $t = 1$ . To start with, we need to introduce the two countries' initial conditions.

**Assumption 2 (Initial conditions)** *At  $t = 1$ ,  $\hat{k}_{1,1} = \hat{k}_1^{aut}$  and  $\hat{k}_{2,1} < \hat{k}_2^{aut}$ .*

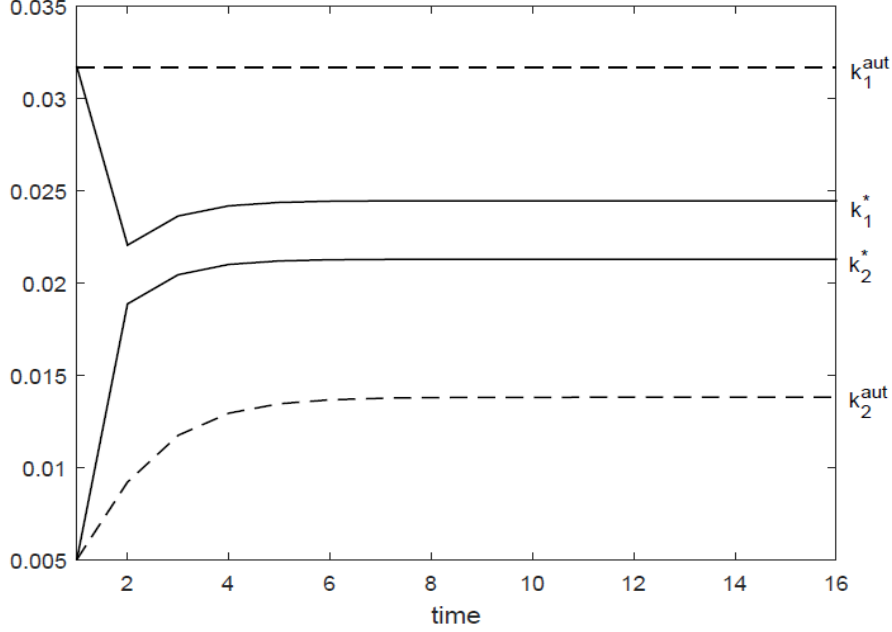
We study the dynamics of capital flows in the realistic scenario where the rich country is at its autarkic steady state, while the poor country is along its transition path to the autarkic steady state.

To analyze the direction of capital flows at the openness, we must characterize the interest rate which clears the world capital market at  $t = 2$ . Since the marginal production of capital in the poor country (country 2) is higher than the marginal product of capital in the rich country (country 1), we can show the following result:

**Proposition 5 (Net foreign assets (financial integration))** *Under Assumption 2, the poor country borrows from the rich country at  $t = 1$ .*

**Proposition 6 (Capital stock (dynamics))** *For each country  $i$ , the function  $\hat{k}_{i,t+1} = \psi(\hat{k}_{i,t})$  is increasing and concave.*

Figure 1: The dynamics of capital in closed and open economy: an example.  $\rho_1 = \rho_2$ ,  $\alpha_1 = 0.3$ ,  $\alpha_2 = 0.4$ ,  $\hat{k}_{2,1} = 0.005$  and  $\hat{k}_{1,1} = \hat{k}_1^{aut}$ .

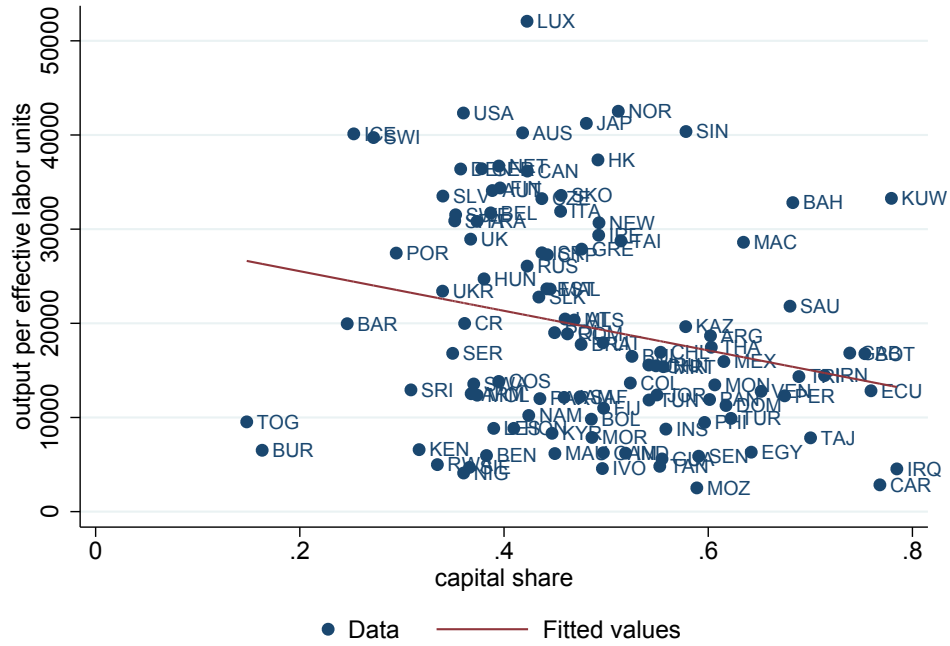


Our initial conditions imply that the initial world interest rate is higher than its long-run value:  $R_2 > R^*$ . By Proposition 2, the world interest rate falls until it reaches the steady state. Since the countries' capital stocks are a negative function of the world interest rate, they accumulate over time and converge to the steady state capital stocks  $\hat{k}_1^*$  and  $\hat{k}_2^*$ . Figure 1 shows an example of how the dynamics of capital in the two countries changes from autarky to financial integration.

Our next step is to analyze the pattern of capital flows along the transition to the steady state. The strategy for the proof is similar to Proposition 5. In each period, we can take the interest rate  $R_t^*$  as given and ask which country has a higher marginal product of capital, i.e. we consider the interest rates which would prevail if the countries were in autarky in period  $t + 1$ . As the marginal product of capital of country 2 is always higher than the marginal product of capital of country 1, we can state the following result.

**Proposition 7 (Net foreign assets (dynamics))** *Under Assumption 2, the poor country borrows from the rich country for any  $t \geq 1$ .*

Figure 2: The relationship between output per effective labor units and capital shares



*Notes.* The data source is the Penn World Tables 8.1. The number of countries is 109 and the data are from 2005. The regression coefficient is significant at 5% level.

### 3 Empirical evidence on capital shares

In this section, we provide some empirical evidence to support the idea that differences in capital shares can help to explain the lack of cross-country convergence as well as the direction of capital flows.

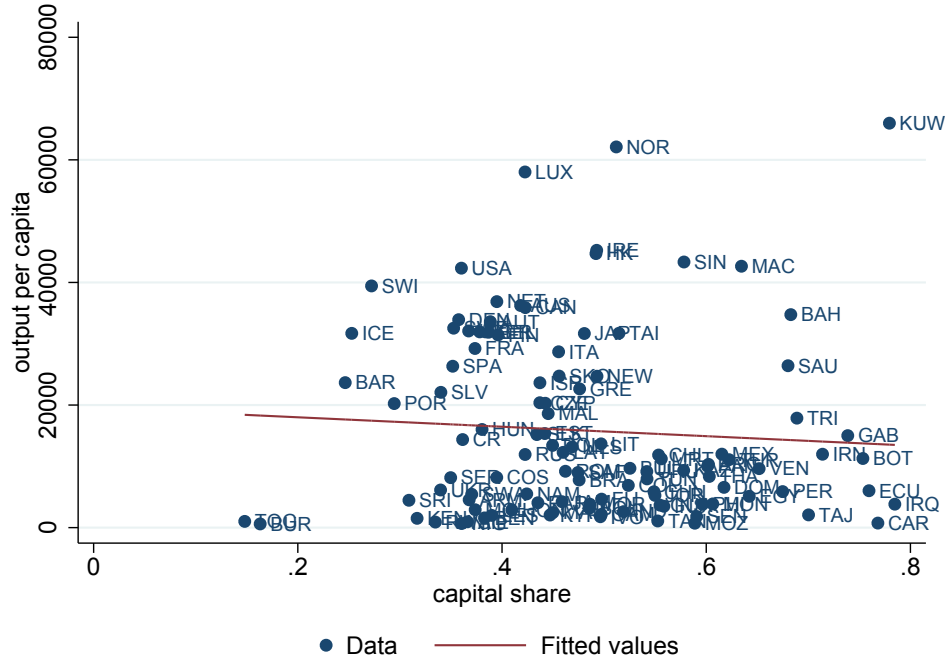
To start with, our model suggests that the country with the highest capital share is the country with the lowest GDP per effective units of labor. This statement holds true independently from countries' level of financial integration (Propositions 1 and 4).

Figure 2 shows that there is a robust negative relationship between output per effective units of labor and the capital share. This result does not contradict previous empirical findings of Caselli and Feyrer (2007) and Feenstra, Inklaar and Timmer (2015), which found no statistical relationship between output per capita and capital shares: we find the same result in our sample (Figure 3). However, our paper stresses the importance of adjusting output per capita with total factor productivity<sup>8</sup>.

Propositions 5 and 7 also show that the country with the highest capital share should

<sup>8</sup>Interestingly, Ortega and Rodriguez (2006) find a negative relationship between capital shares and output per capita using UNIDO and OECD's industrial surveys data.

Figure 3: The relationship between output per capita and capital shares



*Notes.* The data source is the Penn World Tables 8.1. The number of countries is 109 and the data are from 2005. The regression coefficient is not significant.

borrow from the rest of the world. Since countries differ in their production technologies, it seems appropriate to concentrate on foreign direct investments (FDI) as a measure of private capital flows to test the relevance of our channel.

Figure 4 illustrates that there is a negative (statistically significant) relationship between net FDI positions and capital shares: this means that a country with a higher capital share is more likely to be a recipient of capital flows.

Therefore, the data support the idea that differences in capital shares can help to explain countries' different level of development (as proxied by output per effective units of labor) as well as the direction of FDI flows. In the next section, we analyze the welfare implications of international financial integration in a world where countries differ in capital shares.

Figure 4: The relationship between net FDI positions and capital shares



*Notes.* Capital shares are taken from the Penn World Tables 8.1, while the net FDI position is extracted from Lane and Milesi-Ferretti database (2007). The number of countries is 99 and the data are from 2005. The regression coefficient is significant at 5% level. OPEC countries are excluded from the sample.

## 4 The intergenerational consequences of international financial integration

### 4.1 The main trade-off

The calculation of the welfare implications of moving from a scenario of financial autarky to financial integration necessarily depend on the demographic structure imposed to the economy. In models where agents are infinitely-lived, it simply involves comparing the welfare of the representative agent in each country under the two different scenarios. In overlapping-generations models, it is relevant to consider the welfare consequences for each generation born after the reform.

Let us define the gains from international financial integration for an agent born at  $t$  as the difference in utility obtained under financial integration and autarky:

$$\Delta U_{i,t} \equiv U_{i,t}^* - U_{i,t}^{aut}$$

Recall that we assume full depreciation, hence  $1 + r^* = R^*$ . Given the saving function and factor prices, the indirect utility of such agent under the two regimes can be written as:

$$\begin{aligned} U_{i,t}^* &= \log \left( \frac{1}{1+\beta} (1 - \alpha_i) \hat{k}_{i,t}^{\alpha_i^*} \right) + \beta \log \left( \frac{\beta}{1+\beta} (1 - \alpha_i) \hat{k}_{i,t}^{\alpha_i^*} \alpha_i \hat{k}_{i,t+1}^{\alpha_i - 1} \right) \\ U_{i,t}^{aut} &= \log \left( \frac{1}{1+\beta} (1 - \alpha_i) \hat{k}_{i,t}^{\alpha_i^{aut}} \right) + \beta \log \left( \frac{\beta}{1+\beta} (1 - \alpha_i) \hat{k}_{i,t}^{\alpha_i^{aut}} \alpha_i \hat{k}_{i,t+1}^{\alpha_i - 1} \right) \end{aligned}$$

Using the above expressions and simplifying, the gains from international financial integration can be written as:

$$\Delta U_{i,t} = \underbrace{(1 + \beta) \alpha_i (\log \hat{k}_{i,t}^* - \log \hat{k}_{i,t}^{aut})}_{\text{wage channel}} - \underbrace{\beta (1 - \alpha_i) (\log \hat{k}_{i,t+1}^* - \log \hat{k}_{i,t+1}^{aut})}_{\text{interest rate channel}} \quad (18)$$

Let us consider the poor country. We have proved that the country achieves a higher steady state under financial integration. Since the difference equations describing the behavior of  $\hat{k}$  are both increasing and concave, it is easy to show that  $\log k_{2,t}^* > \log k_{2,t}^{aut}$  also holds during the transition to the steady state, for any initial condition<sup>9</sup>.

Equation (18) illustrates that agents born in the poor country face a fundamental trade-off. On the one hand, financial integration means a higher wage which increases consumption both in the first and in the second period of life. On the other hand, a higher

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<sup>9</sup>For an example, see Figure 1.

capital stock also implies a drop in the interest rate which decreases the consumption of the old.

At the steady state of the economy, equation (18) simplifies to:

$$\Delta U_i = [(1 + \beta)\alpha_i - \beta(1 - \alpha_i)](\log \hat{k}_i^* - \log \hat{k}_i^{aut}) \quad (19)$$

which implies that:

$$\Delta U_2 > (<) 0 \quad \text{if} \quad \frac{\alpha_2}{1 - \alpha_2} > (<) \frac{\beta}{1 + \beta} \quad (20)$$

On the other hand, the conditions for the rich country are the opposite since  $\log k_{1,t}^* < \log k_{1,t}^{aut}$ .

In an overlapping-generations model where countries differ in their rate of time preference, Buiter (1981) showed that the ambiguous long-run welfare effects are related to whether the steady state capital stock of an economy in autarky is below or beyond the golden rule<sup>10</sup>. In fact, assume that the planner of each country chooses the capital stock which maximizes the utility of the generations born at the steady state:

$$\max_{\hat{k}_i, c_i^y, c_i^o} \log c_i^y + \beta \log c_i^o \quad (21)$$

subject to:

$$(1 + g)(1 + n)\hat{k}_i + c_i^y + \frac{c_i^o}{(1 + g)(1 + n)} = \hat{k}_i^\alpha \quad (22)$$

It is easy to show from the first-order condition for  $k_i$  that the golden rule level of capital for country  $i$  is:

$$\hat{k}_i^{GR} = \left( \frac{\alpha_i}{(1 + n)(1 + g)} \right)^{\frac{1}{1 - \alpha_i}} \quad (23)$$

Comparing equation (23) with (10), it follows that:

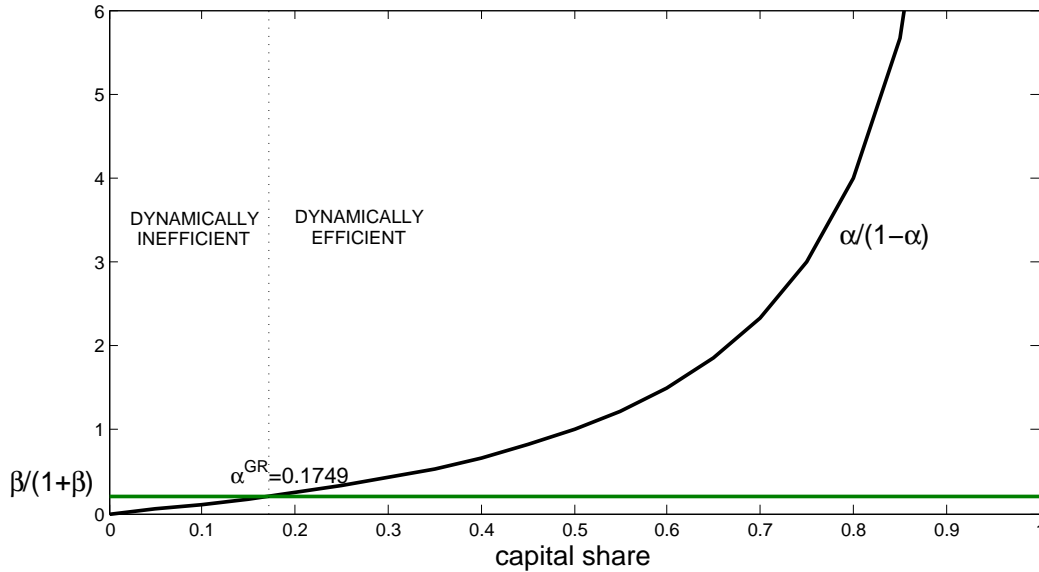
$$\hat{k}_i^{GR} > (<) \hat{k}_i^{aut} \quad \text{if} \quad \frac{\alpha_i}{1 - \alpha_i} > (<) \frac{\beta}{1 + \beta} \quad (24)$$

Conditions (20) and (24) combined show that the country with the highest capital share (poor country), which has a lower capital stock in autarky, gains from financial integration in the long-run only as long as the autarkic steady state is dynamically efficient. On the other hand, the country with the lowest capital share gains from financial integration in the opposite case: as the lender country faces a lower capital stock (and therefore output) in open economy, it can only gain if the country is accumulating too much capital in autarky (dynamic inefficiency)<sup>11</sup>.

<sup>10</sup>More recently, Darreau and Pigalle (2014) derived condition (20) with Cobb-Douglas utility and production functions.

<sup>11</sup>In Buiter (1981) and Darreau and Pigalle (2014), the less patient country plays the role of the country with the highest capital share.

Figure 5: The set of capital shares under which an economy is dynamically (in)efficient for  $\beta = 0.269$ .



Ultimately, whether a country gains from opening their financial markets in the long-run is an empirical/calibration question. We tackle this issue in the next section. For the moment being, it is enough to notice that for a quarterly discount factor of 0.99, which corresponds to a discount factor of 0.269 considering that a period lasts for 30 years, the set of capital shares under which an economy is dynamically efficient is quite large. Figure 5 shows that as long as both countries have a capital share larger than 0.1749, then the poor (rich) country gains (loses) from IFI in the long-run. The novelty of this paper is that we also consider the whole transition path to the steady state when assessing the gains from IFI.

## 4.2 Calibration and methodology

To make our results comparable with the literature, we borrow the parameter values of Gourinchas and Jeanne (2006) where possible. We also follow Gourinchas and Jeanne (2006) in selecting 1995 as the benchmark year. The only precaution that we need to take in calibrating most parameters is that a period roughly lasts for 30 years in a two-period OLG model.

In Gourinchas and Jeanne (2006), the annual growth rates are 1.2% and 0.74% respectively for productivity and population. The equivalent growth rates have been calculated

using the following formula:

$$(1 + x_{\text{yearly}})^{30} = 1 + x \quad 30 \cdot x_{\text{yearly}} \approx x$$

Given the Cobb-Douglas production function, we compute the yearly interest rate of the United States as follows:

$$R_{1,\text{yearly}} = \frac{\alpha_1}{\frac{\hat{k}_{1,1995}}{\hat{y}_{1,1995}}} = \frac{0.3}{2.68} = 0.11$$

where the capital-output ratio is taken from Gourinchas and Jeanne (2006), who also set country 1's capital share at 0.3. As we did for the growth rates, we convert the yearly interest rate using the formula:  $30 \cdot 0.11 \approx 3.36$ . The discount factor is then derived as a residual by plugging the known parameter values into the solution for the autarkic interest rate (11). We find that  $\beta = 0.269$ , which approximately corresponds to a yearly discount rate of 0.96 as in Gourinchas and Jeanne (2006).

Country 2's capital share is calculated as a weighted average of non-OECD countries' capital shares in 1995, where the weights are constructed taking countries' share of world GDP (IMF, World Economic Outlook). Country 2's share of the world's per effective units of labor (country size) is calculated as the average share of world GDP of non-OECD countries.

Finally, we derive the two countries' initial capital stock per effective units of labour. Since  $\frac{\hat{k}}{\hat{y}} = \hat{k}^{1-\alpha}$ , then  $\hat{k}$  can be derived once we know the capital-labour ratio and the capital share. For country 2, we adjust the yearly capital-output ratio from Gourinchas and Jeanne (2006) to our OLG framework (dividing it by 30) and use the average capital share in the developing country calculated above:  $\hat{k} = \left(\frac{1.40}{30}\right)^{\frac{1}{1-0.49}}$ . Regarding country 1,

Table 2: Parameter Values

Country 1's capital share	$\alpha_1 = 0.3$
Country 2's capital share	$\alpha_2 = 0.49$
Discount factor	$\beta = 0.269$
Productivity growth rate	$g = 0.36$
Population growth rate	$n = 0.222$
Country 2's size	$\rho_2 = 0.0042$
Initial capital stock per effective labor units (country 1)	$\hat{k}_{1,1} = 0.0317$
Initial capital stock per effective labor units (country 2)	$\hat{k}_{2,1} = 0.0025$

we assume that it is at the autarkic steady state at  $t = 1$ . Hence, we calculate the initial capital stock using equation (10).

We proceed as follows. Firstly, we calculate the interest rate path in open economy using (62), which is a non-linear first-order difference equation. Using the first-order conditions of the firms, the path of the capital stocks in the two countries are pinned down. Finally, we compute the consumption allocations in the two countries. Given the same initial conditions, we calculate the path for the autarkic capital stocks using (9) and then the consumption paths of the two countries in autarky.

Next, we measure the gains from international financial integration as the percentage increase in wealth that each generation under autarky would require to reach the level of utility achievable under financial integration (Hicksian equivalent variation).

In particular, let us define the level of utility of the generation born at  $t$  respectively under autarky and financial integration as follows:

$$U_{i,t}^{aut} = \log c_{i,t}^{y aut} + \beta \log c_{i,t+1}^o aut \quad (25)$$

$$U_{i,t}^* = \log c_{i,t}^{y *} + \beta \log c_{i,t+1}^o * \quad (26)$$

Therefore:

$$\log c_{i,t}^{y *} + \beta \log c_{i,t+1}^o * = \log c_{i,t}^{y aut} (1 + \mu_{i,t}) + \beta \log c_{i,t+1}^o aut (1 + \mu_{i,t})$$

where  $\mu_{i,t}$  is the percentage increase in wealth (which directly translates into an increase in consumption) that would equate the utility of the generation born in country  $i$  at  $t$  under autarky to the open economy level. After a few steps, we can show that:

$$\mu_{i,t} = \exp \frac{U_{i,t}^* - U_{i,t}^{aut}}{1+\beta} - 1 \quad (27)$$

### 4.3 The financial integration of a small developing economy

Figure 6 shows the intergenerational effects of international financial integration for a typical developing country.

The first observation is that the generation born at  $t = 1$  in the poor country would lose if the domestic capital markets opened. As the initial capital stock is given, their income when young as determined by the wage rate would not be affected. Therefore, the wage channel in (18) drops out. But as the world interest rate at  $t = 2$  would be lower than the autarkic interest rate (Proposition 5), then the consumption when old would drop and total utility fall. If the young influence the political decisions in the poor

countries, our model could explain why financial integration is still limited in many poor countries: the initial generation could suffer a welfare loss as big as 18.5% in equivalent consumption<sup>12</sup>. As the initial generation in the poor country is worse off, this also means that financial autarky is Pareto optimal.

However, such decision would come at the expense of future generations, which they would all gain from international financial integration. The heterogeneity in capital shares imply that those gains are permanent. As the poor country has a higher capital share, it would reach a lower steady state as compared to the rich country if it remained in autarky. In open economy, the developing country has the possibility to reach a higher steady state (although remaining relatively poorer) as it receives capital flows from the developed country. The wider is the difference in the capital shares, the wider is the gap with the rich country and therefore the bigger are the gains from financial integration.

For our benchmark value of  $\alpha_2 = 0.49$ , the gains from international financial integration are in the order of 82.8% of equivalent consumption in the long-run. If we set  $\alpha_2 = 0.35$ , which reduces the difference in the capital shares across countries to a seemingly negligible 0.05, the long-run welfare gains are still substantial as they correspond to an increase of 7.7% of equivalent consumption. These might seem huge gains but they make sense once we consider the case where the capital shares are identical, which is the economy analyzed by Gourinchas and Jeanne (2006). In our OLG framework, the welfare gains approach zero for the generations born at the steady state. Yet, the generations that live in the transition period could reap substantial gains even when countries are identical. After the initial loss, the generation born in year 2 would gain 21.4% of equivalent consumption. In Gourinchas and Jeanne (2006), the representative household in the poor country overall experiences an increase of 1.74% in permanent consumption but the change in output growth can be as high as 27.65% at a one year horizon. We also need to keep in mind that we are calculating the welfare consequences of shifting from a regime of full autarky to a regime of full financial integration, which does not usually happen in one period. Yet, this does not take away the fact that financial integration can involve substantial long-run gains for a developing country.

It is also intuitive that the transitional gains from international financial integration

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<sup>12</sup>See Chinn and Ito (2006). Antunes and Cavalcanti (2013) provide a similar argument in a context where agents are heterogeneous in their wealth. In their setting, the median household is in favour of opening capital markets but if power is in the hands of the rich households, then their incentive is to keep domestic capital markets closed.

Figure 6: The intergenerational effects of IFI for a small developing economy for different values of the capital share.

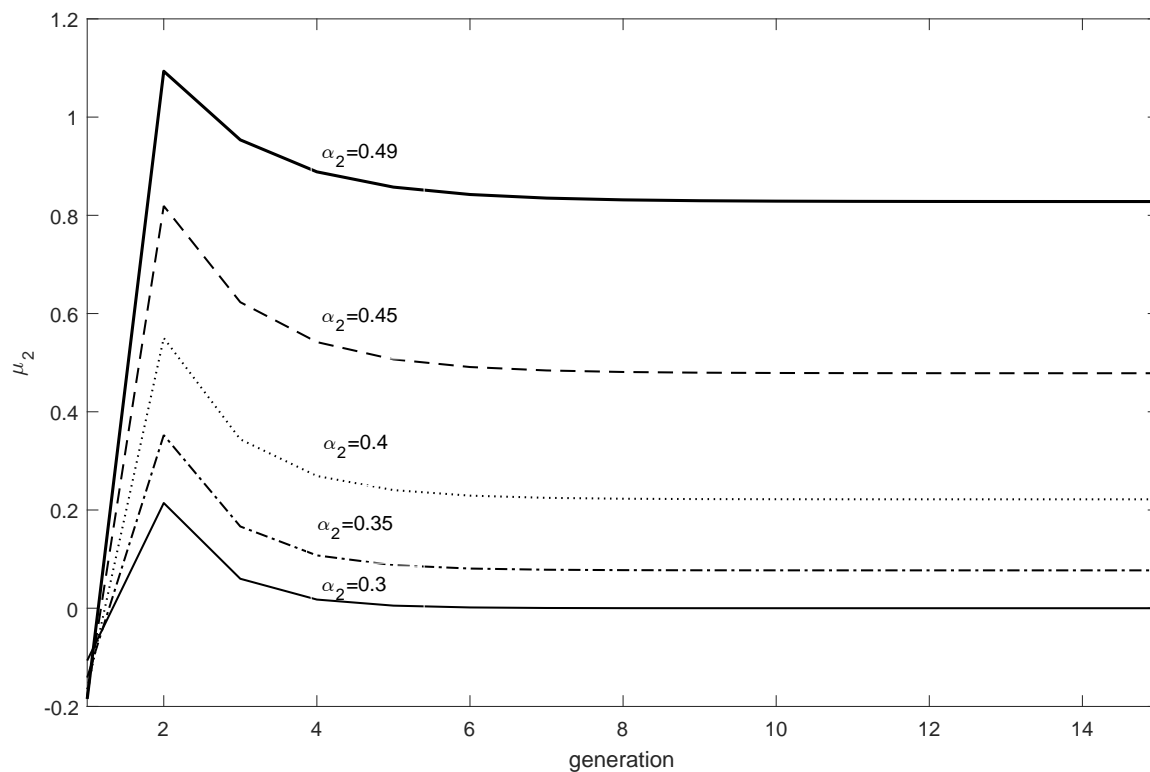


Figure 7: The intergenerational effects of IFI for a small developing economy for different initial values of capital.

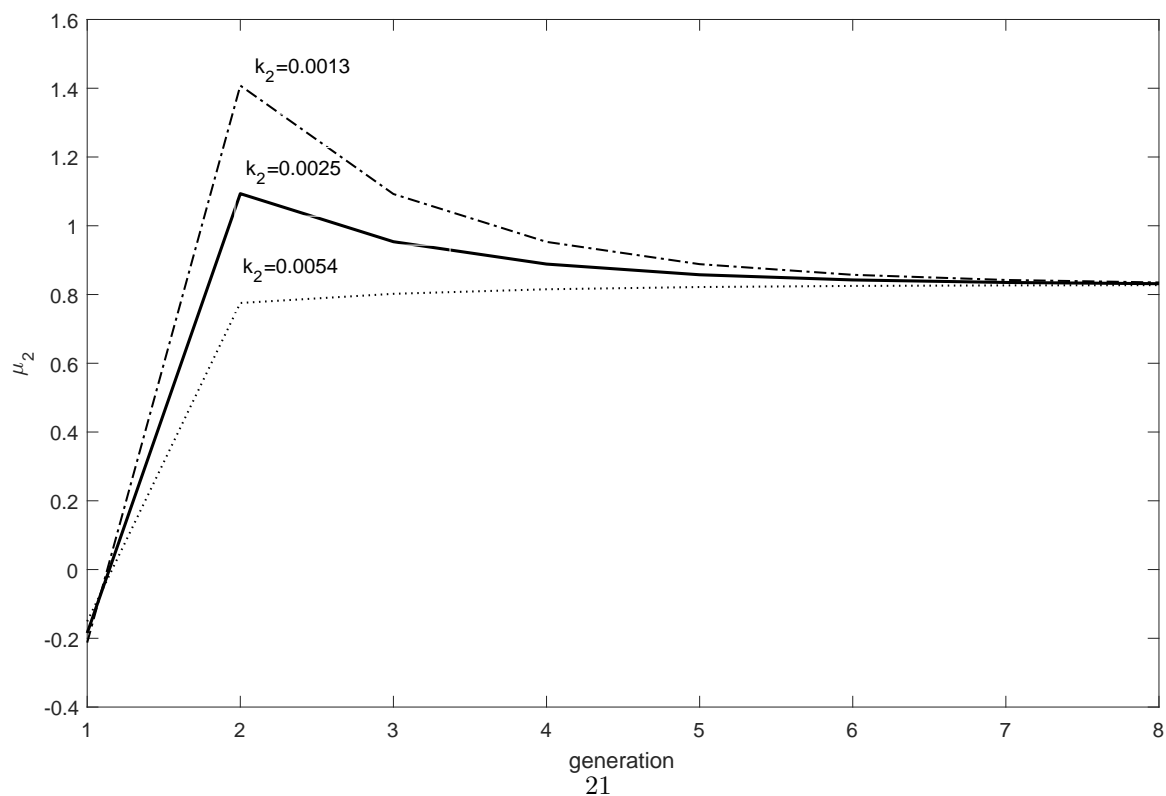
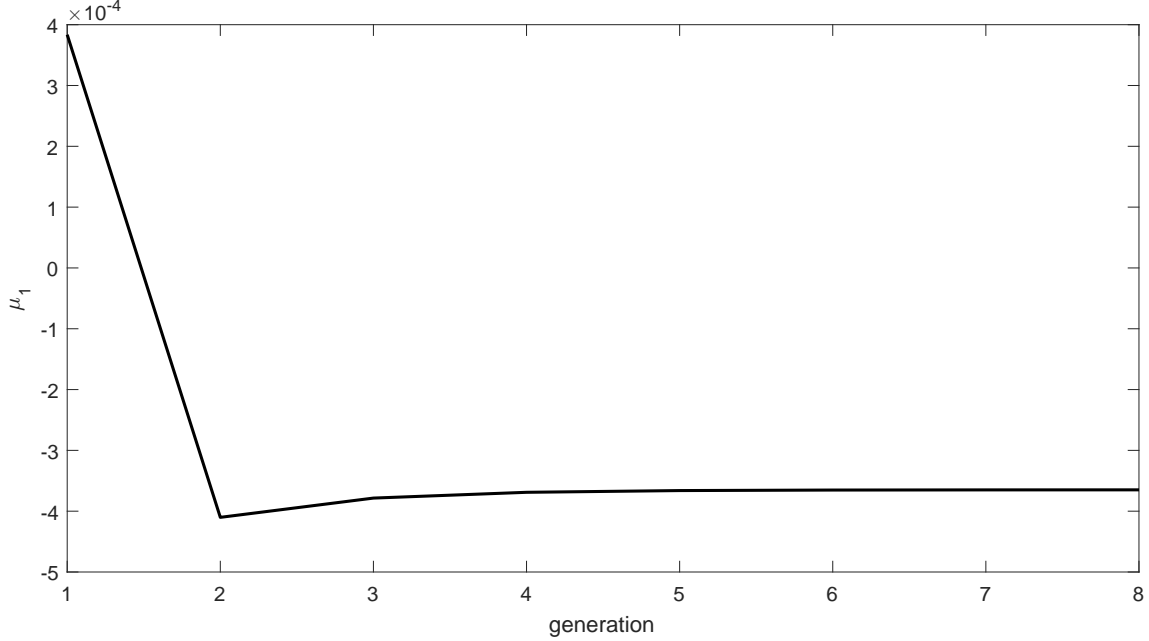


Figure 8: The spillover effects on the developed country when a small developing economy financially integrates.



are larger the lower is the initial capital stock of the poor country, as the transition to the steady state is faster. Figure 7 shows the welfare gains for the top and bottom deciles of the capital-output ratio of non-OECD countries as well as for the benchmark value (in bold)<sup>13</sup>.

Finally, we report the welfare impact on country 1 in Figure 8. When the developing country opens its financial markets, the initial generation gains as the rate of interest on their savings (which are given) increases. However, all the other generations experience a welfare loss. As country 1 converges to a lower steady state, the lifetime income of each generation falls and hence does their utility. It is worth noting that the spillover effects on the developed country is negligible from a quantitative point of view, as the average size of a developing country is very small.

#### 4.4 The financial integration of a large emerging economy

As a typical developing economy is very small, the welfare of the developed country is barely affected as the world interest rate is very close to its autarkic interest rate. Therefore, the quantitative results obtained above can be compared with other small

<sup>13</sup>As we did for the benchmark value, we divide the capital-output ratios of Gourinchas and Jeanne (2006) by 30 years and calculate  $\hat{k}_{2,1}$  using our weighted measure of capital share for the poor country.

open economy environments, which can be seen as a limit case of a two-country model.

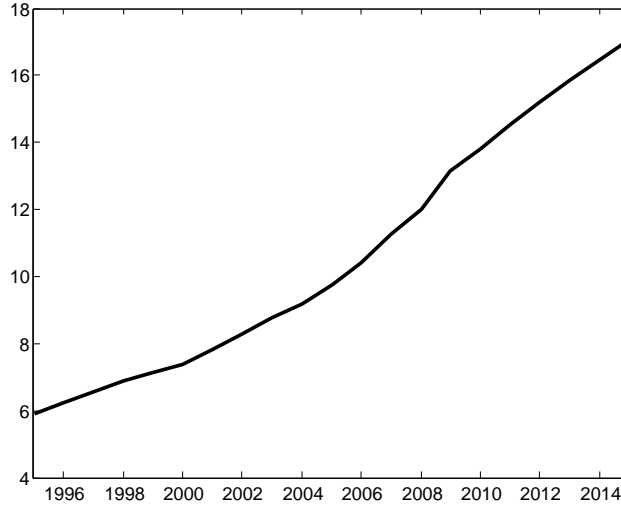
However, a large emerging economy, through a larger  $\rho_2$  in equation (62), would have a bigger influence on the dynamics of the world interest rate. In this section, we will then ask the following questions: are the gains from international financial integration for large emerging economies smaller? Moreover, are the spillovers effects on the rich country significant?

Let us now consider a scenario in which China, the largest country in 1995 in our sample, fully opens its domestic capital market. Let us set China's capital share to 0.46, which is the average between the measure of the Penn World Tables 8.1 and the number calculated in Bai et al. (2006) in 1995. One of the main stylized facts that characterize the Chinese economy over the past three decades is the steady increase in China's share of world GDP (Figure 9). To capture this fact, we allow for  $\rho_2$  to be time-varying. For  $t = 1$  and  $t = 2$ , we calibrate  $\rho_2$  taking China's share of world GDP respectively in 1995 and in 2015. For the following periods, we consider two alternative scenarios. In the first one, China's share of world GDP is assumed to be equal to the 2015 value from period three onwards. The second scenario is more optimistic on the Chinese economy as it assumes that China's share of world GDP will grow at the same rate for the next thirty years, which implies that China's country size would roughly be equal to half of the world's effective labor units by 2045. Possibly, the most realistic scenario is a situation in between.

First of all, it can be observed that the long-run gains for China will be smaller if the country gets larger, as the world interest rate would be closer to China's autarkic interest rate (Figure 10). The initial generation loses around 14% of equivalent consumption in both scenarios while the subsequent generations would gain at least 34% in the long-run (scenario 2).

On the other hand, Figure 11 confirms the intuition that the spillover effects on the rich country increase with China's size. As the world interest rate is higher than the autarkic interest rate, the first generation always gains as the domestic capital stock falls and the country experiences capital outflows (equation (18)). As long as China grows, the generations born in the following periods still gain as the world interest rate becomes closer to China's autarkic interest rate. As soon as China stops growing, the rich country loses out. If China's weight in the world economy stays the same as in 2015, the long-run losses will amount to -1.5% of equivalent consumption for the generations born in the rich

Figure 9: China's share of world GDP, 1995-2015.



*Notes.* China's GDP based on PPP share of the world total (in percentages). Source: World Economic Outlook Database (IMF).

country. If China keeps growing at the same rate for the next thirty years, the losses will amount to -4.7%.

The losses are much smaller than the gains achieved by the emerging country, thereby suggesting that international financial integration is beneficial from the perspective of aggregate welfare. However, our results suggest that there can be important distributional effects, both within and across countries. In fact, although the rich country invests in the poor country receiving rental income from abroad, the higher interest rate is not enough to compensate the fall in the lifetime income that affects all generations.

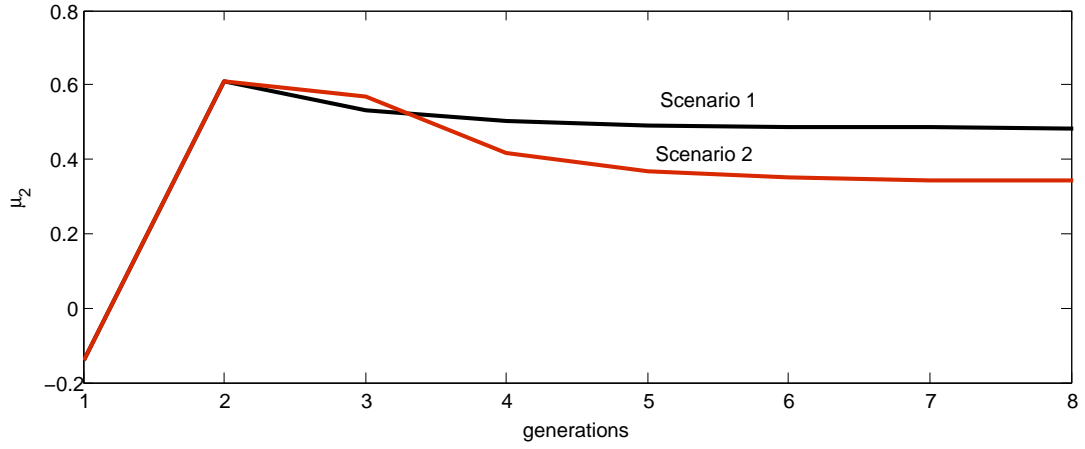
Table 3: Parameter Values.

Country 2's capital share	$\alpha_2 = 0.46$
Country 2's share of world's effective labor units	$\rho_{2,1} = 0.05898$
	$\rho_{2,2} = 0.17082$
Initial capital stock per effective labor units (country 2)	$\hat{k}_{2,0} = 0.0055$

#### 4.5 Is international financial integration beneficial after all?

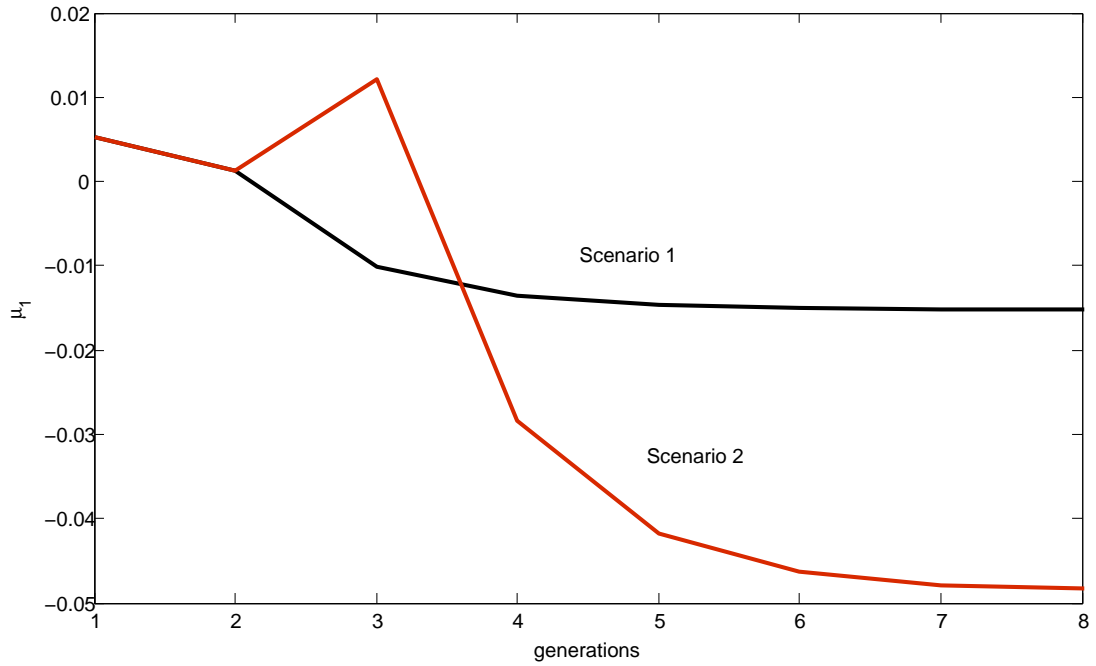
We have established that the process of international financial integration has important distributional consequences across generations. On impact, the first generation loses (gains) in the developing (developed) country, while in the transition to the steady state

Figure 10: The intergenerational effects of IFI for China.



Notes. Scenario 1:  $\rho_{2,t} = 0.17082$  for  $t \geq 3$ . Scenario 2:  $\rho_{2,t} = 0.4947$  for  $t \geq 3$ .

Figure 11: The spillover effects on the developed country of China's financial integration.



Notes. Scenario 1:  $\rho_{2,t} = 0.17082$  for  $t \geq 3$ . Scenario 2:  $\rho_{2,t} = 0.4947$  for  $t \geq 3$ .

and in the long-run international financial integration is only beneficial for the generations born in the developing country. While the spillover effects of financially integrating with a small open economy are negligible, agents born in the developed country (except the first generation) sustain non-negligible losses when a large emerging economy opens its financial markets.

These results might put into doubt the notion that international financial integration is a beneficial process for all countries involved. But is this really the case? To answer this question, we ask whether a benevolent planner that cares about the welfare of all generations would indeed pursue the path of financial openness for its country.

Deciding whether opening financial markets to the rest of the world or not is a discrete decision, therefore a planner would simply need to evaluate the utility that all the generations within its country would face in the two alternative scenarios. The social welfare function of country  $i$  at the time of financial integration ( $t = 1$ ) in the two cases can be defined as follows:

$$V_{i,1}^{aut} = \sum_{t=1}^{\infty} \gamma^{t-1} L_{i,t} U_{i,t}^{aut} \quad (28)$$

$$V_{i,1}^* = \sum_{t=1}^{\infty} \gamma^{t-1} L_{i,t} U_{i,t}^* \quad (29)$$

We have already computed  $U_{i,t}^{aut}$  and  $U_{i,t}^*$  in the previous section. The only parameter that needs to be chosen is the discount factor of the planner. We assume that the discount factor that the planner applies from one generation to another is the same discount factor that each agent applies from one period to another. Hence,  $\gamma = \beta$ .

Next, we calculate the welfare gains of the social planner in terms of Hicksian equivalent variation, where  $\mu_{i,P}$  is the percentage increase in consumption in autarky which would ensure that the utility of the planner is the same as under international financial integration:

$$\mu_{i,P} = \exp\left(\frac{(V_{i,1}^* - V_{i,1}^{aut})(1 - \beta(1+n))}{1 + \beta}\right) - 1$$

We report the results in Table 4.

Our first observation is that both countries gain from international financial integration from a social planner's point of view. Moreover, the welfare gains for country 2 are not negligible. In Gourinchas et al. (2006), the aggregate welfare gains for a small developing economy are only 1.74% of equivalent consumption. The reason is that capital flows

Table 4: The aggregate welfare consequences of international financial integration ( $\mu_{i,P}$ )

	Small economy	Large economy
country 1	0.01%	0.35%
country 2	10.16%	4.78%

*Notes.* For the small economy case, we consider the benchmark set in Table 2. For the large economy case, we consider Scenario 2 (Fig. 10-11) as the developed country loses the most in the long-run. We calculate  $V_{i,t}$  for  $T = 15$ , as  $\beta^{15}$  is already extremely small ( $2.79 \times 10^{-9}$ ).

are only temporary (they take place only for a period) and simply allow the small open economy to reach its steady state faster. When capital shares are different across countries, capital flows are permanent and allows the developing economy to reach a higher steady state than in autarky. As IFI allows a better allocation of capital in every period, the welfare gains are much higher. As one would expect, a small developing economy gains more than a large emerging economy like China from the process of IFI: as the dynamics of the world interest rate is mainly driven by the developed country, a small economy is able to reach a much higher steady state as compared to a large economy, despite never fully converging to the developed country's output per capita.

It might seem surprising that the developed country gains, since all its generations except the first one lose from international financial integration. However, the gains enjoyed by the first generation are high enough to compensate all future losses, since the first generation has the highest weight in the planner's welfare function. Not surprisingly, the developed country gains more when a large growing country such as China opens its financial markets. However, the welfare gains from the perspective of the developed country are still negligible.

This analysis shows the importance of studying the dynamic welfare effects of international financial integration. If we only limited ourselves to a comparative statics exercise between steady states, then the implication would be that the developed country should not open its financial markets<sup>14</sup>. However, we have shown that this is clearly not the case when taking into account the transitional effects.

<sup>14</sup>As we discussed in section 4.1, this depends on the fact that the developed country is dynamically efficient in our calibration. See Buiter (1981) and Darreau and Pigalle (2014).

## 5 Can international financial integration be beneficial for everyone?

Although our results confirm the basic intuition that international financial integration is beneficial for all countries involved from an aggregate perspective, we have shown that not all generations would be affected in a positive way from the reform. But since both countries are better off overall, could the two governments design redistribution policies within their country to ensure that everyone reaps the gains from international financial integration? Notice that a redistribution policy is particularly important for a developing or an emerging economy. In fact, if political power is in the hands of the young at the time of financial integration (the first generation) then the country would not open its financial markets. However, this decision would come at the expense of future generations, which would instead reap sizable welfare gains. Hence, a policy that takes into account the detrimental effect of international financial integration on the first generation is particularly desirable.

Firstly, we consider the small economy case. Since the spillover effects on the developed country are negligible from a quantitative point of view, we assume that the government of the developed country remains inactive. This is particularly convenient, so that we understand the course of action that the developing country's government should take in isolation. When we look at the large country case, we will also consider possible redistribution policies in the developed country so that international financial integration is Pareto improving for all generations.

### 5.1 Fiscal redistribution in the developing economy

From the perspective of the developing country, a redistribution policy should involve compensating the only loser from the process of international financial integration i.e. the first generation. As financial markets integrate, the developing country experiences capital inflows since its initial interest rate is relatively high. As the equilibrium interest rate is lower when the economy opens, then the first generation experiences a drop in consumption when old as the return on savings is lower than it would be in autarky. On the other hand, the second generation receives a boost in wage income as capital inflows imply faster capital accumulation.

To ensure that even the first generation gains from international financial integration,

the government could commit at  $t = 1$  to tax the labor income of the generation born in the following period and redistribute it to the current generation in the old age following a balanced budget rule. This policy only needs to be implemented at  $t = 2$ , since all subsequent generations gain.

Let us define  $T_{w,2}$  as the lump-sum transfer per capita that the first generation would receive when old and  $\tau_{w,2}$  as the tax on labor income. The budget of the government is then:

$$L_{2,1}T_{w,2} = L_{2,2}\tau_{w,2}w_{2,2} \quad (30)$$

Since  $w_{2,2} = Z_{2,2}(1 - \alpha_2)\hat{k}_{2,2}^{\alpha_2*}$  and using the law of motion for the population, the above expression can be rewritten as follows:

$$T_{w,2} = (1 + n)\tau_{w,2}Z_{2,2}(1 - \alpha_2)\hat{k}_{2,2}^{\alpha_2*} \quad (31)$$

We now explore how this policy would change the maximisation problem of the two generations affected by the policy and hence the process of capital accumulation.

*First generation* - Let us consider the budget constraints that the first generation would face if it expected a transfer from the government in the following period:

$$c_{2,1}^{y*} = w_{2,1} - s_{2,1}^* \quad (32)$$

$$c_{2,2}^{o*} = s_{2,1}^*(1 + r_2^*) + T_{w,2}^* \quad (33)$$

The wage is not starred as it is given at the moment of financial integration. Maximising the utility function (1) subject to the constraints above, we obtain the following saving function:

$$s_{2,1}^* = \frac{\beta}{1 + \beta}w_{2,1} - \frac{T_{w,2}^*}{(1 + \beta)(1 + r_2^*)} \quad (34)$$

Since the agent expects a transfer from the government in the next period, it has an incentive to save less. Plugging equation (31) and the first-order conditions of the firms into the saving function, we can rewrite it as follows:

$$s_{2,1}^* = \frac{\beta}{1 + \beta}Z_{2,1}(1 - \alpha_2) \left[ \hat{k}_{2,1}^{aut\alpha_2} - \frac{(1 + n)(1 + g)\tau_{w,2}\hat{k}_{2,2}^{\alpha_2*}}{\beta\alpha_2\hat{k}_{2,2}^{*\alpha_2-1}} \right] \quad (35)$$

As a consequence, the capital accumulation equation at  $t = 1$  becomes:

$$\begin{aligned} (1 + n)(1 + g)(\rho_1\hat{k}_{1,2}^* + \rho_2\hat{k}_{2,2}^*) &= \frac{\beta}{1 + \beta}\rho_1(1 - \alpha_1)\hat{k}_1^{aut\alpha_1} + \\ &+ \frac{\beta}{1 + \beta}\rho_2(1 - \alpha_2) \left( \hat{k}_{2,1}^{aut\alpha_2} - \frac{(1 + n)(1 + g)\tau_{w,2}\hat{k}_{2,2}^{\alpha_2*}}{\beta\alpha_2\hat{k}_{2,2}^{*\alpha_2-1}} \right) \end{aligned} \quad (36)$$

which implies that the world interest rate  $R_2^*$  needs to satisfy the equation below:

$$(1+n)(1+g) \sum_i \rho_i \left( \frac{R_2^*}{\alpha_i} \right)^{\frac{1}{\alpha_i-1}} = \frac{\beta}{1+\beta} \rho_1 (1-\alpha_1) \left( \frac{R_1^{aut}}{\alpha_1} \right)^{\frac{\alpha_1}{\alpha_1-1}} + \quad (37)$$

$$+ \frac{\beta}{1+\beta} \rho_2 (1-\alpha_2) \left( \left( \frac{R_{2,1}^{aut}}{\alpha_2} \right)^{\frac{\alpha_2}{\alpha_2-1}} - \frac{(1+n)(1+g) \tau_{w,2} \left( \frac{R_2^*}{\alpha_2} \right)^{\frac{\alpha_2}{\alpha_2-1}}}{\beta R_2^*} \right)$$

where  $R_1^{aut}$  and  $R_{2,1}^{aut}$  are given.

*Second generation* - The second generation would face instead a tax on labor income:

$$c_{2,2}^{y*} = w_{2,2}^* (1 - \tau_{w,2}) - s_{2,2}^* \quad (38)$$

$$c_{2,3}^{o*} = s_{2,2}^* (1 + r_3^*) \quad (39)$$

which implies that the saving function is:

$$s_{2,2}^* = \frac{\beta}{1+\beta} w_{2,2}^* (1 - \tau_{w,2}) = \frac{\beta}{1+\beta} (1 - \alpha_2) \hat{k}_{2,2}^{*\alpha_2} (1 - \tau_{w,2}) Z_{2,2} \quad (40)$$

Therefore, the capital accumulation equation at  $t = 2$  is:

$$(1+n)(1+g)(\rho_1 \hat{k}_{1,2}^* + \rho_2 \hat{k}_{2,2}^*) = \frac{\beta}{1+\beta} \left[ \rho_1 (1 - \alpha_1) \hat{k}_{1,2}^{*\alpha_1} + \rho_2 (1 - \alpha_2) \hat{k}_{2,2}^{*\alpha_2} (1 - \tau_{w,2}) \right] \quad (41)$$

The equation that pins down the interest rate at  $t = 3$  is then:

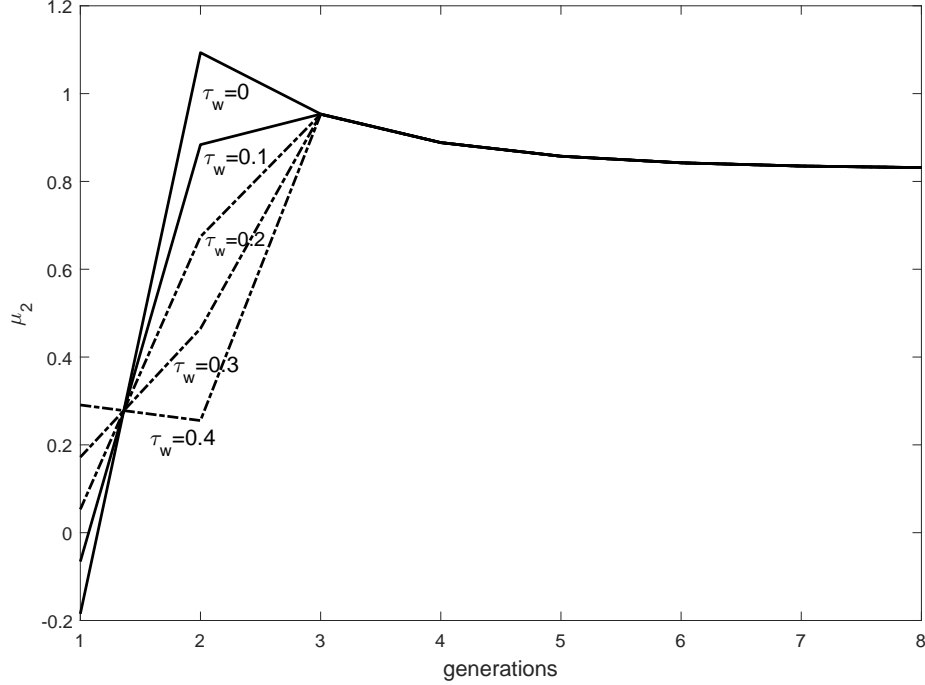
$$(1+n)(1+g) \sum_i \rho_i \left( \frac{R_3^*}{\alpha_i} \right)^{\frac{1}{\alpha_i-1}} = \frac{\beta}{1+\beta} \left[ \rho_1 (1 - \alpha_1) \left( \frac{R_2^*}{\alpha_1} \right)^{\frac{\alpha_1}{\alpha_1-1}} + \rho_2 (1 - \alpha_2) \left( \frac{R_2^*}{\alpha_2} \right)^{\frac{\alpha_2}{\alpha_2-1}} (1 - \tau_{w,2}) \right] \quad (42)$$

Therefore, the path for the world interest rate can be found using (37), (42) and (62) for  $t \geq 3$ .

We calculate the gains from international financial integration for the small developing economy case following the same procedure as in section 4.

Figure 12 reports the welfare effects of international financial integration for the generations born in the developing country for different values of the labour income tax. The figure shows that for a sufficiently high value of the labour income tax, the first generation would gain from the process of international financial integration through a reduction of the welfare gains of the second generation. Although the naked eye cannot detect this pattern from the figure, not only the generation that is directly taxed is affected by the redistribution policy between the first and the second generation. Since the first two generations save less because of the fiscal policy, the convergence to the steady state is slower hence even the subsequent generations would be slightly affected by the policy, albeit indirectly.

Figure 12: The intergenerational effects of IFI for a small developing economy for different values of the labor income tax.



*Notes.* We consider the benchmark case where  $\alpha_2 = 0.49$ .

This shows that a simple redistribution policy where the first generation is compensated is enough to make sure that the process of international financial integration is Pareto improving.

## 5.2 Fiscal redistribution in the large emerging economy case

In section 4, we have shown that a developed economy suffers from non-negligible spillover effects if a large emerging country such as China opens its financial markets. While the country benefits from a social planner's perspective, only the first few generations actually enjoy a welfare gain because of a higher return on their savings. However, the subsequent generations lose as their wage falls as compared to autarky. Although each generation would benefit from a higher return on savings, this is not enough to compensate the fall in the lifetime income. In the steady state of the economy, generations born in the developed country can lose up to 5% in equivalent consumption as compared to autarky. Therefore, our next task is to design a redistribution policy in the developed country such that all

generations can be better off.

To this purpose, we design a fiscal policy which taxes capital income, which is enjoyed by the old in the economy at any given period, and redistribute it to the workers (the young). Let us define  $T_{c,t}$  as the transfer per capita received by the young, while  $\tau_{c,t}$  as the tax on capital income. The government budget in the developed country is then:

$$L_{1,t}T_{c,t} = L_{1,t-1}\tau_{c,t}R_t s_{1,t-1} \quad (43)$$

Since  $s_{1,t-1}L_{1,t-1} = K_{1,t} + A_{1,t}$ , then:

$$L_{1,t}T_{c,t} = \tau_{c,t}R_t(K_{1,t} + A_{1,t}) \quad (44)$$

Notice that capital income includes the return on domestic capital ( $K_{1,t}$ ) as well as foreign-owned capital ( $A_{1,t}$ ). Multiplying each side by  $Z_{1,t}$  and rearranging, we get:

$$T_{c,t} = \tau_{c,t}R_t(\hat{k}_{1,t} + \hat{a}_{1,t})Z_{1,t} \quad (45)$$

*First generation* - The first generation will be subject to a tax on capital income as follows:

$$c_{1,1}^{y*} = w_1^{aut} - s_{1,1}^* \quad (46)$$

$$c_{1,2}^{o*} = s_{1,1}^* R_2^* (1 - \tau_{c,2}) \quad (47)$$

The saving function of the first generation is not affected by the tax:

$$s_{1,1}^* = \frac{\beta}{1+\beta} w_1^{aut} = \frac{\beta}{1+\beta} (1 - \alpha_1) \hat{k}_1^{aut\alpha_1} Z_{1,1} \quad (48)$$

However, its consumption when old will be:

$$c_{1,1}^{y*} = \frac{1}{1+\beta} w_1^{aut} \quad (49)$$

$$c_{1,2}^{o*} = \frac{\beta}{1+\beta} w_1^{aut} R_2^* (1 - \tau_{c,2}) \quad (50)$$

*Subsequent generations* - The future generations will also be subject to a tax on capital income but will also benefit from a government transfer when young. For  $t \geq 2$ , the following budget constraint will hold instead:

$$c_{1,t}^{y*} = w_{1,t}^* - s_{1,t}^* + T_{c,t}^* \quad (51)$$

$$c_{1,t+1}^{o*} = s_{1,t}^* R_{t+1}^* (1 - \tau_{c,t+1}) \quad (52)$$

implying that the saving function is<sup>15</sup>:

$$s_{1,t}^* = \frac{\beta}{1+\beta}(w_{1,t}^* + T_{c,t}^*) = \frac{\beta}{1+\beta} \left( (1 - \alpha_1) \hat{k}_{1,t}^{*\alpha_1} + \tau_{c,t} R_t^* (\hat{k}_{1,t}^* + \hat{a}_{1,t}^*) \right) Z_{1,t} \quad (53)$$

or

$$s_{1,t}^* = \frac{\beta}{1+\beta} \left( (1 - \alpha_1 + \alpha_1 \tau_{c,t}) \hat{k}_{1,t}^{*\alpha_1} + \tau_{c,t} R_t^* \hat{a}_{1,t}^* \right) Z_{1,t} \quad (54)$$

which implies that the consumption allocation is:

$$c_{1,t}^{y*} = \frac{1}{1+\beta} ((1 - \alpha_1 + \alpha_1 \tau_{c,t}) \hat{k}_{1,t}^{*\alpha_1} + \tau_{c,t} R_t^* \hat{a}_{1,t}^*) Z_{1,t} \quad (55)$$

$$c_{1,t+1}^{o*} = \frac{\beta}{1+\beta} ((1 - \alpha_1 + \alpha_1 \tau_{c,t}) \hat{k}_{1,t}^{*\alpha_1} + \tau_{c,t} R_t^* \hat{a}_{1,t}^*) R_{t+1}^* (1 - \tau_{c,t+1}) Z_{1,t} \quad (56)$$

Let us also assume that the large emerging economy carries out the redistribution policy in favour of the first generation as described in the previous subsection. We then compute the world interest rate path in a situation where both governments commit to and implement a redistribution policy. At  $t = 1$ , the two saving functions are (48) and (35), while for  $t = 2$  we use (54) and (40). For  $t \geq 3$ , the saving function of the developing country is the standard one as the policy only involves the first two generations, while (54) still applies to the developed country.

Following the results of the previous section, we set the labour income tax rate in China in period 2 to 20%: we will see below that this is enough for the first generation in China to be compensated and enjoy a welfare gain from international financial integration.

Given  $\tau_w = 0.2$ , let us then characterize a path of capital income tax in the developed country which ensures that international financial integration is Pareto superior with respect to financial autarky. Firstly, the tax imposed on the first generation must be such that it still gains from international financial integration. As only the consumption when old is affected by the tax, this implies that  $c_{1,2}^{o*} > c_{1,2}^{o aut}$  must hold or alternatively:

$$\tau_{c,2} < \frac{R_2^* - R_1^{aut}}{R_2^*} \quad (57)$$

where the autarkic interest rate and the world interest rate in period 2 are both given, as the saving function of the first generation is not affected by the tax. Another condition

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<sup>15</sup>The redistribution policy has an unambiguously positive effect on savings. Although a tax on capital income alters the relative price of consumption in the two periods, the substitution effect cancels out the income effect under logarithmic utility. Hence, the only channel at work is the increase in the lifetime income of the young due to the redistribution policy. Notice that if we departed from log utility and assumed that the income effect dominates the substitution effect (which holds for low values of the intertemporal elasticity of substitution), the positive impact of the capital income tax on savings would be reinforced.

is that  $\tau_{c,2}$  must be sufficiently high to allow the lifetime income of the second generation to be no less than under autarky:

$$(1 - \alpha_1 + \alpha_1 \tau_{c,2}) \hat{k}_{1,2}^{*\alpha_1} + \tau_{c,2} R_2^* \hat{a}_{1,2} \geq (1 - \alpha_1) \hat{k}_1^{aut\alpha_1}$$

$$\iff \tau_{c,2} \geq \frac{(1 - \alpha_1)(\hat{k}_1^{aut\alpha_1} - \hat{k}_{1,2}^{*\alpha_1})}{R_2^*(\hat{k}_{1,2} + \hat{a}_{1,2})} \quad (58)$$

This condition guarantees that the consumption of the young is no less than in autarky. The two conditions basically give us respectively an upper and a lower bound on the tax. Let us implement the lower bound on the tax, so that the tax is not too high to erase completely the welfare gain of the first generation while the young at  $t = 2$  sees no change in its income:

$$\tau_{c,2}^* = \frac{(1 - \alpha_1)(\hat{k}_1^{aut\alpha_1} - \hat{k}_{1,2}^{*\alpha_1})}{R_2^*(\hat{k}_{1,2} + \hat{a}_{1,2})}$$

Given  $\tau_{c,2}^*$ , we calculate the interest rate in period  $R_3^*$  using the capital accumulation equation at  $t = 2$ . We repeat the same reasoning to determine the capital income tax at  $t = 3$ . Similarly, the aim is that the tax is low enough so that the second generation gains while the tax should be high enough to ensure that the income of the third generation is no less than the autarkic income. Since the income of the second generation is the same as in autarky under  $\tau_{c,2}^*$ , the second generation will gain as long as the consumption when old is higher than in autarky, which is equivalent to the following condition:

$$\tau_{c,3} < \frac{R_3^* - R_1^{aut}}{R_3^*} \quad (59)$$

The third generation has an income no less than in closed economy as long as:

$$\tau_{c,3} \geq \frac{(1 - \alpha_1)(\hat{k}_1^{aut\alpha_1} - \hat{k}_{1,3}^{*\alpha_1})}{R_3^*(\hat{k}_{1,3} + \hat{a}_{1,3})} \quad (60)$$

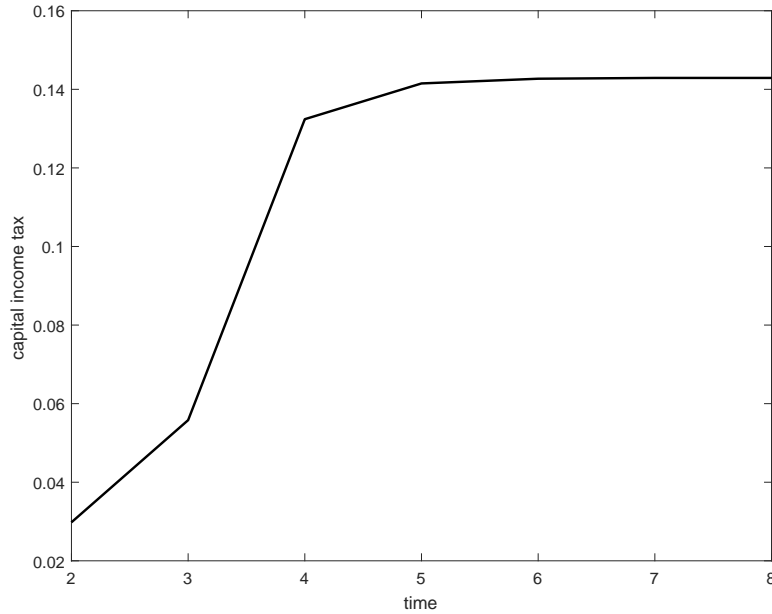
As before, we choose the lower bound on the tax:

$$\tau_{c,3}^* = \frac{(1 - \alpha_1)(\hat{k}_1^{aut\alpha_1} - \hat{k}_{1,3}^{*\alpha_1})}{R_3^*(\hat{k}_{1,3} + \hat{a}_{1,3})} \quad (61)$$

Therefore, we proceed by induction to find a path for the capital income tax which would make everyone better off.

Figure 13 shows that taxation on capital income should increase in the transition to the steady state. The reason is that as the welfare losses progressively increase (Figure 11), capital income should be taxed more aggressively. Under the path for the capital income tax identified above, we can see from Figure 14 that the redistribution policy

Figure 13: A Pareto improving path for the capital income tax.



ensures that all generations gain from China's financial integration and not just the first few generations.

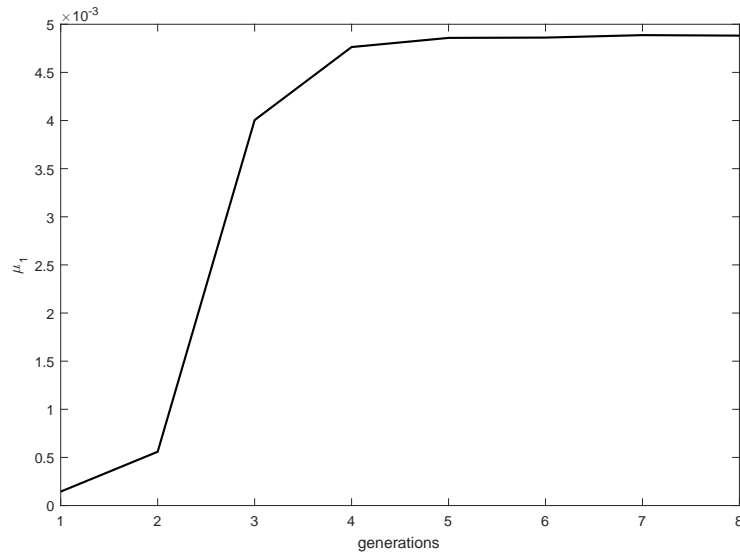
Figure 15 illustrates the intergenerational effects of the redistribution policies for China. If the developed country does not redistribute, a labour income tax of 20% in the second period is enough to ensure that the first generation in China is also gaining from international financial integration (see Figure 10). It is also interesting to observe that China would also benefit from a redistribution policy in the developed country. Since the capital income tax in the developed country stimulates savings (equation (54)), capital accumulation in the world economy is intensified and China is able to reach an even higher steady state.

## 6 Conclusions

This paper takes seriously the most recent evidence showing that there is significant variation of capital shares across countries (Feenstra, Inklaar and Timmer, 2015). In this context, we study the consequences of international financial integration, both in terms of the direction of capital flows and their welfare implications.

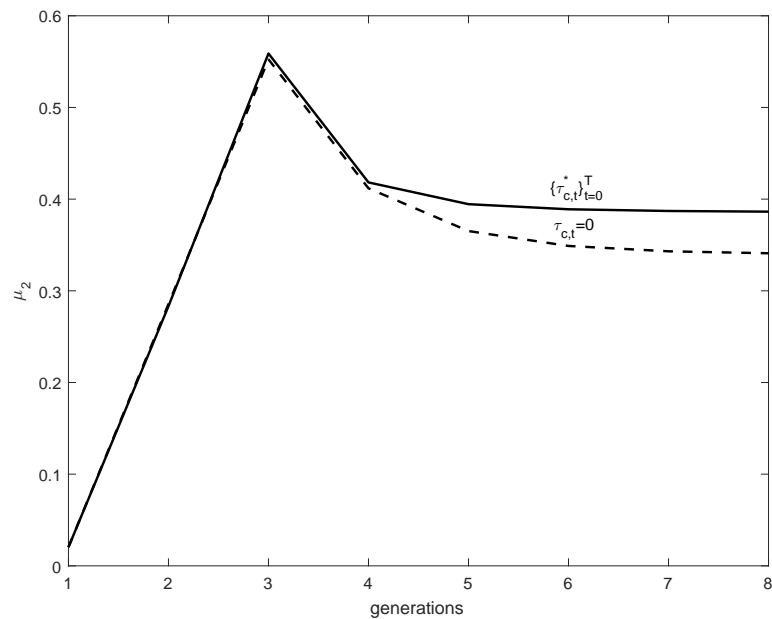
Our results challenge the belief that neoclassical growth models are not able to support the idea that openness of the capital account is a desirable policy reform for developing

Figure 14: The spillover effects on the developed country of China's financial integration when capital income is taxed and redistributed to the workers.



Notes. The path of capital income tax implemented is shown in Figure 13.

Figure 15: The intergenerational effects of international financial integration for China when the first generation is compensated.



Notes. We have set  $\tau_{w,2} = 0.20$ .

countries. We have shown that since developing countries tend to have a higher capital share, capital inflows allow them to reach a higher steady state as compared to financial autarky. The permanent as opposed to the transitory nature of capital flows generates large welfare gains for developing countries.

The paper also emphasizes that there are important intergenerational effects. We offer a rationale as to why there is often resistance to financial openness in developing countries: the current generation would suffer from the opening of capital markets and would decide against it if they have the political power. However, this would come at the expense of all future generations which would be able to reap large gains. While the developed country is barely affected by the decision of a small country of opening their capital markets, we demonstrate that the financial integration of a large emerging country has non-negligible spillover effects. In the developed country, the initial generation would gain from exporting capital as they enjoy a higher return on their savings. But as the country converges to a lower steady state, the subsequent generations lose out as they receive a lower lifetime income.

Finally, we show that redistribution policies within countries can be designed to compensate the losers from international financial integration. For international financial integration to be Pareto superior to autarky, the developing country should tax the labour income of the second generation to compensate the first generation, while the developed country should tax capital income and redistribute it to the workers.

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## Appendix

### Appendix A: Proofs

#### *Proof of Proposition 1*

Firstly, we compute the derivative of  $\hat{k}$  with respect to  $\alpha$  using equation (10):

$$\frac{\partial \hat{k}}{\partial \alpha} = \left[ \frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)} \right]^{\frac{1}{1-\alpha}} \cdot \frac{1}{(1-\alpha)^2} \cdot \left[ \log \left( \frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)} \right) - 1 \right]$$

Since  $\frac{\beta(1-\alpha)}{(1+\beta)(1+n)(1+g)} < 1$ , then  $\frac{\partial \hat{k}}{\partial \alpha} < 0$ .

Second, the derivative of  $R$  with respect to  $\alpha$  is (see equation (11)):

$$\frac{\partial R}{\partial \alpha} = \frac{(1+\beta)(1+n)(1+g)}{\beta(1-\alpha)^2} > 0$$

#### *Proof of Corollary 1*

Suppose that country 1 has the same level of capital of country 2:  $\hat{k}_1^{aut} = \hat{k}_2^{aut}$ . Then, it is easy to show that  $\hat{k}_2^{aut^{\alpha_1}} > \hat{k}_2^{aut^{\alpha_2}}$  since  $\hat{k}_2^{aut} < 1$  (equation (10)). However, we have proved that country 1's level of capital in autarky is higher (Proposition 1). Hence, it follows that:  $\hat{k}_1^{aut^{\alpha_1}} > \hat{k}_2^{aut^{\alpha_1}} > \hat{k}_2^{aut^{\alpha_2}}$ .

### *Proof of Proposition 2*

First, let us rewrite (15) using  $R_t = \alpha_i k_{i,t}^{\alpha_i - 1}$ :

$$\sum_i \rho_i \left( \frac{R_{t+1}^*}{\alpha_i} \right)^{\frac{1}{\alpha_i - 1}} = \frac{\beta}{(1+\beta)(1+n)(1+g)} \left[ \sum_i \rho_i (1 - \alpha_i) \left( \frac{R_t^*}{\alpha_i} \right)^{\frac{\alpha_i}{\alpha_i - 1}} \right] \quad (62)$$

Using the implicit function theorem, we find that:

$$\frac{dR_{t+1}}{dR_t}(R_t) = \frac{\frac{\beta}{(1+\beta)(1+n)(1+g)} \left[ \sum_i \rho_i \left( \frac{R_t}{\alpha_i} \right)^{\frac{1}{\alpha_i - 1}} \right]}{\sum_i \frac{\rho_i}{\alpha_i(1-\alpha_i)} \left( \frac{R_{t+1}}{\alpha_i} \right)^{\frac{2-\alpha_i}{\alpha_i - 1}}} > 0 \quad \forall R_t \quad (63)$$

Since the derivative exists, we can write  $R_{t+1} = \phi(R_t)$ . The difference equation is an increasing function, with  $\phi(0) = 0$ . It can also be checked that  $\lim_{R_t \rightarrow 0} \phi'(R_t) = \infty$  and  $\lim_{R_t \rightarrow \infty} \phi'(R_t) = 0$ . These conditions imply that a stable steady state exists. Moreover, we have that  $\phi''(R_t) < 0$ . Concavity of the  $\phi$  function means that the steady state is unique.

### *Proof of Proposition 3*

Country  $i$ 's net foreign assets at the steady state is:

$$\hat{a}_i = \frac{\beta}{(1+\beta)(1+n)(1+g)} (1 - \alpha_i) \left( \frac{R}{\alpha_i} \right)^{\frac{\alpha_i}{\alpha_i - 1}} - \left( \frac{R}{\alpha_i} \right)^{\frac{1}{\alpha_i - 1}} \quad (64)$$

Suppose that  $\hat{a}_i(R^*) > 0$  for some  $i$ . By directly manipulating the above equation, it turns out that this is true only as long as  $R^* > R_i^{aut}$ . Similarly,  $\hat{a}_i(R^*) < 0$  if  $R^* < R_i^{aut}$ .

Suppose that  $R_i^{aut} \geq R^*$  for every  $i$ . Then, we would have that  $\hat{a}_i(R^*) \leq 0$  for every  $i$  and  $\sum_i \hat{a}_i(R^*) < 0$  (where the equality sign disappears as  $R_1^{aut} \neq R_2^{aut}$  by assumption). For the same reason,  $R^* \geq R_i^{aut}$  for every  $i$  is impossible. In order for  $R^*$  to clear the world capital market, the only possibility is that  $R_1^{aut} < R^* < R_2^{aut}$ . Hence, at the world steady state,  $\hat{a}_2(R^*) < 0$  and  $\hat{a}_1(R^*) > 0$ .

*Proof of Corollary 2*

Trivial.

*Proof of Proposition 4*

We are interested in showing that  $\hat{y}_{1,t}^* > \hat{y}_{2,t}^*$  for any  $R_t^* \geq R^*$ . Using the first-order conditions of the firm in open economy (12):

$$\hat{y}_{1,t}^* > \hat{y}_{2,t}^* \quad \Leftrightarrow \quad \left( \frac{R_t^*}{\alpha_1} \right)^{\frac{\alpha_1}{\alpha_1-1}} > \left( \frac{R_t^*}{\alpha_2} \right)^{\frac{\alpha_2}{\alpha_2-1}}$$

After a few steps, the inequality can be rearranged as follows:

$$R_t^* > \frac{\alpha_2^{\frac{\alpha_2(1-\alpha_1)}{\alpha_2-\alpha_1}}}{\alpha_1^{\frac{\alpha_1(1-\alpha_2)}{\alpha_2-\alpha_1}}} \equiv \bar{R}$$

This is a necessary and sufficient condition for country 1 to have a higher output than country 2 for any given interest rate  $R_t^*$ . Our strategy to check that this inequality actually holds in equilibrium is the following. We know that  $R^* > R_1^{aut}$  by Proposition 3. If we can show that  $R_1^{aut} > \bar{R}$ , then  $R^* > \bar{R}$  and therefore the inequality holds for any  $R_t^* \geq R^*$ .

$$R_1^{aut} > \bar{R} \quad \Leftrightarrow \quad \frac{\alpha_1(1+\beta)(1+n)(1+g)}{\beta(1-\alpha_1)} > \frac{\alpha_2^{\frac{\alpha_2(1-\alpha_1)}{\alpha_2-\alpha_1}}}{\alpha_1^{\frac{\alpha_1(1-\alpha_2)}{\alpha_2-\alpha_1}}}$$

which, upon rearranging, becomes:

$$\frac{(1+\beta)(1+n)(1+g)}{\beta(1-\alpha_1)} > \left( \frac{\alpha_2}{\alpha_1} \right)^{\frac{\alpha_2(1-\alpha_1)}{\alpha_2-\alpha_1}}$$

which is the sufficient condition stated in the Proposition.

*Proof of Proposition 5*

The first step is to show that  $R_{2,2}^{aut} > R_2^* > R_1^{aut}$ , where  $R_{2,2}^{aut}$  and  $R_1^{aut}$  are respectively the interest rates that would prevail in country 2 and 1 if they remained in autarky. To start with, let us prove by contradiction that  $R_2^* \neq R_{2,2}^{aut}$ . If  $R_2^* = R_{2,2}^{aut}$ , then the young in country 2 would not trade capital even if they were allowed to do so. Therefore, the demand for capital would be equal to savings (which are given):  $(1+n)(1+g)\hat{k}_{2,2} = \hat{s}_{2,1}$ . In country 1, the demand for capital would be lower than in

autarky as  $R_1^{aut} < R_2^{aut} < R_{2,2}^{aut} = R_2^*$ :  $(1+n)(1+g)\hat{k}_{1,2} < \hat{s}_{1,1}$ . But then, the world capital market does not clear since  $(1+n)(1+g)\sum_i \hat{k}_{i,2} < \sum_i \hat{s}_{i,1}$ . Similarly, it can be proved that  $R_2^* \neq R_1^{aut}$  as the aggregate demand for capital would exceed aggregate savings. In the initial period, each country's savings are given. Since the demand for capital is decreasing in  $R$ , it must be that  $R_{2,2}^{aut} > R_2^* > R_1^{aut}$  in order for  $(1+n)(1+g)\sum_i \hat{a}_i(R_2^*) = 0$  to hold.

It is then straightforward to show which country is the international borrower. Since  $R_2^* < R_{2,2}^{aut}$ , then  $(1+n)(1+g)\hat{k}_{2,2}^* > \hat{s}_{2,1}$ . Therefore, therefore  $(1+n)(1+g)\hat{a}_{2,2}^* < 0$ .

### *Proof of Proposition 6*

Since  $\hat{k}_{i,t+1} = \left(\frac{R_{t+1}}{\alpha_i}\right)^{\frac{1}{\alpha_i-1}}$ ,  $R_{t+1} = \phi(R_t)$  and  $R_t = \alpha_i \hat{k}_{i,t}^{\alpha_i-1}$ , we can write the following accumulation equation for the capital stock per effective units of labour of country  $i$ :

$$\hat{k}_{i,t+1} = \psi(\hat{k}_{i,t}) = \left(\frac{\phi(\alpha_i \hat{k}_{i,t}^{\alpha_i-1})}{\alpha_i}\right)^{\frac{1}{\alpha_i-1}}$$

We now compute the first and the second derivative:

$$\begin{aligned} \frac{\partial \hat{k}_{i,t+1}}{\partial \hat{k}_{i,t}} &= \left(\frac{\phi(\alpha_i \hat{k}_{i,t}^{\alpha_i-1})}{\alpha_i}\right)^{\frac{2-\alpha_i}{\alpha_i-1}} \cdot \phi'(R_t) \cdot \hat{k}_{i,t}^{\alpha_i-2} \\ \frac{\partial^2 \hat{k}_{i,t+1}}{(\partial \hat{k}_{i,t})^2} &= \phi''(R_t) \cdot \hat{k}_{i,t}^{\alpha_i-2} \cdot \left(\frac{\phi(\alpha_i \hat{k}_{i,t}^{\alpha_i-1})}{\alpha_i}\right)^{\frac{2-\alpha_i}{\alpha_i-1}} + \\ &+ \phi'(R_t) \cdot (\alpha_i - 2) \hat{k}_{i,t}^{\alpha_i-3} \cdot \left(\frac{\phi(\alpha_i \hat{k}_{i,t}^{\alpha_i-1})}{\alpha_i}\right)^{\frac{2-\alpha_i}{\alpha_i-1}} + \\ &+ \phi'(R_t) \cdot \hat{k}_{i,t}^{\alpha_i-2} \cdot (2 - \alpha_i) \left(\frac{\phi(\alpha_i \hat{k}_{i,t}^{\alpha_i-1})}{\alpha_i}\right)^{\frac{3-\alpha_i}{\alpha_i-1}} \phi'(R_t) \hat{k}_{i,t}^{\alpha_i-2} \end{aligned}$$

The first derivative is positive since  $\phi'(R_t) > 0$  by Proposition 2. The second derivative is negative since  $\phi''(R_t) < 0$ . Therefore, the above function is increasing and concave.

### *Proof of Proposition 7*

By Assumption 2, the initial interest rate is higher than the steady state interest rate in the integrated economy. Therefore, we must show that  $R_{2,t+1}^{aut} > R_{t+1}^* > R_{1,t+1}^{aut}$  for every  $R_t^* \geq R^*$ .

Firstly, we verify that  $R_{2,t+1}^{aut} > R_{1,t+1}^{aut}$  for any  $R_t^* \geq R^*$ . Given  $R_t^*$ , the autarkic interest rate of country  $i$  is derived by manipulating the domestic capital market clearing equation. We find that  $R_{i,t+1}^{aut} \equiv \left[ \frac{(1+\beta)(1+n)(1+g)\alpha_i}{\beta(1-\alpha_i)} \right]^{1-\alpha_i} R_t^{*\alpha_i}$ . Plugging the autarkic interest rates into  $R_{2,t+1}^{aut} > R_{1,t+1}^{aut}$  we obtain the following condition:

$$R_t^* > \frac{(1+\beta)(1+n)(1+g)}{\beta} \left[ \frac{\left( \frac{\alpha_1}{1-\alpha_1} \right)^{1-\alpha_1}}{\left( \frac{\alpha_2}{1-\alpha_2} \right)^{1-\alpha_2}} \right]^{\frac{1}{\alpha_2-\alpha_1}} \equiv \tilde{R} \quad (65)$$

The next step is to check that  $R_1^{aut} > \tilde{R}$ :

$$\frac{\alpha_1(1+\beta)(1+n)(1+g)}{(1-\alpha_1)\beta} > \frac{(1+\beta)(1+n)(1+g)}{\beta} \left[ \frac{\left( \frac{\alpha_1}{1-\alpha_1} \right)^{1-\alpha_1}}{\left( \frac{\alpha_2}{1-\alpha_2} \right)^{1-\alpha_2}} \right]^{\frac{1}{\alpha_2-\alpha_1}}$$

The above inequality can be simplified to  $\alpha_1 < \alpha_2$ , which holds by assumption. Since  $R_2^{aut} > R^* > R_1^{aut}$  and  $R_1^{aut} > \tilde{R}$ , then  $R^* > \tilde{R}$ . Therefore, inequality (65) holds for  $R_t^* \geq R^*$ .

We can now prove that the world interest rate is in between the autarkic interest rates:  $R_{2,t+1}^{aut} > R_{t+1}^* > R_{1,t+1}^{aut}$ . The argument is now routine. If  $R_{i,t+1}^{aut} \geq R_{t+1}^*$  for every  $i$ , we would have that  $(1+n)(1+g) \sum_i \hat{a}_i(R_t^*, R_{t+1}^*) < 0$ . The opposite is true for  $R_{t+1}^* \geq R_{i,t+1}^{aut}$ . Given  $R_t^*$ , the equilibrium interest rate at  $t+1$  must lie between the corresponding autarkic steady states for the world capital market to clear.

Finally, the net foreign assets of country  $i$  along the transition:

$$(1+n)(1+g)\hat{a}_i(R_t^*, R_{t+1}^*) \equiv \frac{\beta(1-\alpha_i)}{(1+\beta)} \left( \frac{R_t^*}{\alpha_i} \right)^{\frac{\alpha_i}{\alpha_i-1}} - (1+n)(1+g) \left( \frac{R_{t+1}^*}{\alpha_i} \right)^{\frac{1}{\alpha_i-1}}$$

For country 1, we have that  $R_{t+1}^* > R_{1,t+1}^{aut}$ . Then,  $(1+n)(1+g)\hat{k}_{1,t+1}^* < \hat{s}_{1,t}^*$  or  $(1+n)(1+g)\hat{a}_1(R_t^*, R_{t+1}^*) > 0$ . On the other hand, country 2 will import capital, i.e.  $(1+n)(1+g)\hat{a}_2(R_t^*, R_{t+1}^*) < 0$ .

## Appendix B: Empirical evidence

The capital share is calculated as 1 minus the share of labour compensation in GDP at current national prices. Output per capita is output-side real GDP at current PPPs divided by the population. Output per effective labor units is calculated as output per

capita divided by TFP level at current PPPs. The net FDI position is calculated as net FDI=FDI assets–FDI liabilities.