How crucial are preferences for non-tradable goods and cross-country sectoral TFP gap for integration?

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A b s t r a c t

This paper deals with the effects of economic integration in a 2x 2x 2 model of overlapping generations. We distinguish between a non-tradable and a tradable sector which use human and physical capital. We show that the preference for non-tradable consumption in total consumption expenditure and sectoral productivities are crucial factors to determine which country does benefit from integration in terms of economic growth. Short-run and long-run effects of in-tegration may differ, especially when countries are heterogeneous and when there exist high cross border externalities in education. Moreover, an impatient country may lose to integration when it has a comparative advantage in the tradable sector and/or when the preference for non-tradable goods is high.

Keywords: Two-sector model, Non-tradable goods, Endogenous growth, Economic integration

JEL classification: F15 J24 O41

1. Introduction

The British decision to leave the European Union following the referendum held on 23 June 2016 contributes to a renewed interest in understanding short and long-term economic impacts of integration (or disintegration). As underlined by Kutan and Yigit (2007), integration shapes many aspects of an economy, which makes the evaluation of its overall impact a non-trivial question. From a theoretical point of view, static implications of economic integration have been largely documented through the standard trade theory. Dynamical consequences of international trade on growth have been investigated for example by Rivera-Batiz and Romer (1991).[1]

The first aspect of economic integration lies in the mobility of capital between countries. Integrated economies no longer need to save in order to invest, since foreign saving can be used in the case of a domestic saving shortfall. To investigate the impact of integration on long-run economic growth, the question of human capital accumulation is an important issue. The standard assumption concerning human capital accumulation is that human capital does not circulate between countries. Rather, economic integration may sometimes generate some cross-border externalities in human capital accumulation between countries (Michel and Vidal, 2000). In Michel and Vidal (2000), domestic and foreign patience and altruism, which respectively determine the accumulation of physical and human capital, drive the effects of economic integration. They obtain that two countries can benefit from integration when cross-border externalities in human capital are high enough. Our paper deals with economic integration in such an endogenous growth framework but extends the analysis in three aspects. First, by considering the role played by cross-country

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[1] Rivera-Batiz and Romer (1991) focus on the pure scale effect of integration by considering trade between similar countries. They show that the increase in the flow of ideas, generated by integration, improves the productivity of research in both regions.

disparities in the share of non-tradable goods consumption and cross-country sector productivities. Second, by examining the short-term consequences of economic integration in both the short and the long run. Third, by providing intuitions to explain the emergence of the non-tradable sector, using non-homothetic preferences.

In the standard one-sector setting with physical capital accumulation, the impatient country always benefits from integration in both the short and the long-run. Intuitively, this impatient country is the one with the highest autarky interest rate. Integration generates capital inflows towards this impatient country. In a one-sector setting with both human and physical capital accumulation, Michel and Vidal (2000) show that the patient country may benefit from integration if this country has a high rate of altruism. This is due to the fact that the autarky interest rate is now a decreasing function of the ratio of physical over human capital. However, they do not analyze the benefit of integration across time. Our paper shows that introducing a second sector in this setting, with both human and physical capital accumulation, a patient country may also benefit from integration. This is due to the fact that the autarky interest rate is no longer a function of the ratio of physical over human capital but becomes a function of the relative price between the two goods. Another result is that there is a short-run and a long-run gain from integration and that these gains may qualitatively differ.

We distinguish two sectors in the economy: a tradable and a non-tradable one. This disaggregation allows us to consider sectoral TFP disparities between countries and sectoral factor shares. Such distinction is empirically relevant as recent studies underline that the TFP gaps between countries are sector-specific. For example, Hsieh and Klenow (2007) show that TFP gaps are higher in the investment good sector. To be more specific, they emphasize that less developed countries are particularly unproductive in producing manufactured tradable goods. They also show that sectoral factor shares vary considerably across sectors.[2]

The presence of non-tradable goods in our setting introduces a key variable for factor allocation in the economy: the price of the non-tradable goods in terms of the tradable goods. This relative price determines the factor returns and eventually the growth rate. This paper contributes to the literature into two points. First, the transitional dynamics in the integrated economy is driven by both the dynamics of the relative price and the dynamics of the ratio of foreign over domestic education spending. As a result, the effects of economic integration may differ between the short and the long-run. This contrasts with the long-run analysis of Michel and Vidal (2000). When heterogeneous countries integrate, there is a transitional adjustment of the relative prices which affects the transitional dynamics of the growth rate. Such an adjustment depends mainly on the initial cross-country tradable TFP gaps. We focus on the standard case in which the tradable sector is capital intensive.[3] In this way, a high-tradable TFP country exhibits a high interest rate. Following integration, physical capital goes from the low-tradable TFP to the high-tradable TFP country. When the non-tradable sector is human capital intensive, it entails a fall in the relative price of non-tradable good, and inevitably of the growth rate for the low-tradable TFP country. The dynamics shows that this effect is transitional and reduces across time.

The second originality in our results, due to this two-sector structure, is that integration may be bad for growth in the long-run - compared to autarky - even for impatient and altruistic countries. We emphasize that the long-term consequences of integration on economic growth do not result only from the differences in time preferences and education preferences between countries. In Michel and Vidal (2000), integration enhances growth in the long-run for an economy with a relatively low capital intensity (due to a low saving rate or a high altruism degree for example) in autarky. This high-return domestic country will receive capital at the time of integration. This drives up the domestic wage and gives more incentive for domestic education. In our setting, saving and altruism matter but the share of non-tradable goods in total consumption spending plays a crucial role as well in determining the effects of integration on growth. Such a domestic country with a relatively low capital intensity may have a high propensity to consume non-tradable goods. In that case, the relative price of the non-tradable good will be relatively high compared to the foreign country. Assuming that the tradable sector is capital intensive, this high relative price implies a low domestic return on capital and a high domestic wage. At the time of integration, capital will move from this low return domestic country to the high return foreign country. Because of integration, the domestic wage will decrease, giving less incentive for education in this domestic country. Under these circumstances, the domestic country, with a low relative capital intensity but a high propensity to consume non-tradable goods won't benefit from integration in terms of long-run growth.

Finally, our paper is also partly related to the literature on structural change (see Herrendorf et al., 2014, for a survey).[4] We show in the first section that in European countries the share of final consumption dedicated to the non-tradable sector has largely increased in recent years. We then extend our simple model by considering a more general utility function with non-homothetic preferences. We thus show that when integration generates an increase in human capital accumulation, it drives resources towards the non-tradable sector as well: the share of non-tradable consumption in total consumption spending increases, and so does the allocation of human capital towards the non-tradable sector.

The paper is structured as follows. Some empirical facts are given in Section 2; Section 3 presents the model. Section 4 deals with autarky whereas Section 5 deals with integration introducing capital mobility between the two countries. Section 6 highlights the importance of non-traded consumption and sectoral productivity in determining which country benefits from integration, and Section 7 extends the model considering non-homothetic preferences. Section 8 concludes.

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[2] For example, food has a labor share of only 0.62 while construction has a labor share as high as 0.79.

[3] This assumption means through the Stolper–Samuelson theorem that the return on capital (wage) is a decreasing (increasing) function of the relative price.

[4] This literature builds multi-sector growth models to identify the channels that drive structural change, *i.e* the reallocation of economic activities across sectors.

Table 1
Share of tradable consumption.

Countries	2000	2005	2010	2014	Average
Austria	0.47	0.48	0.44	0.45	0.46
Belgium	0.45	0.44	0.38	0.38	0.41
Denmark	0.41	0.35	0.31	0.32	0.35
Finland	0.70	0.41	0.39	0.37	0.47
France	0.46	0.43	0.40	0.39	0.42
Germany	0.48	0.43	0.42	0.45	0.44
Greece	0.67	0.63	0.61	0.62	0.63
Italy	0.54	0.51	0.44	0.42	0.48
Netherlands	0.69	0.43	0.39	0.42	0.48
Portugal	0.59	0.55	0.52	0.51	0.54
Spain	0.59	0.56	0.46	0.46	0.52
Sweden	0.44	0.42	0.41	0.40	0.42
UK	0.46	0.44	0.35	0.35	0.40
Czech Republic	0.51	0.49	0.45	0.46	0.48
Estonia	0.58	0.54	0.49	0.51	0.53
Poland	0.63	0.50	0.48	0.50	0.53

2. Empirical evidence

Our objective is to highlight the effects of economic integration on economic growth when production is disaggregated into two sectors: a tradable and a non-tradable one. This section presents empirical evidence concerning the characteristics of these two sectors, in the European context. In the literature, Piton (2017) provides evidence on key-aggregate variables over the post-integration period (1995–2014) for 12 European countries. It shows that the evolution of interest rates, unit labor costs and relative price of non-tradable goods is very different in the periphery than in core European countries.[5] Compared to what happens in the core countries, the periphery countries experience a huge drop in their interest rates, a relative rise in their unit labor costs and a large increase in the share of the non-tradable sector in terms of total hours worked. If we consider that these empirical facts on European countries provide evidence on the long-run impact of economic integration, our model should be able to link the relative price response to integration with country-specific characteristics. Using the Berka and Devereux (2013) database, we plot the variable ”non-traded Price Level Index” across time in Appendix.[6] We can see that the relative price evolution after integration (between 1995 and 2009) is mixed. Countries like France or Germany have a drop in their relative price, whereas Greece or Spain experience an increase in their relative price. Finally, Estonia, Poland and the Czech Republic which jointed the European Union later in 2004 experienced the highest rise in their relative price over the period. The model we develop in the next sections explains this relative price evolution using altruism, time preference, productivity and preference for non-tradable goods. Using the World Input Output Database, we collect figures concerning the final consumption expenditure of households based on national input-output data for some European countries between 2000 and 2014. Sectors where the tradability ratio is higher than 10% are considered as tradable sectors.[7] Table 1 collects the ratio of final consumption expenditure in tradable goods over total final consumption expenditure. This ratio generally decreases between 2000 and 2014. For some countries (Germany, Greece, Netherlands, UK, Czech Republica, Estonia, and Poland), this decrease is non-monotonic. This means that along the development process, the share of final consumption dedicated to non-tradable goods generally increases.

The empirical literature already highlighted the fact that along the development process, the share of services in final consumption increases. Following Buera and Kaboski (2012), the share of the service sector in production was 60% in 1990 while 80% in 2000. These authors conclude that this has been explained entirely by the increase in human capital-intensive services and has been accompanied by a rise in the price of services. For European countries, we notice that even though the emergence of information technology has increased the tradability of some services, the share of non-tradable goods in total consumption spending has still increased. Finally, considering 12 European countries between 1995 and 2014, Piton (2017) shows that both unit labor costs and the share of employment dedicated to the non-tradable sector have increased (4.8%) in the ’periphery’ of the Euro area compared to the ’core’ European countries. To conduct our analysis, we develop a simple model by assuming that the share of non-tradable goods consumed is constant in order to derive analytical results. Then, to match the features presented in this section, we extend our Cobb-Douglas endogenous growth model to consider non-homothetic preferences in Section 7. This framework explicitly links the share of non-tradable goods in consumption spending to the human capital stock. Thus, when integration increases human capital and the relative price, it drives up the allocation of both consumption and human capital towards the non-tradable goods sector, which is empirically consistent.

In our model, we assume that the non-tradable sector also produces the goods used to accumulate human capital.[8] This is

[5] Piton (2017) qualifies as ”Core countries” countries like Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands and ”periphery countries as Greece, Spain, Ireland, Portugal.

[6] Appendix is available on-line as supplementary material. Non-traded Price Level Index in the Berka and Devereux (2013) database corresponds to an average (for non-traded sectors) price for one country against an aggregate EU15 average price level.

[7] The list of tradable sectors is fixed over the period and corresponds to sectors: A,B,C,I,H,J,M,N of the World Input Output Database.

[8] There are few papers considering multi-sector models in an international environment with human and physical capital accumulation. Bond et al. (2003) and Hu et al. (2009) are important exceptions that study the dynamic effect of trade. In these papers, the education sector is non-tradable.

consistent with empirical evidence. According to Mano and Castillo (2015), who measure the tradability of a sector across time and countries using the average exports to gross value added ratio for 56 countries over the 1995–2011 period, education has a tradability ratio of 0.9%.

3. The model

We consider a two-country endogenous growth model that is an extension of Michel and Vidal (2000) in which we introduce two production sectors: a tradable one and a non-tradable one. In line with Erosa et al. (2012), the tradable sector produces a manufacturing good which can either be consumed or invested in physical capital. The non-tradable sector produces a good which can be either consumed or invested in human capital. This two-sector production structure is a generalization of the standard two-sector setting in which one good is a pure consumption while the other is a pure investment good (Galor, 1992; Venditti, 2005). We assume that investment in physical capital is carried out only in the tradable good because empirical evidence suggests that the import component of investment is important and larger than consumption (see Burstein et al., 2004). We normalize the tradable good price to unity. In this setting, the relative price of the non-tradable good, P_N, denotes the domestic real exchange rate but also the price of human capital relative to physical capital.

In what follows, we describe the home country economy. The foreign country economy is analogous and asterisks denote foreign country variables.

3.1. Production

The representative firm produces over the two sectors using human capital H and physical capital K according to Cobb-Douglas production technologies. Let Y_T denote production in the tradable sector and Y_N production in the non-tradable sector. Let K_i and H_i, $i = T, N$, be respectively the quantities of capital and labor used by sector i, production is given by

$$Y_T = A_T K_T^{\alpha_T} H_T^{1-\alpha_T} \tag{1}$$

$$Y_N = A_N K_N^{\alpha_N} H_N^{1-\alpha_N} \tag{2}$$

with α_T, $\alpha_N \in (0, 1)$, $A_T > 0$ and $A_N > 0$. For simplicity and because we focus on developed countries, we consider:

Assumption 1. $\alpha_N < \alpha_T$.

Investment instantaneously transforms a unit of tradable good into a unit of installed capital and capital fully depreciates after one period. Both inputs are perfectly mobile between the two sectors provided that:

$$H_T + H_N \leq H, \qquad K_T + K_N \leq K \tag{3}$$

K being the total stock of physical capital and H the total amount of human capital.

Let $k_i = Ki/Hi$ be the capital intensity of sector i, $h_i = H_i/H$ be the share of human capital allocated to sector i, $i = T, N$, and $k = K/H$ the physical to human capital ratio. Eqs. (2) and (3) can be rewritten as follows:

$$h_T + h_N \leq 1, \qquad k_T h_T + k_N h_N \leq k \tag{4}$$

Denoting w the wage rate, R the gross rental rate of capital and P_N the price of the non-tradable good, first order conditions give:

$$R_t = \alpha_T A_T {k_T}_t^{\alpha_T - 1} = P_{Nt} \alpha_N A_N {k_N}_t^{\alpha_N - 1} \tag{5}$$

$$w_t = (1 - \alpha_T) A_T {k_T}_t^{\alpha_T} = P_{Nt} (1 - \alpha_N) A_N {k_N}_t^{\alpha_N} \tag{6}$$

From which we derive the physical to human capital ratios as functions of the price of the non-tradable good:

$$\begin{aligned} k_{Tt} &= B(P_{N_t})^{\frac{1}{\alpha_T - \alpha_N}} \\ k_{N_t} &= \frac{\alpha_N(1-\alpha_T)}{\alpha_T(1-\alpha_N)} B(P_{N_t})^{\frac{1}{\alpha_T - \alpha_N}} \\ \text{with } B &= \left(\frac{\alpha_N}{\alpha_T}\right)^{\frac{\alpha_N}{\alpha_T-\alpha_N}} \left(\frac{A_N}{A_T}\right)^{\frac{1}{\alpha_T-\alpha_N}} \left(\frac{1-\alpha_T}{1-\alpha_N}\right)^{\frac{\alpha_N - 1}{\alpha_T - \alpha_N}} \end{aligned} \tag{7}$$

And thus the input prices are:

$$\begin{aligned} w_t &= (1 - \alpha_T) A_T B^{\alpha_T} {P_N}_t^{\frac{\alpha_T}{\alpha_T - \alpha_N}} \equiv w(P_{N_t}) \\ R_t &= \alpha_T A_T B^{\alpha_T - 1} {P_N}_t^{\frac{\alpha_T - 1}{\alpha_T - \alpha_N}} \equiv R(P_{N_t}) \end{aligned} \tag{8}$$

Under Assumption 1, and from the Stolper Samuelson theorem, P_N has a negative effect on R_t and a positive effect on w_t. We also have that a rise in A_T increases R_t and decreases w_t.

3.2. Consumption, savings and children's education

In each country, the economy consists of a sequence of three life periods. In the second period of his life, each individual gives birth to one child so that there is no population growth. We normalize to 1 the population size of each generation. Each generation born in period t consists of identical individuals who make decisions concerning consumption, children's education, and savings. During childhood, individuals make no decision: their consumption is included in their parent's consumption. They are brought up by their parents who decide on their level of educational attainment. As adult, they work and receive the market wage, consume, save, and rear their own children. When they grow old they retire, and consume the proceeds of their savings.

Individuals care about their children's education. They exhibit a kind of paternalistic altruism whereby they value their child's human capital. Our modeling of intergenerational altruism follows Glomm and Ravikumar (1992), who assume that the parental bequest is the quality of education received by their children. The preferences of an individual born at time $t-1$ are represented by:

$$U(c_t, d_{t+1}, h_{t+1}) = (1-\beta)\ln c_t + \beta \ln d_{t+1} + \gamma \ln h_{t+1} \tag{9}$$

where c_t, d_{t+1} and h_{t+1} are respectively consumption when adult, consumption when old, and the child's human capital. Parameter $\beta \in]0, 1[$ denotes individuals' thrift and γ is the altruism factor.

The child's human capital at adulthood h_{t+1} depends on his parents' decision on education during childhood:

$$h_{t+1} = b_t e_t^a \tag{10}$$

where b_t is an externality, e_t the amount of resources a parent devotes to his child's education, and $a \in]0, 1[$ the elasticity of the technology of human capital formation.

We assume consumption is a composite of tradable and non-tradable consumption. Let $x = c, d$ denote individual consumption at each period of life, x_N and x_T be the spending allocated to non-tradable and tradable goods, respectively. Instantaneous preferences over the two goods are defined according to:

$$x_t = x_{Tt}^{\mu} x_{Nt}^{1-\mu} \tag{11}$$

with $\mu \in (0, 1)$.

Individuals born in period $t-1$ are endowed with h_t units of human capital at the beginning of adulthood. They supply it inelastically and distribute their earnings, which consist of labor income $w_t h_t$, between their own consumption spendings c_t, investments in child's education e_t, and savings, s_t:

$$w_t h_t = \pi_t c_t + P_{Nt} e_t + s_t \tag{12}$$

with π the price index in terms of tradable goods. When old, individuals retire and consume the proceeds of their savings:

$$R_{t+1} s_t = \pi_{t+1} d_{t+1} \tag{13}$$

Agents choose e_t and s_t so as to maximize their life-cycle utility (9) under their budget constraints (10), (12) and (13). Solving the first-order conditions gives the standard individual's optimal choice:

$$s_t = \frac{\beta}{1+\gamma a} w_t h_t \tag{14}$$

$$e_t = \frac{\gamma a}{P_{Nt}(1+\gamma a)} w_t h_t \tag{15}$$

As usual in overlapping generation models with paternalistic altruism, savings increase with individuals' thrift and decrease with altruism. The more altruistic parents are, the more they invest in their offspring's education.

We obtain the allocation of consumption spending between the two goods, at each period of life, using instantaneous preferences (11) with budget constraint $\pi_t x_t = x_{Tt} + P_{Nt} x_{Nt}$:

$$\begin{aligned} x_{Tt} &= \mu \pi_t x_t \\ P_{Nt} x_{Nt} &= (1-\mu)\pi_t x_t \\ \pi_t &= \phi(\mu) \equiv \mu^{-\mu}\left(\frac{1-\mu}{P_{Nt}}\right)^{-(1-\mu)} \end{aligned} \tag{16}$$

3.3. Cross-border external effects in human capital

We assume cross-border externalities in human capital formation. An individual's investment in his child's human capital generates a positive externality for his fellow countrymen. Such externalities can be viewed as international spillovers in education resulting from international student mobility.[9] For example, a visiting student can transfer his knowledge to students in the host country and conversely, a visiting student can acquire specific learning competences when studying aboard.

[9] The global population of internationally mobile students more than doubled, from 2.1 millions in 2000 to 4.5 millions in 2011. According to the European commission, around 4.5% of all European students receive Erasmus grants at some stage during their higher education studies.

We assume an externality of the form:

$$b_t = b(p\overline{e_t} + p^*\overline{e_t}^*)^{\lambda}\overline{e_t}^{1-a-\lambda} \text{ and } b_t^* = b(p\overline{e_t} + p^*\overline{e_t}^*)^{\lambda}\overline{e_t}^{*1-a-\lambda} \tag{17}$$

where $b > 0$, $\lambda \in [0, 1 - a]$ and $p = p^* = 1/2$ the share of each country in the world population. We denote respectively $\overline{e_t}$ and $\overline{e_t}^*$ the average levels of investment in children's human capital in the home and the foreign country. Since individuals are identical within each country, in equilibrium: $e_t = \overline{e_t}$ and $e_t^* = \overline{e_t}^*$. The magnitude of these cross-border external effects is given by λ. The term $(\overline{e_t} + \overline{e_t}^*)^{\lambda}$ is intended to capture the strength of international spillover of knowledge. The higher λ, the more the home country benefits from the foreign country's private expenditures in education.

In equilibrium, human capital depends both on domestic and foreign investment in education and on cross-border externalities in human capital formation:

$$h_{t+1} = b_t e_t{}^a = b\left(\frac{e_t + e_t^*}{2}\right)^{\lambda} e_t^{1-\lambda} \tag{18}$$

As the population size is normalized to one, the labor market equilibrium gives $H_t = h_t$ and we define the economic growth rate as $g_t = h_{t+1}/h_t - 1$. Let $\rho_t = e_t^*/e_t$ be the ratio of foreign over home average investment, by using Eqs. (15), (18) and finally (6), we obtain:

$$1 + g_t = \frac{\gamma ab}{(1+\gamma a)}(1-\alpha_T)A_T B^{\alpha_T} P_{Nt}^{\frac{\alpha_N}{\alpha_T-\alpha_N}}\left(\frac{1+\rho_{t-1}}{2}\right)^{\lambda} \tag{19}$$

3.4. The non-tradable market clearing condition

Since there exists a non-tradable good, we should consider a market clearing condition for that good:

$$Y_{Nt} = c_{Nt} + d_{Nt} + e_t \tag{20}$$

This equation simply states that production equals total consumption in non-tradable goods. We can rewrite this condition with only wage, interest factor and physical to human capital ratios:

Lemma 1. *The home country non-tradable market clearing condition can be written*

$$\frac{w_t}{1+\gamma a}((1-\mu)(1-\beta)+\gamma a) + \frac{R_t(1-\mu)\beta P_{Nt-1}}{\gamma ab\left(\frac{1+\rho_{t-1}}{2}\right)^{\lambda}} = P_{Nt}A_N Dk_T{}^{\alpha_N-1}(k_t - k_{Tt}) \tag{21}$$

With $D = \frac{(\alpha_N(1-\alpha_T))^{\alpha_N}(\alpha_T(1-\alpha_N))^{1-\alpha_N}}{\alpha_N-\alpha_T}$.

Proof. See on-line appendix. □

It can be noted that expression D is the same for both countries as we assume home and foreign technologies have identical elasticities of substitution between production factors.

4. Autarky

First, we consider autarky and thus we rule out any interactions between countries. Without external effect, *i.e* $\lambda = 0$, the human capital externality depends only on the average level of education. From Eq. (18) we have $h_{t+1} = be_t$.

Young people's savings finance the following period's physical capital:

$$s_t = K_{t+1} = h_{t+1}k_{t+1} \tag{22}$$

Combining (14), (15), (18), and (22), we obtain the next period equilibrium physical to human capital ratio:

$$k_{t+1} = \frac{\beta}{b\gamma a}P_{Nt} \tag{23}$$

which depends on P_{Nt}, the price of human capital relative to physical capital in the current period t. Using Eqs. (5) and (6) with non-tradable market clearing condition (21), we obtain:

$$P_{Nt}^{\frac{1}{\alpha_T-\alpha_N}} = \frac{1}{B}\frac{\alpha_T}{1-\alpha_T}\frac{1-\alpha_T-(1-\mu)(\alpha_N-\alpha_T)}{\frac{\alpha_N-\alpha_T}{1+\gamma a}((1-\beta)(1-\mu)+\gamma a)+\alpha_T}k_t \tag{24}$$

From Eqs. (23) and (24) we finally obtain the dynamic equation characterizing equilibrium paths:

$$P_{Nt+1} = \left(\frac{\beta}{B\ b\gamma a}\frac{\alpha_T}{1-\alpha_T}\frac{1-\alpha_T-(1-\mu)(\alpha_N-\alpha_T)}{\frac{\alpha_N-\alpha_T}{1+\gamma a}((1-\beta)(1-\mu)+\gamma a)+\alpha_T}P_{Nt}\right)^{\alpha_T-\alpha_N} \tag{25}$$

Definition 1. We define a balanced growth path (BGP) as an equilibrium where all per capita variables grow at the same and constant rate. This equilibrium path is such that the relative price is constant and defined by $P_{Nt+1} = P_{Nt} = \overline{P}_N$.

We then compute the autarky growth rate $\overline{g}^A$ on the BGP.

Lemma 2. *The autarky growth factor on the balanced growth path is:*

$$1 + \overline{g}^A = \frac{\gamma ab}{1 + \gamma a}(1 - \alpha_T)A_T B^{\alpha_T} \overline{P}_N{}^{A \frac{\alpha_N}{\alpha_T - \alpha_N}} \tag{26}$$

with

$$\overline{P}_N^A = \left[\frac{\beta}{b\gamma a}\frac{\zeta}{B\eta}\right]^{\frac{\alpha_T - \alpha_N}{1-(\alpha_T - \alpha_N)}} \tag{27}$$

The physical to human capital ratio on the balanced growth path is:

$$\overline{k} = \left[\frac{\beta}{b\gamma a}\left(\frac{\zeta}{B\eta}\right)^{\alpha_T - \alpha_N}\right]^{\frac{1}{1-(\alpha_T - \alpha_N)}} \equiv k^A \tag{28}$$

with $\zeta = 1 + \frac{(\alpha_T - \alpha_N)(1-\mu)}{1-\alpha_T}$ *and* $\eta = \frac{(\alpha_N - \alpha_T)}{\alpha_T}\frac{(1-\beta)(1-\mu)+\gamma a}{1+\gamma a} + 1$.

Proof. See on-line Appendix. □

From (25) and (27), the BGP equilibrium is globally stable. An increase in P_{Nt} affects the return on human capital (w_t). This tends to increase both education spending (e_t) and savings (s_t) in the same way. Nevertheless, this rise in P_{Nt} also makes education more expensive. Consequently, from Eq. (23), a rise in P_{Nt} increases the next period physical to human capital ratio. From the Rybczynski theorem, this rise in physical capital increases the (capital-intensive) production of tradable goods which increases the relative price of non-tradable goods. As a result, from Assumption 1, the relative price of the non-tradable good (in terms of tradable) goes up and the dynamics around the BGP is monotonous. As the growth rate is monotonically related to the relative price of goods through Eq. (26), we can thus claim the following:

Proposition 1. *Under Assumption 1, the autarky growth rate exhibits monotonic behavior.*

The dynamic effect of the relative price of goods on the transitional growth rate is little discussed in the literature. Alonso-Carrera et al. (2015) is an exception and emphasizes that the dynamic adjustment of the relative price alters the growth rate of consumption expenditure under particular conditions. In the infinitely lived agent model, the variation in the relative prices generates a growth effect when there are multiple consumption goods and non logarithmic preferences. In our model, the growth rate is endogenously determined and depends on the relative price through the returns to human capital and the price of education spending. The growth rate dynamics is then directly driven by relative price movements.

The following propositions contain some comparative static results relating the long-term relative price of goods and the growth rate to preference parameters.

Proposition 2. *Under Assumption 1, the relative price of the non-tradable good is a decreasing function of the altruism rate γ, an increasing function of the rate of time preference β and a decreasing function of the share for the tradable good in total consumption spending μ.*

Proof. We can easily check from Eq. (27) that P_N^A is decreasing with γ and μ and increasing with β. □

An increase in γ rises the human capital accumulation relative to the physical capital accumulation. Indeed, the K/H ratio decreases. We know from the Rybczinski theorem that this decrease in the relative endowment of physical capital increases the production of non-tradable goods and decreases the production of tradable goods. This implies that a country with a higher taste for education (γ) will be characterized by a lower relative price for the non-tradable good. The same intuition explains why the relative price of the non-tradable good increases with β: the higher β, the higher the K/H ratio, the higher Y_T, and the lower Y_N. Finally, a rise in μ leads to an increase in the share of global consumption spendings dedicated to tradable goods. This drop in the demand for non-tradable goods decreases the price of non-tradable goods.

We examine implications of agent's preferences on the long-term growth rate:

Proposition 3. *The growth rate first increases and then decreases with γ reaching a maximum in* $\overline{\gamma} = \frac{1-\alpha_T-\alpha_N+\sqrt{(1-\alpha_T-\alpha_N)^2+4\alpha_N(1-\alpha_T)((1-\mu)(1-\beta)(\alpha_N-\alpha_T)+\alpha_T)}}{2a\alpha_N}$. *Under Assumption 1, the growth rate decreases in μ and increases in β.*

Proof. See on-line Appendix. □

The more altruistic individuals are, the higher their investment in children's education and the lower their consumption. We obtain, as in Michel and Vidal (2000), that excessive as well as weak altruism can lead to poor growth records. Eq. (26) shows that the growth rate does depend on the rate of time preference (β) and on the share for the tradable good in total consumption spending (μ) but only through their effects on the relative price given by Eq. (27). Because of Assumption 1, a rise in P_N increases the return on education, human capital accumulation and finally the long-run growth rate. A rise in β, as well as a fall in μ, leads to an increase in P_N which improves the growth rate.

5. Economic integration

We consider a two-country overlapping generations world in which countries differ in levels of patience and altruism, in their preference for non-tradable goods and in sectoral-TFP. We establish the growth implications of world economic integration.

5.1. International environment

In the integrated economy, we assume no human capital mobility between the two countries and a perfect physical capital mobility. By definition, the tradable good can be exchanged without any cost between countries while the non-tradable good is not concerned by international trade. Thus, the non-tradable market clearing condition is always given by Eq. (21) . The foreign country equations are obtained if we denote by * foreign variables.

In a two-country integrated world, there are capital flows between countries and the equality between domestic savings and domestic investment -Eq. (22)- no longer holds. The equilibrium on the world capital market is given by:

$$K_{t+1} + K^*_{t+1} = s_t + s^*_t \tag{29}$$

Including the definition of the physical to human capital ratio:

$$k_{t+1}h_{t+1} + k^*_{t+1}h^*_{t+1} = s_t + s^*_t \tag{30}$$

With perfect capital mobility, the interest rate is the same for both countries:

$$R_t = R^*_t \tag{31}$$

Using Eq. (8), we can determine the ratio between foreign and domestic relative prices:

$$\frac{P^*_{Nt}}{P_{N_t}} = \left[\frac{A_N}{A^*_N}\right]\left[\frac{A^*_T}{A_T}\right]^{\frac{1-\alpha_N}{1-\alpha_T}} \equiv \mathscr{E} \tag{32}$$

This ratio reflects the bilateral real exchange rate between these two countries.

The following Lemma provides a simple expression of the world capital accumulation equation, and expressions of the physical to human capital ratios:

Lemma 3. *In an integrated world, the international capital market clearing condition is:*

$$(k_{t+1} + k^*_{t+1}\rho_t^{1-\lambda}) = \frac{2^\lambda}{b(1+\rho_t)^\lambda}\left(\frac{\beta P_{Nt}}{\gamma a} + \rho_t\frac{\beta^* P^*_{Nt}}{\gamma^* a}\right) \tag{33}$$

and, the physical to human capital ratios are obtained from non-tradable market clearing conditions:

$$k_{t+1} = P_{Nt+1}^{\frac{1}{\alpha_T-\alpha_N}} B\eta + (1-\zeta)\frac{2^\lambda \beta P_{Nt}}{b(1+\rho_t)^\lambda \gamma a} \tag{34}$$

$$k^*_{t+1} = P^*_{Nt+1}{}^{\frac{1}{\alpha_T-\alpha_N}} B^*\eta^* + (1-\zeta^*)\frac{\rho_t^\lambda 2^\lambda \beta^* P^*_{Nt}}{b(1+\rho_t)^\lambda \gamma^* a} \tag{35}$$

The domestic price of the non-tradable good is:

$$P_{Nt+1}^{\frac{1}{\alpha_T-\alpha_N}} = \frac{2^\lambda\left(\frac{\beta P_{Nt}\zeta}{\gamma a} + \frac{\rho_t \beta^* \mathscr{E} P_{Nt}\zeta^*}{\gamma^* a}\right)}{B(1+\rho_t)^\lambda b\left(\eta + \rho_t^{1-\lambda}\left(\frac{A^*_T}{A_T}\right)^{\frac{1}{1-\alpha_T}}\eta^*\right)} \tag{36}$$

With $\zeta = 1 + \frac{(\alpha_T-\alpha_N)(1-\mu)}{1-\alpha_T}$, $\zeta^* = 1 + \frac{(\alpha_T-\alpha_N)(1-\mu^*)}{1-\alpha_T}$, $\eta = \frac{(\alpha_N-\alpha_T)}{\alpha_T}\frac{(1-\beta)(1-\mu)+\gamma a}{1+\gamma a} + 1$ *and* $\eta^* = \frac{(\alpha_N-\alpha_T)}{\alpha_T}\frac{(1-\beta^*)(1-\mu^*)+\gamma^* a}{1+\gamma^* a} + 1.$

Proof. See on-line appendix. □

Introducing cross-border external effects, each country can benefit from the level of education in the other country. Using Eq. (15) we can compute:

$$\rho_{t+1} = \frac{e^*_{t+1}}{e_{t+1}} = \frac{\gamma^*}{\gamma}\frac{1+\gamma a}{1+\gamma^* a}\frac{w^*_{t+1}h^*_{t+1}}{w_{t+1}h_{t+1}}\frac{1}{\mathscr{E}} \tag{37}$$

Including Eqs. (18) and (32), we have:

$$\rho_{t+1} = \frac{\gamma^*}{\gamma}\frac{1+\gamma a}{1+\gamma^* a}\left(\frac{A^*_T}{A_T}\right)^{\frac{\alpha_N}{1-\alpha_T}}\frac{A^*_N}{A_N}\rho_t^{1-\lambda} \tag{38}$$

5.2. Steady state

Integration adds a dynamical dimension given by Eq. (38). Assuming that integration occurs at period $t = 0$, we consider as initial condition the state of the economy in autarky at period $-\,1$, which gives P_{N0} from Eq. (36) with $P_{N-1} = \overline{P}_N^A$, $P^*_{N-1} = \overline{P}_N^{*A}$ and $\rho_{-1} = \frac{e^{A*}_{-1}}{e^{A}_{-1}}$. As a result, in the integrated world, the behavior of economies is driven by a bi-dimensional dynamical system.

$$\begin{cases} \rho_{t+1} = \frac{\gamma^*}{\gamma}\frac{1+\gamma a}{1+\gamma^* a}\left(\frac{A_T^*}{A_T}\right)^{\frac{\alpha_N}{1-\alpha_T}}\frac{A_N^*}{A_N}\rho_t^{1-\lambda} & \forall\, t \geq 0 \\ P_{Nt+1} = \left(\frac{\frac{\beta\zeta}{\gamma a} + \frac{{}^*\beta^*\zeta^*\mathscr{E}\rho_t}{\gamma^* a}}{(\frac{1+\rho_t}{2})^{\lambda} b\left(\eta + \rho_t^{1-\lambda}\left(\frac{A_T^*}{A_T}\right)^{\frac{1}{1-\alpha_T}}\eta^*\right)}P_{Nt}\right)^{\alpha_T-\alpha_N} & \forall\, t > 0 \\ P_{N0}^{\frac{1}{\alpha_T-\alpha_N}} = \frac{\left(\frac{\beta P_{N-1}\zeta}{\gamma a} + \frac{{}^*\rho_{-1}\beta^* P^*_{N-1}\zeta^*}{\gamma^* a}\right)}{B(\frac{1+\rho_{-1}}{2})^{\lambda} b\left(\eta +^* \rho_{-1}^{1-\lambda}\left(\frac{A_T^*}{A_T}\right)^{\frac{1}{1-\alpha_T}}\eta^*\right)} & \\ \text{with } P_{N-1} = \overline{P}_N^A, \quad P^*_{N-1} = \overline{P}_N^{*A} \quad and \quad \rho{-1} = \frac{e^{A*}_{-1}}{e^{A}_{-1}} & \end{cases} \tag{39}$$

We examine the steady state of the integrated economy by considering that $\rho_{t+1} = \rho_t = \overline{\rho}$ and $P_{Nt+1} = P_{Nt} = \overline{P}_N$ in system (39):

Proposition 4. *Under Assumption 1 and* $\lambda \in (0,\, 1 - a]$, *there exists a unique non trivial stable steady state* $(\overline{\rho},\, \overline{P}_N)$ *where human capital grows at the same constant rate in the two economies.*

$$\begin{cases} \overline{\rho} = \left(\frac{\gamma^*}{\gamma}\frac{1+\gamma a}{1+\gamma^* a}\left(\frac{A_T^*}{A_T}\right)^{\frac{\alpha_N}{1-\alpha_T}}\frac{A_N^*}{A_N}\right)^{\frac{1}{\lambda}} \\ \overline{P}_N = \left(\frac{\frac{\beta\zeta}{\gamma a} + \frac{\beta^*\zeta^*\mathscr{E}\overline{\rho}}{\gamma^* a}}{B\left(\frac{1+\overline{\rho}}{2}\right)^{\lambda} b\left(\eta + \overline{\rho}^{1-\lambda}\left(\frac{A_T^*}{A_T}\right)^{\frac{1}{1-\alpha_T}}\eta^*\right)}\right)^{\frac{\alpha_T-\alpha_N}{1-(\alpha_T-\alpha_N)}} \end{cases} \tag{40}$$

and

$$\overline{g} = \overline{g}^* \equiv \overline{g}^w$$

with

$$\overline{g}^w = \frac{\gamma a b}{1+\gamma a}(1-\alpha_T)A_T B^{\alpha_T}\overline{P}_N^{\frac{\alpha_N}{\alpha_T-\alpha_N}}\left(\frac{1+\overline{\rho}}{2}\right)^{\lambda} - 1$$

In the integrated economy, the home and foreign countries grow at the same rate as soon as there exists a positive cross border externality ($\lambda > 0$). To promote convergence across countries, a policy maker should boost international spillovers in education, by promoting student mobility for instance. Nonetheless, this convergence is not systematically growth enhancing for the integrated countries. It may even be growth damaging in the long run depending on the countries' characteristics.

6. Non-tradable goods and sectoral productivity

We examine the impact of integration on the growth rates of both economies. We highlight that both the share of tradable consumption in total consumption spending (μ, μ^*) and sectoral productivity differential (relative TFP) matter to determine the consequences of economic integration. Let a country benefiting from integration be a country whose growth rate improves with economic integration. With cross-border externality in education, integration means a convergence of the growth rates of integrated economies. The dynamical system (39) and Proposition 4 show that the integrated growth rate depends on two factors: the relative price of the non-tradable goods and the education ratio. Thus, a country benefiting from integration can be:

- a country whose relative price increases with integration (so do both the wage and the growth rate, according to Eq. (8).
- a country benefiting from a positive externality in education, which means a country with a relatively low level in education

The originality of this setting compared to previous works is that the benefits of integration depend on the relative price reaction to integration. Since this relative price is a forward variable, the effects of economic integration can be different in the short-run and in the long-run.

6.1. Long-term analysis

We determine the conditions under which an economy benefits from economic integration in the long-run. We compare for each country the autarky long-term growth rate with the integrated one. Integration is growth enhancing when $\bar{g}^w/\bar{g}^A > 1$. We define $\frac{A_T}{A_T^*} \equiv \mathscr{A}$ and using Eqs. (26) –(28) and (40), we write $1 + \bar{g}^w/1 + \bar{g}^A$ as follows :

$$\frac{1+\bar{g}^w}{1+\bar{g}^A} = \left(\frac{1 + \mathscr{A}^{-\frac{1-\alpha_N}{1-\alpha_T}} \left(\frac{A_N}{A_N^*}\right)\left(\frac{\zeta^*\gamma\beta^*}{\zeta\gamma^*\beta}\right)\bar{\rho}(\mathscr{A})}{1 + \mathscr{A}^{-\frac{1}{1-\alpha_T}} \frac{\eta^*}{\eta}\bar{\rho}(\mathscr{A})^{1-\lambda}} \right)^{\frac{\alpha_N}{1-\alpha_T+\alpha_N}} \left(\frac{1+\bar{\rho}(\mathscr{A})}{2}\right)^{\frac{\lambda(1-\alpha_T)}{1-\alpha_T+\alpha_N}} \equiv G(\mathscr{A}) \tag{41}$$

$$\frac{1+\bar{g}^w}{1+\bar{g}^{A*}} = \left(\frac{\mathscr{A}^{\frac{1-\alpha_N}{1-\alpha_T}} \left(\frac{\beta\zeta\gamma^*}{\beta^*\zeta^*\gamma}\right)\left(\frac{A_N^*}{A_N}\right) + \bar{\rho}(\mathscr{A})}{\mathscr{A}^{\frac{1}{1-\alpha_T}} \frac{\eta}{\eta^*}\bar{\rho}(\mathscr{A})^{\lambda} + \bar{\rho}(\mathscr{A})} \right)^{\frac{\alpha_N}{1-\alpha_T+\alpha_N}} \left(\frac{1+\bar{\rho}(\mathscr{A})}{2\bar{\rho}(\mathscr{A})}\right)^{\frac{\lambda(1-\alpha_T)}{1-\alpha_T+\alpha_N}} \equiv G^*(\mathscr{A}) \tag{42}$$

To determine the growth implication of economic integration we compare the value of functions $G(\mathscr{A})$ and $G(\mathscr{A})^*$ to one. For the rest of the analysis, let us denote $\left(\frac{\gamma^*}{\gamma}\frac{1+\gamma a}{1+\gamma^* a}\frac{A_N^*}{A_N}\right)^{\frac{1-\alpha_T}{\alpha_N}} \equiv \mathscr{A}_1$ and $\frac{1+\gamma a}{1+\gamma^* a}\frac{\eta\beta^*\zeta^*}{\eta^*\beta\zeta} \equiv x$.[10] Notice that x decreases with both β and μ. We present the main properties of function $G(\mathscr{A})$ and $G^*(\mathscr{A})$ in the following Lemma:

Lemma 4. *(i) Properties of $G(\mathscr{A})$:*

- *When $\lambda = 0$:*
  - *$G(\mathscr{A}_1) >$ (resp. $<$) 1 if $x >$ (resp. $<$) 1.*
  - *For $\mathscr{A} >$ (resp. $<$) $\mathscr{A}_1$, $\bar{\rho} = 0$ (resp. $\bar{\rho}$ tends to ∞) and $G(\mathscr{A}) = 1$ (resp. $G(\mathscr{A}) = \left(\frac{\mathscr{A}}{\mathscr{A}_1}^{\frac{1}{1-\alpha_T}}(x)\right)^{\frac{\alpha_N}{1-\alpha_T+\alpha_N}}$).*

    We deduce that if $x < 1$, $G \le 1$ $\forall$ $\mathscr{A}$, and if $x > 1$, there exists $\underline{\mathscr{A}}$ such that $G > 1$ for $\mathscr{A} \in [\underline{\mathscr{A}}, \mathscr{A}_1)$.
- *When $0 < \lambda \leqslant 1 - a$:*
  - *$G(0) = +\infty$ and $\lim G_{\mathscr{A}\to\infty} = 0$*
  - *$G(\mathscr{A}_1) > 1$ (resp. < 1) if $x > 1$ (resp. < 1)*
  - *$G'(\mathscr{A}) < 0$ if $x > 1$*

    We deduce that when $x > 1$ there exists a critical threshold $\bar{l} > \mathscr{A}_1$ with $G(\bar{l}) = 1$ and when $x < 1$ there exists a critical threshold $\underline{l} < \mathscr{A}_1$ with $\underline{l} = \min\{sol\{G(\mathscr{A}) = 1\}\}$. Thus, we have $G(\mathscr{A}) > 1$ $\forall$ $\mathscr{A}$ $\in [0, \underline{l})$ and $G(\mathscr{A}) < 1$ $\forall$ $\mathscr{A} \in (\bar{l}, +\infty)$.

(ii) Properties of $G^*(\mathscr{A})$:

- *When $\lambda = 0$:*
  - *$G^*(\mathscr{A}_1) >$ (resp. $<$) 1 if $x <$ (resp. $>$) 1.*
  - *For $\mathscr{A} >$ (resp. $<$) $\mathscr{A}_1$, $\bar{\rho} = 0$ (resp. $\bar{\rho}$ tends to ∞) and $G^*(\mathscr{A}) = \left(\frac{\mathscr{A}}{\mathscr{A}_1}^{\frac{1}{1-\alpha_T}}(x)\right)^{\frac{-\alpha_N}{1-\alpha_T+\alpha_N}}$ (resp. $G^*(\mathscr{A}) = 1$).*

    We deduce that if $x > 1$, $G^* \le 1$ $\forall$ $\mathscr{A}$, and if $x < 1$ there exists a $\overline{\mathscr{A}}$ such that $G^* > 1$ for $\mathscr{A} \in [\mathscr{A}_1, \overline{\mathscr{A}}]$
- *When $0 < \lambda \leqslant 1 - a$:*
  - *$G^*(0) < 1$ and $\lim_{\mathscr{A}\to\infty} G^*(\mathscr{A}) = +\infty$*
  - *$G^*(\mathscr{A}_1) > 1$ (resp. < 1) if $x < 1$ (resp. > 1)*
  - *$G^{*'}(\mathscr{A}) > 0$ if $x < 1$*

    We deduce that when $x > 1$ there exists a critical threshold $\bar{z} > \mathscr{A}_1$ with $\bar{z} = \max\{sol\{G^*(\mathscr{A}) = 1\}\}$ and when $x < 1$ there exists a critical threshold $\underline{z} < \mathscr{A}_1$ with $G^*(\underline{z}) = 1$. Thus, we have $G^*(\mathscr{A}) < 1$ $\forall$ $\mathscr{A}$ $\in [0, \underline{z})$ and $G^*(\mathscr{A}) > 1$ $\forall$ $\mathscr{A} \in (\bar{z}, +\infty)$.

Proof. See on-line appendix. □

Fig. 1 plots the long-run benefits of integration.[11] Case *a*) is a situation where $x < 1$, which corresponds to situations where the domestic country has a relatively high preference for tradable goods (μ) and/or a relatively high rate of time preference (β), and/or a relatively low degree of altruism (γ). Conversely, case *b*) corresponds to a situation where $x > 1$. The blue dotted line and the red line depict very different situations, which means that the effects of integration largely depend on the size of the cross-border externality λ.

The following proposition summarizes these statements:

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[10] Thus we can write $\rho_{t+1} = \left(\frac{\mathscr{A}_1}{\mathscr{A}}\right)^{\frac{\alpha_N}{1-\alpha_T}}\rho_t^{1-\lambda}$.

[11] When λ > 0 and $x < 1$, we are not able to know how the function $G(\mathscr{A})$ evolves with $\mathscr{A}$ such that the figure in the top left is a possible representation with $\underline{l} = \min\{sol\{G(\mathscr{A}) = 1\}\}$. In the same way, when λ > 0 and $x > 1$, we are not able to know how the function $G(\mathscr{A})^*$ evolves with $\mathscr{A}$ thus the figure in the bottom right-hand is a possible representation with $\underline{z} = \max\{sol\{G(\mathscr{A}) = 1\}\}$.

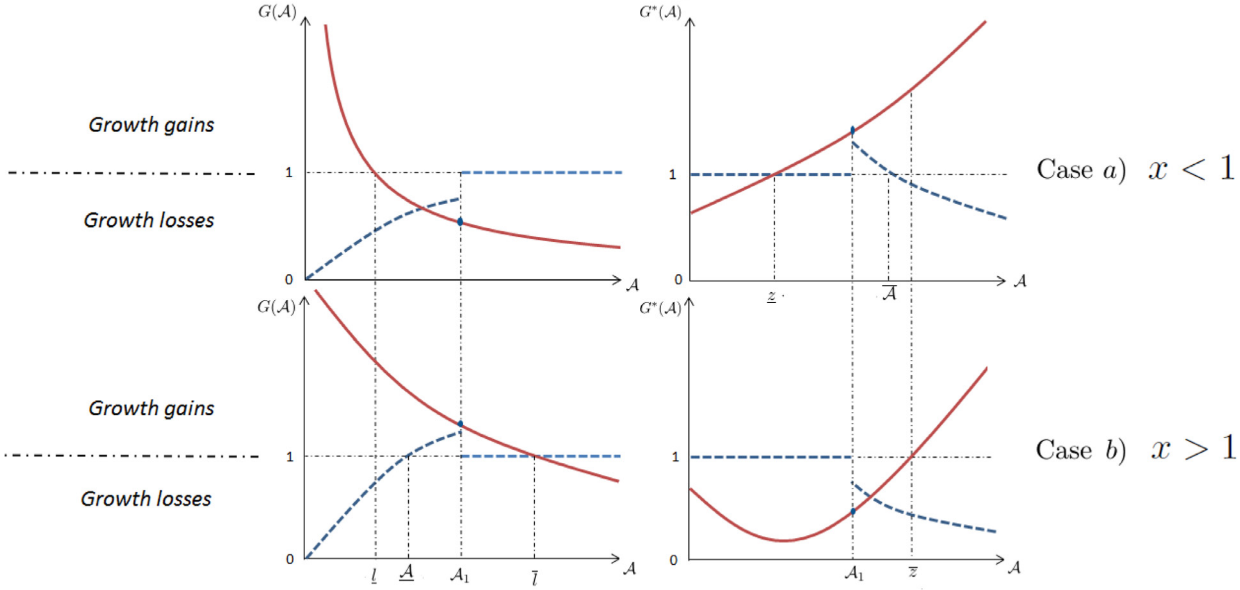

Fig. 1. Growth effects of economic integration in the long run.

Proposition 5. *Under Assumption 1*

- *When* $\lambda = 0$*:*
  - *Economic integration improves the long-term growth rate of the domestic economy if and only if* $x > 1$ *and* $\mathscr{A} \in (0, \mathscr{A}_1]$.
  - *Economic integration improves the long-term growth rate of the foreign economy if and only if* $x < 1$ *and* $\mathscr{A} \in [\mathscr{A}_1, \infty)$.
- *When* $0 < \lambda \leqslant 1 - a$*:*
  - *Economic integration improves the long-term growth rate of the domestic economy when* $\mathscr{A} < \underline{l}$ *and when* $\underline{l} < \mathscr{A} < \bar{l}$ *with* $x > 1$.
  - *Economic integration improves the long-term growth rate of the foreign economy when* $\mathscr{A} > z$ *and when* $\underline{z} < \mathscr{A} < \bar{z}$ *with* $x < 1$.

Proposition 5 states that without cross border externalities ($\lambda = 0$), economic integration cannot be growth enhancing for both countries. In a one-sector model of endogenous growth with human capital accumulation, countries benefiting from integration in terms of growth are thus countries with a relatively high interest rate ($R^A > R^{A^*}$). This high return on domestic capital reflects a low capital intensity which may result from a low β, or a high altruism degree γ. Thus, countries benefiting from integration in terms of growth are impatient countries or countries loving their children. Introducing a second sector in this 2-factor economy, Eq. (8) shows that the factor returns no longer depend directly on capital intensity but on the relative price instead. With economic integration, domestic and foreign relative prices are linked through Eq. (32).

Under Assumption 1 and $\lambda = 0$, a domestic country benefiting form integration in the long-run is characterized by $P_N^A \mathscr{E} < P_N^{A*}$ and therefore by at least one of these features

(i) a high endowment in human capital i.e. a high degree of altruism (high γ)
(ii) a low endowment in physical capital i.e. an impatient country (low β)
(iii) a productivity relatively higher in the non-tradable sector (A_N/A_N^* high relative to A_T/A_T^*)[12]
(iv) a low share for the non-tradable good in total consumption spending (high μ).

Features (i) and (ii) were already present in the one-sector model with human capital accumulation. Features (iii) and (iv) are specific to the 2x2 structure. Introducing a second sector in this economy, we have shown that countries benefiting from integration in terms of growth may also be countries with a low preference for non-tradable goods or countries with a relatively high TFP in the non tradable sector. This result suggests that a patient country (or a country with a low degree of altruism) may benefit from integration if the preference for non-tradable goods is low or if the productivity in non-tradable goods is relatively high. Alternatively, integration may be growth damaging in an impatient country (or a country with a high degree of altruism) if the preference for non-tradable goods is high or the productivity in the non-tradable sector is relatively low.

In the presence of cross-border externalities ($0 < \lambda \leqslant 1 - a$), economic integration affects the economy through an additional channel. Not only does the long-run benefit of integration depend on the difference between initial autarky relative prices ($P_N^A - P_N^{A*}$), but also on the long-run ratio of education ($\bar{\rho}$). If $\bar{\rho} > 1$, integration generates a positive externality for the domestic country since the foreign economy is more educated. This long-run ratio of education ($\bar{\rho}$) depends on relative TFP level and on relative altruism degrees (Eq. (40)). This additional channel, due to the externality, highlights another situation in which the less

[12] $P_N^A \mathscr{E}/P_N^{A*}$ is decreasing with $\frac{A_N A_T^*}{A_N^* A_T}$

Table 2
Example.

Countries	β	γa	μ	A_T	A_N
France	0.26	0.35	0.42	0.95	1.18
UK	0.16	0.29	0.40	0.93	1.10
Portugal	0.14	0.35	0.54	0.31	0.55
Germany	0.33	0.34	0.44	1	1.03

Table 3
Long-term benefits of integration - an example.

	$\mathscr{A}$	$\mathscr{A}_1$	x
France/UK	1.02	0.81	0.68
France/Portugal	3.12	0.47	0.49
France/Germany	0.95	0.86	1.23

patient country does not benefit from economic integration. This is the case when the impatient country is relatively more productive in the non-tradable sector ($A_N/A_T > A_N^*/A_T^*$) i.e. when this country integrates with a less educated foreign country.

Example: Table 2 collects the characteristics of some European countries (rate of time preference, altruism, relative productivity). To determine the value of the preference for tradable goods, we use Eq. (16) to proxy μ in this Cobb-Douglas setting based on: $\mu = \frac{x_T}{\pi x}$. Section 2 and on-line Appendix give details concerning this calibration.

Let us consider that France is the domestic economy, and that the Foreign economy is alternatively either the UK, Portugal and Germany. Among these countries, the more patient is Germany, the more altruistic countries are France and Portugal. France has the lower share of tradable good in total consumption spending and Portugal has the lowest ratio A_N/A_T. Table 3 computes $\mathscr{A}$, $\mathscr{A}_1$ and x to determine which country benefits from integration.

For example, the France/UK integration corresponds to Case a) of Fig. 1 since $x < 1$. As $\mathscr{A} = 1.02$ and $\mathscr{A}_1 = 0.81$, we have $\mathscr{A} > \mathscr{A}_1$ and Fig. 1 shows that the UK benefits from integration whereas France's growth rate drops with integration when $0 < \lambda < 1 - a$. As for $\lambda = 0$, UK still benefits from integration whereas France keeps the same growth rate as in autarky. Compared to France, Britain is relatively impatient, less educated and has a higher preference for tradable goods. Therefore, France has a high P_N^A and experiences a negative cross-border externality when integrating with the UK. The case France/Portugal leads to the same conclusion: integration is growth enhancing for Portugal (Foreign Economy) whatever λ. This positive effect of integration is reinforced by the fact that Portugal is relatively more productive in the non-tradable sector ($A_N/A_T = 1.77$ against 1.24 for France). Finally, the case France/Germany corresponds to the Case *b*) of Fig. 1 where $\mathscr{A} > \mathscr{A}_1$. If we compare France and Germany (see Table 2) we have:

(a) A higher share of non-tradable good in France ($\mu < \mu^*$)
(b) A higher relative productivity in the non-tradable goods sector in France ($A_T/A_T^* > A_N/A_N^*$)
(c) A higher degree of altruism in France ($\gamma > \gamma^*$)
(d) A lower patience degree in France ($\beta < \beta^*$)

Features (b), (c) and (d) suggest that the production of non-tradable goods in France is higher than in Germany but feature (a) means that the demand for non-tradable goods may be higher in France. Since the demand for non-tradable goods tends to be higher in France but the production of non-tradable goods tends to be higher as well, we may have that $\mathscr{E}P_N^A > P_N^{A*}$ or $\mathscr{E}P_N^A < P_N^{A*}$. Computing the relative price values, we have $\mathscr{E}P_N^A = 0.74$ (0.59×1.25) and $P_N^{A*} = 0.84$ which means $R^A > R^{A^*}$. However, France is a slightly more educated country so it should experience a negative cross border externality when integrating with Germany. The effects of economic integration are in this case ambiguous, so we also have to consider the size of the cross-border externality to conclude. Computing the value of $G(\mathscr{A})$ and $G^*(\mathscr{A})$ we have that integration reduces the growth rate of both countries in the long run when externality is low and increases (resp.reduces) the growth rate of the impatient (resp.patient) country when externality is sufficiently high. When λ is low, Germany experiences a decrease in its growth rate because it integrates with a country characterized by a lower autarky non-tradable goods price, while benefiting only from a small positive externality effect. In this context, France -being impatient- cannot benefit from integrating with a less educated country while the presence of externality ensures a convergence of growth rates across countries.

6.2. *Short-term vs long-term*

Contrary to the previous literature, in our framework, the benefit of integration depends on the relative price. Since this price is a forward variable, short-run benefits of integration may differ from long-run ones. We also show how externalities on human capital contribute to explaining the difference between short and long terms. Below, we evaluate the impact of economic integration for both countries at the time of integration.[13] We consider that before integration economies have achieved their autarky steady states. It

[13] Using the dynamical system (39), we can provide a complete dynamical analysis in the integrated world. Such analysis describes the evolution of the relative price and of the ratio of foreign over home education spending along the convergence path. Nonetheless, it does not allow us to analytically examine the growth consequences of economic integration, and therefore is relegated in on-line Appendix.

follows that, immediately after economic integration, the growth rate jumps in each economy by a factor that depends on countries characteristics and initial conditions. To evaluate the costs or benefits of such an adjustment, we compare the growth rates in autarky, given by Eq. (26), and the growth rates after the jump, obtained with Eq. (19) at time $t = 0$. We define the ratio $G_0 \equiv \frac{1+g_0}{1+\bar{g}^A}$ and $G_0^* \equiv \frac{1+g_0^*}{1+\bar{g}^{*A}}$, with:

$$G_0(\mathscr{A}) = \left(\frac{P_{N0}}{P_N^A}\right)^{\frac{\alpha_T-\alpha_N}{\alpha_N}} \left(\frac{1+\rho_{-1}}{2}\right)^{\lambda(1-\alpha_N)} \tag{43}$$

with

$$\frac{P_{N0}}{P_N^A} = \left(\frac{1+\rho_{-1}\left(\frac{\eta}{\eta^*}\right)^{\frac{\alpha_T-\alpha_N}{1-\alpha_T+\alpha_N}}\left(\frac{\beta^*\zeta^*\gamma}{\beta\zeta\gamma^*}\frac{A_N}{A_N^*}\frac{1}{\mathscr{A}}\right)^{\frac{1}{1-\alpha_T+\alpha_N}}}{1+(\mathscr{A})^{\frac{-1}{1-\alpha_T}}\frac{\eta^*}{\eta}\rho_{-1}^{1-\lambda}}\right)^{\frac{\alpha_N^2}{\alpha_T-\alpha_N}} \tag{44}$$

$$G_0^*(\mathscr{A}) = \left(\frac{P_{N0}^*}{P_N^{*A}}\right)^{\frac{\alpha_T-\alpha_N}{\alpha_N}} \left(\frac{1+\rho_{-1}}{2\rho_{-1}}\right)^{\lambda(1-\alpha_N)} \tag{45}$$

with

$$\frac{P_{N0}^*}{P_N^{A*}} = \left(\frac{\left(\frac{\eta^*}{\eta}\right)^{\frac{\alpha_T-\alpha_N}{1-\alpha_T+\alpha_N}}\left(\frac{\beta\zeta\gamma^*}{\beta^*\zeta^*\gamma}\frac{A_N^*}{A_N}\mathscr{A}\right)^{\frac{1}{1-\alpha_T+\alpha_N}}+\rho_{-1}}{(\mathscr{A})^{\frac{1}{1-\alpha_T}}\frac{\eta}{\eta^*}\rho_{-1}^{\lambda}+\rho_{-1}}\right)^{\frac{\alpha_N^2}{\alpha_T-\alpha_N}} \tag{46}$$

From Eq. (15), the initial level of relative education spending is given by the relative price of goods in Autarky and initial conditions on the human capital stock in each countries at the times of integration:

$$\rho_{-1} = e_{-1}^{A*}/e_{-1}^{A} = \left(\frac{\mathscr{A}_1\, x}{\mathscr{A}}\right)^{\frac{\alpha_N}{1-\alpha_T+\alpha_N}} \frac{h_{-1}^*}{h_{-1}}$$

The first terms of Eq. (43) and (45) reflect the initial variation of the relative prices P_N and P_N^* -namely the price effect- whereas the second terms correspond to the initial impact of the education externality when integration occurs -namely the externality effect.

Contrary to the long-term situation, the relative ratio of education ρ_{-1} depends on the past (autarky). As for the price effect, from Eqs. (44) and (46), we can see that when the domestic country has a relatively strong productivity in tradable sector (high $\mathscr{A}$), the domestic P_N does not initially vary that much (P_{N0} tends to P_N^A). This is due to the fact that at the time of integration, the relative price of each country adjusts in order to satisfy the convergence of real interest rates (Eq. (32)), we have $\frac{P_{N0}^*}{P_{N0}} = \mathscr{E}$). As a result, when a country is characterized by a relatively strong productivity, its relative price does not vary very much while the relative price of the other country adjusts. With similar levels of tradable productivity between countries, both prices will adjust.

The initial effect of the externality is simple, it will be positive for the country with the lower education level, and negative for the other one. As the size of the externality effect depends on the initial stock of human capital in the foreign economy relative to the domestic economy $\frac{h_{-1}^*}{h_{-1}}$, we can claim the following:

Proposition 6. *Under Assumption 1 and* $0 < \lambda \leqslant 1 - a$,

i) *There exists a critical level* $\tilde{\rho}_{-1}$ *such that when* $\rho_{-1} > \tilde{\rho}_{-1}$, *economic integration is growth enhancing in the short run for the domestic economy* $\forall\, \mathscr{A}$.
ii) *There exists a critical level* $\hat{\rho}_{-1}$ *such that when* $\rho_{-1} < \hat{\rho}_{-1}$, *economic integration is growth enhancing in the short run for the foreign economy* $\forall\, \mathscr{A}$.

Proof. See on-line Appendix. □

From this Proposition, we can conclude that the long-term impact of economic integration does not depend on the short-term one. The size of the externality effect differs between the short and the long run according to the initial stocks of human capital in each country at the time of integration. Consequently, a country can observe growth gains in the short run while growth losses in the long run or the contrary.

Example: We illustrate Proposition 6 using as before three examples of integration: France/Britain, France/Portugal and France/Germany. We use the calibration provided in Table 2 and data on education spendings per student (on-line Appendix) to calibrate the initial condition ρ_{-1}. Then, we compute $\hat{\rho}_{-1}$ and $\tilde{\rho}_{-1}$ by using Eqs. (43) and (45):

From Table 4 and Proposition 6, we conclude that for the France-Britain, the UK benefits from integration while France loses both in the short and the long-term. This is because the price effect for France -while positive- is not sufficiently high to offset the initial lower level of education spending in the UK at the time of integration.

For the France-Germany case, we also obtain that the effect of integration is qualitatively the same in the short and in the long

Table 4
Example. short-term analysis for $\lambda = 0.2$.

	$\hat{\rho}_{-1}$	$\tilde{\rho}_{-1}$
France/UK		
$\rho_{-1} = 0.93$	1.60	1.50
France/Germany		
$\rho_{-1} = 1.09$	0.43	0.38
France/Portugal		
$\rho_{-1} = 0.63$	0.50	0.01

run. As for the first example, economic integration between these two countries does lead to an important price effect in the short run because sectoral TFP gaps are not large enough. However, there is a positive externality effect for France which allows it to benefit from integration when the externality is large enough.

The France-Portugal is an example where the long-run effects of integration reverses the short-run effects. In the short-run France benefits from integration, but not in the long-run, while Portugal growth rate decreases at the time of integration. This is because Portugal has an advantage in terms of productivity in the non-tradable sector ($\mathscr{A} = 3.12$). In the short-run, both returns on capital converge and Portugal suffers from a negative price effect. The positive effect of externality in education for Portugal ($\rho_{-1} = 0.63$) is not large enough to compensate this negative effect. Reversely, in the long-run, the externality in education is endogenously determined and exceeds the negative price effect.

7. Economic integration and the rise of the human-capital-intensive sector

With Cobb–Douglas preferences, the share of tradable and non-tradable consumption in total consumption expenditure is constant. This implies that the share of human capital allocated to non-tradable sector h_N is constant, and so is $P_N Y_N / Y$.[14] Section 2 pointed out that, empirically both the share of non-tradable consumption and the allocation of human capital in the non-traded sector increase with GDP. The previous version of the model is analytically tractable but does not fit this empirical evidence. In this section, we consider the share of non-tradable consumption in total consumption expenditure that depends on human capital. In such a setting, the increase in human capital also entails the growth in the production of non-tradable goods in line with empirical evidence. As Herrendorf et al. (2013), we use a functional form for agents' preferences, which allows the allocation of consumption spendings between the two goods to change with income. We assume non-homothetic preferences, changing Eq. (11) into:

$$\max_{x_{Tt}, x_{Nt}} x_{Tt}^{\mu} [x_{Nt} + \overline{C}]^{1-\mu} \quad ; \quad \overline{C} > 0$$
$$\text{s.t} \;\; \pi_t x_t = P_{Nt} x_{Nt} + x_{Tt} \tag{47}$$

with $x = c, d$, $\overline{C}$ being a constant level of consumption in non-traded goods. Agent's optimal choices give:

$$P_{Nt} x_{Nt} = (1-\mu)\pi_t x_t - \mu P_{Nt} \overline{C} \quad ; \quad x_{Tt} = \mu \pi_t x_t + \mu P_{Nt} \overline{C}$$

The share of non-tradable consumption in total consumption expenditure is now given by:

$$\frac{P_{Nt} x_{Nt}}{\pi_t x_t} = (1-\mu) - \frac{\mu \overline{C}}{P_{Nt}^{\frac{\alpha_N}{\alpha_T - \alpha_N}} (1-\beta)(1-\alpha_T) A_T B^{\alpha_T} h_t} \tag{48}$$

Notice here that a rise in P_N increases the share of the non-tradable consumption in total consumption spending. This is due to the fact that there exists a fixed minimal level of non-tradable good consumption and that a rise in P_N is associated to an increase in wages. With integration, countries with an initially high interest rate (i.e. countries with an initially low level of relative price due to a high productivity in the non-tradable sector for example), experience an increase in capital inflows, human capital accumulation and a rise in relative price. This rise in relative price affects the allocation of consumption spendings between the two goods only when preferences are non-homothetic.[15] Here, integration - through a rise in h and an increase in P_N - increases the share of consumption spending allocated to non-tradable goods. This may temporarily reinforce the effects of integration. Even if human capital can grow indefinitely, the share of the non-tradable consumption asymptotically converges to a maximal level $1-\mu$. This means that the long-term results presented in previous sections (Cobb-Douglas case) are relevant to describe economies with structural change once they have converged to a BGP - along which the share of non-tradable goods in total consumption expenditure approaches a constant value.[16] Before achieving such a long-term state, the share of non-tradable goods increases with human capital. We then have to ensure that the analysis of the short-run effects conducted in Section 5.2 is still relevant. To achieve this aim, we examine whether, in

[14] Eq. (16)gives non-tradable consumption in total consumption expenditures equal to $1-\mu$. This property implies that the share of human capital employed in the non-traded good sector h_N is constant (see Eqs. (4) with (7) and (21)), so does the share of each sector in GDP. Indeed, using (2), (4) and (7) we have $\frac{P_N Y_N}{P_N Y_N + Y_T} = \frac{h_N(1-\alpha_T)}{1-\alpha_T+(1-h_N)(\alpha_T-\alpha_N)}$.

[15] In the simple Cobb-Douglas case, the allocation spending of consumption between the two goods is constant.

[16] We call it asymptotic BGP because BGP cannot be reached but is gradually achieved when time goes to infinity.

the presence of structural change, short and long-term consequences of economic integration in terms of growth may still differ.

To evaluate the costs or benefits of economic integration at the time of integration we proceed as previously, by comparing the growth rates in autarky with the growth rates right after integration (using respectively Eq. (43) for the domestic economy and (45) for the foreign one). Eqs. (44) and (46) are no longer valid since expenditures on non-tradable goods now increase with human capital h - both in autarky and also right after integration according to Eq. (48). Since there is no reason to assume that countries have reached their BGP before integration, the level of human capital at the time of integration determines both the autarky relative price and the relative price right after economic integration. We can see this by examining the dynamic equation characterizing equilibrium paths. In autarky, Eq. (25) is modified and depends on the level of development of the country (through h_{t+1}):[17]

$$P_{Nt+1}^{\frac{1}{\alpha_T-\alpha_N}} + \frac{2\mu\overline{C}B^{1-\alpha_T}P_{Nt+1}^{\frac{1-\alpha_N}{\alpha_T-\alpha_N}}(\alpha_T-\alpha_N)}{\eta\alpha_T A_T h_{t+1}} = \frac{\beta\zeta}{b\gamma aB\eta}P_{Nt}$$

We can also show that the share of human capital in each sector h_N increases with both the level of human capital and the relative price of non-tradable goods.[18]. These two characteristics are consistent with empirical evidence (see Section 2). Additionally, we can notice that for a given P_{Nt}, a rise in h_{t+1} increases the consumption of non-tradable goods and the allocation of resources towards the non-tradable sector, which entails a rise in P_{Nt+1}, at least outside the BGP. This is in line with Berka et al. (2018), who show that the Balassa–Samuelson effect holds for European countries.

Due to externalities in education and to the fact that human capital stocks now matter for the allocation of consumption spendings between the two goods, the dynamic system characterizing the equilibrium paths in an international context, (34) and (35), becomes:[19]

$$k_{t+1} = P_{Nt+1}^{\frac{1}{\alpha_T-\alpha_N}}B\eta - \frac{2\mu\overline{C}P_{Nt+1}^{\frac{1-\alpha_N}{\alpha_T-\alpha_N}}B^{1-\alpha_N}}{h_{t+1}A_N D} + \frac{(1-\zeta)\beta P_{Nt}}{b\gamma a\left(\frac{1+\rho_t}{2}\right)^{\lambda}}$$

$$k^*_{t+1} = (P_{Nt+1}\mathscr{E})^{\frac{1}{\alpha_T-\alpha_N}}B^*\eta^* - \frac{2\mu^*\overline{C}\,(P_{Nt+1}\mathscr{E})^{\frac{1-\alpha_N}{\alpha_T-\alpha_N}}B^{*1-\alpha_N}}{h^*_{t+1}A^*_N D} + \frac{(1-\zeta^*)\beta^*(P_{Nt}\mathscr{E})}{b\gamma^* a\left(\frac{1+\rho_t}{2\rho_t}\right)^{\lambda}}$$

Finally, the main differences between the Cobb-Douglas case and the non-homothetic preferences lies in the short-run. However, we still observe that the short-term effect of economic integration does not presume of the long-term effect. This conclusion is valid with or without the presence of structural change.

This section helps highlighting the fact that capital market integration could be a source of structural change and could explain the rise of the service-skilled intensive- sector observed in many developed integrated economies. We contend that this constitutes an interesting line of future research, enabling one to take into account additional effects of economic integration.

8. Conclusion

The disagregation of the standard one-sector setting into a two-sector model with production of tradable and non-tradable goods helps to account for effects of economic integration. We have shown that the rate of time preference and the degree of altruism are not the only factors determining whether a country benefits or not from integration. The comparative advantage of the country in the tradable sector as well as the taste for non-tradable goods are crucial factors to consider in order to determine whether integration is good or bad for growth. In a one-sector setting with physical capital accumulation, the impatient country always benefits from integration in both the short and the long-run. In a one-sector setting with both human and physical capital accumulation, the patient country may benefit from integration both in the short and in the long-run if this country has a high rate of altruism. We show that in a two-sector setting with both human and physical capital accumulation, this patient country may also benefit from integration if this country has a relative advantage in producing the non-tradable goods and/or a high preference for tradable goods. Using a calibration, we show that the UK benefits from integration with France both at the time of integration and in the long-run. Conversely, France benefits of integration with Portugal in the short-run but experiences a decrease in its long-run growth rate.

From a policy perspective, we reveal that providing funds to increase the transboundary externalities in education is favorable to reduce cross country disparities. However, less advanced country being particularly unproductive in the tradable sector, we have then shown that in the short run economic integration may exacerbate this disparity, improving the growth rate in the more advanced country and reducing it in the less advanced ones. As a result, the interpretation of observations of short-term growth variations must

[17] Details for computations are available upon request.

[18] The share of human capital allocated to the non-tradable sector in autarky is:

$$h_{Nt} = \left[1 - \left(\eta + \frac{2\mu\overline{C}B^{1-\alpha_T}(\alpha_T-\alpha_N)}{\eta\alpha_T A_T h_t P_{Nt}^{\frac{\alpha_T}{\alpha_T-\alpha_N}}}\right)\right]\frac{\alpha_T(1-\alpha_N)}{\alpha_T-\alpha_N}$$

[19] The variables h_{t+1} and h^*_{t+1} affect the non-tradable market clearing conditions. Details for computations are available upon request.

be done with care: an increase or decrease in the growth rate in the years following the integration does not mean that integration will be favorable / unfavorable in the long run.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmacro.2018.05.007.

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