Increasing returns, migrations and convergence

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Abstract

The paper investigates the link between convergence and factor mobility. It contrasts the predictions of exogenous growth models (where factor mobility is found to promote convergence) with endogenous growth models (where factor mobility invariably leads to a cumulative process of regional divergence). The paper develops a simple model of regional growth with mobile factors, increasing returns to scale and diminishing returns to the reproducible factor. It also tries to provide more solid microfoundations to the specification of the migration choice. Because of diminishing returns to the reproducible factor, the economy will not be able to generate endogenous self-sustaining growth. Nevertheless, the results suggest that, even in the context of an exogenous growth model, convergence is not warranted. However, convergence may occur, for some particular constellations, despite the presence of increasing returns to scale. More precisely, it is shown that convergence is more likely the greater is the scope for scale economies and (somewhat paradoxically) the lower is the degree of labor mobility.

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1. Introduction

Despite the optimism of conventional growth theory, regional disparities appear to be disconcertingly persistent. Even within Europe, there is little sign that backward regions, say in Italy or Spain, have made significant headway in
reducing their income gap with respect to more advanced regions. In addressing these issues, the 'convergence' literature has examined in particular first whether low-income countries grow more rapidly (after controlling for the determinants of their steady state income) than relatively richer countries, and second whether convergence is affected by trade and/or factor mobility. Theory alone does not provide clear-cut answers to these questions. For instance, the standard neoclassical growth model predicts that low income countries will grow more rapidly than relatively richer ones and that factor mobility will typically enhance the convergence process. In a two-factor world, for instance, it will take only one (fully) mobile factor to achieve instantaneous convergence. In contrast, endogenous growth models are less sanguine about convergence. However, if capital is mobile, convergence in per capita GNP should be observed (Rebelo, 1991). Finally, economic geography models (Krugman, 1991a,b; Matsuyama, 1991; Faini, 1984) tend to predict that a pattern of regional economic concentration will emerge, if increasing returns to scale are sufficiently pervasive (and transport costs are not too high).

The available empirical evidence seems to support the neoclassical model (Barro and Sala-i-Martin, 1991, 1992; Mankiw et al., 1992) and suggests that freer commodity trade plays a crucial role in fostering convergence (Ben David, 1993, 1994). Allowing for factor mobility however makes it harder to reconcile empirical findings and theoretical predictions. First, controlling for migrations does not appear to affect the rate of convergence. Second, both in Europe and the U.S., the rate of convergence within regional economies is too slow when compared to that predicted by a neoclassical model with capital mobility (Barro et al. (1992) argue that this finding can be explained by capital market imperfections). Notice that the convergence literature normally assumes that economies will approach their steady state in a linear way. While this approach is grounded in the neoclassical growth model, it neglects some of the original insights of the early regional development literature. In his classical paper, Williamson (1965) argues that regional inequalities are likely to increase in a first phase of economic development and to decline later, in a mature phase of the growth process. Convergence, in this framework, should occur only after a period where poor and rich economies have grown increasingly apart.

The purpose of this paper is to investigate the link between convergence and factor mobility. The issue has been studied, among others, by Bertola (1992), Burda and Wyplosz (1992), Rauch (1994) and Reichlin and Rustichini (1993). All of them rely on endogenous growth models. Typically, the market outcome is found to be inefficient because of either human (Burda and Wyplosz, 1992) or physical

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1 See de la Fuente and Vives (1995) and Goria and Ichino (1994) for an analysis of the growth performance of the backward regions in Spain and Italy respectively.

2 For an opposing view, based on a simulation model, see however Taylor and Williamson (1994).
(Bertola, 1992) capital externalities. Moreover, introducing factor mobility invariably leads to a cumulative process of regional divergence (Reichlin and Rustichini, 1993; Rauch, 1994; Bertola, 1992). In this paper, we take a somewhat different route and develop a simple model of regional growth with mobile factors, increasing returns to scale and diminishing returns to the reproducible factor. We also try to provide more solid microfoundations to the specification of the migration choice. Because of diminishing returns to the reproducible factor, the economy is incapable of generating endogenous self-sustaining growth. Nevertheless, our results suggest that, even in the context of an exogenous growth model, convergence is not warranted. However, convergence may occur, for some parameter constellations, despite the presence of increasing returns to scale. More precisely, we show that convergence is more likely when scale economies are not too strong and (somewhat paradoxically) when labor mobility is limited. We also argue that, if properly extended, this framework can account for Williamson’s inverse U-pattern of regional inequalities.

The paper is organized as follows. In the next section, we present a simple model of growth and migration. We then turn in Section 3 to the analysis of the growth interaction between a backward and an advanced region. Section 4 concludes the paper.

2. A model of migration and growth

2.1. The households

As in Reichlin and Rustichini (1993), we rely on a simple overlapping generation framework. Consumers are assumed to live two periods. In period 1, they earn the prevailing wage, $W$, consume the quantity $C < W$ and save $W - C$. In period 2, they do not work and consume all their assets, leaving no bequests. Capital fully depreciates in one period. Utility is isoelastic in total consumption. Consumers must also decide whether to live in their own region or to migrate. There are two alternative locations, the North ($n$) and the South ($s$). Formally, a household planning to live in region $j$ ($j = n,s$) maximizes

$$\max U^j = \left(\theta^j C_t\right)^{1-\sigma} \frac{1}{1 - \sigma} + \frac{1}{1 + \delta} \left(\theta^j C_{t+1}\right)^{1-\sigma}$$  \hspace{1cm} (1)

s.t.

$$C_t + S_t = W_t^j$$  \hspace{1cm} (2)

\footnote{The assumptions of finite life for consumers and full depreciation for capital allow to analyze the location choice for both factors in a one-period set-up.}
and
\[ S_t(1 + \rho) = C_{t+1} \]  
(3)
where \( S \) denotes saving, \( \delta \) is the discount rate, \( \sigma \) is the intertemporal elasticity of substitution, \( \rho \) is the interest rate, \( \theta^j \) is a parameter which depends on location and superscripts refer to alternative locations. Manipulation of the first-order condition yields
\[ \frac{C_{t+1}}{c_t} = \left[ \frac{1 + \rho}{1 + \delta} \right]^{1/\sigma}. \]  
(4)
Substituting Eq. (4) in Eq. (1) and using the intertemporal budget constraint, we can derive the optimal level of utility for a household living in region \( j \) as a function of that region’s wage, the discount and the interest rate:
\[ u^* = (\theta^j W^j) \left( \frac{1 - \sigma}{1 - \sigma} \right) \left[ (1 + \delta)^{1/\sigma} + (1 + \rho)^{(1 - \sigma)/\sigma} \right]^{\sigma}. \]  
(5)
At time 1, individuals must also choose where to live. We assume that consumers have a preference for living in their region of birth. More precisely, we postulate that for a consumer living in his region of birth (say \( j \), where he earns the wage \( W^j \), the preference parameter will satisfy \( \theta^j = \theta > 1 \). In region \( k \), he would earn the wage \( W^k \) (where presumably \( W^k > W^j \)), but \( \theta^k \) would be equal to one. \(^4\) That is, migration implies a fall in \( \theta^j \) from \( \theta \) to 1. The resulting decline in utility (for a given wage differential) reflects well-known social and psychological costs associated with migration, in particular the loss of social relationships and the need to adapt to a new environment. The size of the parameter \( \theta \) is presumed to capture the home-market bias in the locational choice. For a fuller discussion of this effect and some empirical evidence, see Djajic and Milbourne (1988) and Faini and Venturini (1994).

From the previous discussion, it is clear that rational consumers will not move unless the wage differential covers the disutility costs of migration. As a result, only individuals from the low-wage region will migrate. Consider for concreteness a consumer located in the South. He will move if \( U^{*n} > U^{*s} \), i.e. if his intertemporal utility in the North is higher than in the South. With integrated capital markets, the interest rate will be the same over regions. The migration condition \( U^{*n} > U^{*s} \) is then equivalent to
\[ W^n > \theta W^s. \]  
(6)
\(^4\) Migrants could choose to retire in their own region of birth. The migration condition becomes then more complicated, but can still be reconciled with Eq. (6) in the text through a simple linear expansion. Alternatively, one could assume that returning migrants after spending one period abroad become indifferent between amenities at home and abroad. Formally, this would imply that \( \theta = 1 \) also for returning migrants. In both cases, migrants would be temporary.
Suppose now that individuals in each region differ in their degree of preference for the home region. It is analytically convenient to assume that the parameter $\theta$ is distributed according to a Pareto function:

$$f(\theta) = \frac{\epsilon X_0^\epsilon}{\theta^{\epsilon+1}}, \quad \theta \in [X_0, \infty), \quad \epsilon > 0$$  \hfill (7)

where $\epsilon$ is a parameter of the Pareto distribution. The fraction of the initial population which remains in the South is:

$$\chi = \int_{W^n/W^s}^{+\infty} f(\theta) \, d\theta = x_0^\epsilon \left( \frac{W^n}{W^s} \right)^\epsilon.$$  \hfill (8)

Therefore, the percentage of the population which moves $(1 - \chi)$ will increase with the wage differential $(W^n/W^s)$.

In what follows, we shall assume that the distribution of $\theta$ is stable over generations. We will however investigate the implications of exogenous variations in $\epsilon$. It is easy to check that an increase in $\epsilon$ corresponds both to a decline in the average value of the locational preference parameter $(\theta)$ and to a reduction in $\chi$, namely the percentage of the Southern population that does not migrate. The parameter $\epsilon$ can then be considered an indicator of the degree of labor mobility.

2.2. The producers

We rely with a few modifications on the set-up of Faini (1984). We distinguish two production sectors. The first sector produces a good which is freely traded at a fixed world price. Production of the traded good ($Q_T$) is described by a first-degree homogeneous function of labor ($L$), capital ($K_T$) and non-traded inputs ($Q_N$). We postulate a Cobb–Douglas functional form:

$$Q_T = F(L, K_T, Q_N) = L^\alpha K_T^\beta Q_N^{1-\alpha-\beta}.$$  \hfill (9)

The output of the traded goods sector can either be used as a consumption good or transformed, at an increasing cost, into a capital good. The second sector produces a non-traded good used as input for traded goods production. Production of non-traded goods is assumed to be a function of capital only. Returns to scale are...
increasing at the firm's level and the elasticity of output with respect to capital is constant:

\[ q_N = k_N^\phi, \quad \phi > 1, \quad (10) \]

where \( q_N \) and \( k_N \) indicate respectively the output level and the stock of capital of the representative firm in the non-traded goods sector.

At each point in time, the regional stocks of both capital and labor are fixed. Within each region, however, capital moves freely between the two sectors. The intersectoral allocation of capital will be determined by the condition that the value of the marginal productivity of capital be the same in the traded and the non-traded goods sector. Producers of traded goods behave competitively in all markets. Producers of non-traded goods take the rental rate of capital as given, but exploit their market power in the output market. In modelling imperfect competition, we rely on a simple Cournot framework with homogeneous products. Producers of non-traded inputs take therefore their competitors' output as given and charge a mark-up over their costs of production. This mark-up is a decreasing function of the price elasticity of the demand for non-traded inputs and of the number of competitors. Let \( \eta \) be the price elasticity of (total) demand for \( Q_N \).

Profit maximization requires that perceived marginal revenue be equal to marginal costs:

\[ P_N \left( 1 - \frac{1}{\eta m} \right) = R \frac{\delta k_N}{\delta q_N} \quad (11) \]

where \( P_N, k_N, R \) and \( m \) stand respectively for the price of non-traded goods, the representative firm's stock of capital, the rental rate and the number of firms in the non-traded goods sector. After some simple algebra, we find that

\[ P_N q_N \left( \phi \left( 1 - \frac{1}{\eta m} \right) \right) = R k_N \quad (12) \]

where \( \phi > 1 \) denotes the elasticity of \( q_N \) with respect to capital inputs (see Eq. (10)). Free entry will drive profits to zero, i.e. \( P_N q_N = R k_N \). From Eq. (12), we see that this implies that

\[ \phi \left( 1 - \frac{1}{\eta m} \right) = 1. \quad (13) \]

Suppose that the price elasticity of demand \( \eta \) is fixed. Eq. (13) will then determine the number of active firms \( (m^*) \) in the non-traded goods sector. Notice that total output, \( Q_N \), can be written as \( m^* q_N = m^* (k_N)^\phi = m^* (K_N/m^*)^\phi = \)

\[ \text{8 Faini (1984) provides considerable evidence that the production of non-traded inputs for the manufacturing sector is subject to increasing returns to scale. This assumption however is not essential. See footnote 10 for an alternative approach.} \]
We see therefore that the elasticity of aggregate output with respect to aggregate capital in sector $N$ is also equal to $\phi$. Notice also that the price elasticity of demand for $Q_N$ is a function of technological conditions in the traded goods sector. Suppose that capital is perceived to be fixed by each firm in the traded goods sector. Then the price elasticity of demand for $Q_N$ can be shown to be equal (in absolute value) to $(1 - \alpha)/\beta$. In equilibrium, therefore, $m^*$ will be equal to $\phi\beta/[(1 - \alpha)(\phi - 1)]$. The equilibrium number of firms is therefore a declining function of the strength of increasing returns (i.e. of $\phi$).

Given increasing returns to scale in the production of $Q_N$, the model is able to generate endogenous growth. The condition for endogenous growth can be easily derived. Let express Eq. (9) in growth terms:

$$Q'_T = \alpha L' + \beta K'_T + (1 - \alpha - \beta) Q'_N = \alpha L' + \beta K'_T (1 - \alpha - \beta) \phi K'_N$$

(14)

where a prime indicates a proportional rate of growth. It can be shown that $K'_N = K'_T$ even in the short run. Suppose on the contrary that capital grows relatively more rapidly in the traded goods sector. We will have two effects: first, output growth in the traded goods sector will exacerbate the pressure on wages; second, the growth in $K_T$ will lead to an expansion in the demand for $Q_N$ which in turn will lead to higher prices for non-traded goods. Under both counts, the return to capital in the traded goods sector will decline. At the same time, the increase in both $P_N$ and $Q_N$ will boost the return to capital in the non-traded goods sector. Only if $K'_N = K'_T$, will the value of the marginal productivity of capital be the same across sectors. 9 10

As usual, for endogenous growth to arise, the output elasticity of reproducible factors must be at least one, i.e. $\beta + (1 - \alpha - \beta)\phi \geq 1$. As mentioned earlier, in what follows we will assume that the technology is not able to generate endogenous growth, i.e. $\beta + (1 - \alpha - \beta)\phi < 1$.

To conclude the description of production, we need to discuss the impact of capital and labor growth on factor returns. The impact of a proportional expansion

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9 Formally, the proportional change in the value of the marginal productivity in the traded and in the non-traded goods sector are respectively equal to $R_T = -\alpha/\beta W' + (\alpha + \beta - 1)/\beta P_N'$ and $R_N = Q_N - K'_N + P_N'$. Recalling that $K'$ is a weighted average of $K'_N$ and $K'_T$ substituting the demand function for $Q_N$ and imposing $R_T = R_N$ yields the desired result. In terms of Rauch's (1994) terminology, our model exhibits balanced (sectoral) growth.

10 An alternative (and somewhat simpler) way to derive our results is to assume that production of non-traded inputs exhibits constant returns of scale (so that $Q_N = K'_N$), but the output of the non-traded goods sector has a positive external effect on the production of traded goods. It can be easily shown that in equilibrium $K'_T = K'_N$. Eq. (14) would then read as $Q'_T = \alpha L' + \beta K'_T (1 - \alpha - \beta) K'_N + \psi K'_N$, where $\psi$ measures the elasticity of the external effect. After some simple algebra, it can be shown that $R' = \alpha L' + (\psi - \alpha) K'$ and $W' = (1 - \alpha + \psi) K' - (1 - \alpha) L$. These two expressions would substitute Eqs. (16)-(17) in the text. The analysis in Section 3 would then be virtually unchanged.
of capital in the two sectors will have an ambiguous effect on the price of non-traded goods. The reason is simple. Both the demand and the ‘supply’ of non-traded goods will shift, but non-traded goods producers will be able to exploit more fully the existence of scale economies. If increasing returns to scale are strong enough, $P_N$ will fall. The impact on the wage rate of a higher capital stock will be unambiguously positive. The growth of capital will indeed lead to a larger demand for the (given) quantity of labor. Finally, the impact of capital growth on the rental rate will be ambiguous: for instance, if $\beta + (1 - \alpha - \beta)\phi = 1$, aggregate returns to capital are constant. As a result, increases in the capital stock have no effect on the return to capital. If, as we assume, $\beta + (1 - \alpha - \beta)\phi < 1$, growth in the capital stock will be associated with a fall in the return to capital. The analysis of the effect of labor growth is even simpler. Labor growth will lead to a fall in the wage rate and an increase in the return to capital. Formally, we find that:

$$R' = \alpha L' - (1 - \beta - \phi \gamma) K'$$

and

$$W' = (\beta + \phi \gamma) K' - (1 - \alpha) L'$$

where $\gamma = 1 - \alpha - \beta$ is the output elasticity of non-traded inputs. We can easily check that, if $\phi = 1$, then both $R$ and $W$ depend only on the aggregate capital–labor ratio. Moreover, if $\beta + (1 - \alpha - \beta)\phi = 1$, then $1 - \beta - \phi \gamma = 0$ and the return to capital is independent of the capital stock.

3. Growth and factor mobility in a two-region economy

Macroeconomic equilibrium is determined by the interaction of saving, investment and factor location decisions in the two regions. Labor and capital are assumed not to move internationally, but may move across regional borders. We consider two cases depending on whether migrations respond to interregional wage differentials. At each point of time, producers must determine the allocation of capital among the two regions. With non-durable capital, this is the same as deciding the regional allocation of investment. As noticed earlier, regional investment is subject to convex installation costs. Capital therefore is less than fully mobile. In a closed economy equilibrium, aggregate saving would have to finance both the aggregate flow of investment and the installation costs. Fluctuations in the interest rate $\rho$ would in turn ensure that aggregate saving is equal to aggregate investment. Alternatively, we could assume that the two-region economy is open to foreign capital flows and that the interest rate is fixed at its world level. Saving and investment decisions are then taken independently and the aggregate current
account balance will hold only in a present value sense. In the remainder of this paper, we take this latter approach and assume that the interest rate \( p \) is fixed.\(^{11}\)

We can now examine the process of growth in the two regional economies. We first study the interregional allocation of investment. We assume that adjustment costs are a quadratic function of net investment.\(^{12}\) Capital growth in region \( j \) will then be equal to

\[
\frac{dK^j}{dt} = -\frac{1}{\xi} R^j, \quad j = N, S, \tag{18}
\]

where \( \xi \) is a parameter of the adjustment cost function.

In what follows, it is more convenient to express our model in logarithmic terms. Let lower case letters denote logarithms. Variables with no superscript are henceforth used to define log-differentials across regions: \( r = r^n - r^s = \ln R^n - \ln R^s, k = k^n - k^s, \) etc. From Eq. (18), we see that the difference in the growth rate of capital among the two regions \( (\dot{k}) \) will be equal to zero if and only if \( R^n = R^s \), i.e. if \( r = 0 \). In Fig. 1, the \( \dot{k} = 0 \) schedule is therefore depicted as an horizontal line at \( r = 0 \). If \( r \) is positive, capital will grow more rapidly in the North than in the South.

We must now express the relationship between the (relative) rental rate, \( r \), and the relative stock of capital, \( k \). From Eq. (16), we know that the marginal productivity of capital in each region is a function of the regional stocks of labor and capital. Given the assumption that production in both sectors can be described by a Cobb–Douglas function, the elasticities of factor prices with respect to capital and labor will be constant.\(^{13}\) Hence,

\[
r = r^n - r^s = \alpha(l^n - l^s) - (1 - \beta - \phi \gamma)(k^n - k^s) = \alpha l - (1 - \beta - \phi \gamma)k
\]

and

\[
w = w^n - w^s = (\beta + \phi \gamma)k - (1 - \alpha)l. \tag{20}
\]

To study the pattern of interregional growth, we need only to determine how labor will be allocated between the two regions. To do so, however, we must make explicit our hypotheses about the migration of labor. We first consider the case where labor does not move across regional borders.

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\(^{11}\) With fixed discount rates and interest rates, however, households will have an incentive to accumulate or decumulate foreign assets depending on whether \( p > \delta \) or \( p < \delta \) respectively. In what follows, we assume \( p = \delta \) to rule out such behavior.

\(^{12}\) Formally, the adjustment cost function is \( \xi(K_{t+1} - K_t)^2/(2K_t) \). It is implicitly assumed that, even though capital fully depreciates after one period, there are still costs associated with changes in the size of productive capacity. Notice also that in a full intertemporal model investors would take into account that by investing more today they would reduce the costs of capital installation tomorrow. In this model, short-lived selfish investors are assumed to neglect this effect.

\(^{13}\) If production relationships are not of the constant elasticity type, our results are only valid locally.
3.1. The immobile labor case

Consider first the case where labor is immobile across regions. Suppose also that population \( (L^1) \) is the same in the two regions. With labor immobility and initially equal population, \( l = \ln L^N - \ln L^S \) will be equal to zero. The relative marginal productivity of capital \( (r) \) will then be simply equal to \(- (1 - \beta - \phi \gamma) k\). Provided therefore that \((1 - \beta - \phi \gamma) > 0\), an increase in the relative capital stock in the North will lead to a reduction in the relative rental rate. This relationship is depicted in the curve \( rr \) in Fig. 1. Equilibrium will always lie on the schedule \( rr \). When above (below) the \( k = 0 \), the (relative) capital stock will increase (decline). It is easy to check that \( k \) and \( r \) will converge at a point where both are equal to zero. Therefore, even with increasing returns to scale, regional growth will be balanced. If a region, say the North, starts with a relatively larger stock of capital, it will grow more slowly than the other region, until the capital stocks are equalized. The model therefore predicts full convergence, in spite of the existence of increasing returns to scale. The explanation is simple. With diminishing

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14 In terms of the model of Section 2, this can be formalized by assuming that \( \epsilon = 0 \). From Eq. (8), we see that \( \chi \) is then equal to one, namely that migrations are nil.

15 From Eq. (15), we see that, with fixed labor, faster capital growth will imply faster growth in per worker GDP.
returns to capital, a larger capital stock in the North will imply a lower return to capital. Wages will be higher in the North, but with immobile labor this will not prompt workers to leave the South. As a result, investors will find it more profitable to allocate a relatively larger proportion of capital to the South. As we shall see in the next section, relaxing the assumption of immobile labor leads to a dramatic change in the conclusion.

3.2. Introducing migrations

Let us turn to the situation where \( \epsilon \) is different from zero and, in each period, a finite flow of migration takes place from the low- to the high-wage region. We saw in Section 2 that a proportion \( 1 - \chi \) of the local population will migrate from the low-wage region. We still assume that the initial population size \( (L') \) is the same in the two regions and is constant over time. \(^{16}\) Suppose for concreteness that the North is the high-wage region. Labor supply will then be equal to \( \chi L' \) and \( (1 + 1 - \chi)L' \) in the South and in the North respectively. Taking logs and using the approximation \( \ln(1 + x) = x \), \(^{17}\) we find that \( l^n = \ln(\chi) + \hat{l} \) and \( l^n = -\ln(\chi) + \hat{l} \). Therefore,

\[
\hat{l} = \hat{l} + \hat{l} = \hat{l} + \hat{l}.
\]

We can substitute the expressions for \( \hat{l} \) and \( \hat{l} \) in the equation for \( w = w^n - w^* \). If we assume for simplicity that \( x_0 = 1 \), \(^{18}\) we find after some simple algebra that

\[
w = \frac{1}{1 + (1 - \alpha)2\epsilon \beta + \phi \gamma} k.
\]

Eq. (22) describes the relationship between the relative wage levels and the relative capital stocks. It incorporates two effects. First, a rise in the wage rate will lead, because of migrations, to an increase in the supply of labor. Second, a larger stock of labor will be associated with a decline in the wage rate (Eq. (17)). An

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\(^{16}\) The assumption of constant regional populations in spite of ongoing migrations can be rationalized by considering a guest-workers type of labor mobility. In this case, family reunification never occurs and it is perfectly legitimate to take the regions’ initial population to be constant in each period. Alternatively, we could assume that migrants return home after retiring and raise a family there (see footnote 4).

\(^{17}\) The approximation is valid only if \( 1 - \chi \) is close to one, i.e. if migrants are a small fraction of the sending region’s population. We are thus investigating only the dynamics of the economy in the neighborhood of the symmetric equilibrium where \( \chi = 1 \).

\(^{18}\) The assumption is made only for analytical convenience. It lends itself however to a simple interpretation. Recall first that the domain of the Pareto distribution function is defined over \( [x_0, +\infty) \). Assuming that \( x_0 = 1 \) therefore simply amounts to suppose that the locational preference parameter \( \theta \) never takes values less than one, i.e. that nobody in the sending region population has a preference for living abroad.
increase in the relative capital stock would shift the latter relationship to the right, resulting in a higher (relative) wage. From Eq. (22), we see that the effect of an increase in \( k \) on wages will be dampened by a strong response of migrations to the wage differentials. Indeed, the initial increase in the regional wage differential would prompt a substantial reallocation (through migrations) in the supply of labor that would limit the size of the wage increase. In turn, the responsiveness of migrations to wages is increasing in the value of \( \epsilon \) (Eq. (8)). Therefore, Eq. (22) shows that, if labor mobility is high, i.e. if \( \epsilon \) is large, an increase in the stock of capital in either region will have only a limited effect on (relative) wages.

To study the dynamics of our two-region economy, we must determine what happens to the relative rental rate \( (r) \). We can follow basically the same procedure used to derive Eq. (22). We first substitute the two (approximate) identities for \( I_s \) and \( I_n \) in Eq. (16) and express the rental rate in each region as a function of its capital stock, its initial labor force and the share of immigrants (emigrants). After computing the rental rate differentials between the North and the South, we use Eq. (8) to express the flow of migrants as a function of the wage differential. The wage differential is in turn a function of the relative capital stock (Eq. (22)). We can therefore express the relative rental rate as a function of the relative capital stock only. Recalling that \( \ln x_0 = 0 \) and \( \bar{I} = 0 \), some simple but tedious algebra yields

\[
\frac{1}{1 + (1 - \alpha)2 \epsilon} \left[ 2 \epsilon \gamma (\phi - 1) - (1 - \beta - \phi \gamma) \right] k. \tag{23}
\]

Again this is a remarkably simple and easy to interpret equation. The denominator is unambiguously positive. The numerator however could have either sign. Consider the case where \( \epsilon = 0 \). From Eq. (8), we know that a proportion \( \chi = 1 \) of the Southern population will stay home and no migration will take place. For \( \epsilon = 0 \), in other words, we are back to the case of full labor immobility. Eq. (23) shows in turn that \( r = - (1 - \beta - \phi \gamma) k \). This is exactly the result we found in the previous paragraph. Given the assumption \( (1 - \beta - \phi \gamma) > 0 \), the schedule \( rr \) will be negatively sloped, as in Fig. 1.

Suppose now that \( \epsilon \) increases from zero to some positive number. As noticed earlier, the increase in \( \epsilon \) corresponds to an increase in the percentage of the Southern population that does migrate. The effects of a greater labor mobility can now easily be traced. If the increase in \( \epsilon \) is not large enough to make the numerator of Eq. (23) positive, the schedule \( rr \) will still be negatively sloped, albeit flatter than in the case with \( \epsilon = 0 \). Convergence to the balanced regional equilibrium (point E in Fig. 1) will then be slower. If, on the other hand, the value of \( \epsilon \) is sufficiently large, the \( rr \) schedule will be positively sloped (Fig. 2). The two regional economies will then grow increasingly apart.

Scale economies will matter also, in the context of our model, in determining whether the final equilibrium will witness a full convergence (as in Fig. 1) or a process of regional polarization (as in Fig. 2). Consider first the case where \( \phi = 1 \).
With constant returns to scale in the production of non-traded inputs, convergence is unambiguous (the numerator of Eq. (23) is negative) and does not depend on the degree of labor mobility. Suppose however that $\phi$ increases. If $\phi > \phi^* = (1 - \beta + 2\epsilon\gamma)/(1 - \alpha - \beta + 2\epsilon\gamma) > 1$, the rr schedule will be positively sloped and the two regions will diverge. Moreover, Eq. (23) shows that the degree of labour mobility and the strength of increasing returns will interact in determining the slope of the rr schedule and thus the pattern of regional growth. Formally, let $\zeta$ be the slope of the rr schedule. It can be checked that $\partial \zeta / \partial \epsilon > 0$ (i.e. the slope of the rr schedule is an increasing function of $\epsilon$) and $\partial^2 \zeta / (\partial \epsilon \partial \phi) > 0$, namely that a higher degree of labour mobility is more likely to cause a process of regional divergence when economies of scale are pervasive. Therefore, strongly increasing returns to scale and a high degree of labour mobility have a mutually reinforcing effect in eliciting a pattern of diverging regional growth.

Overall, our results can be summarized as follows. Growth in our model will be either characterized by full income convergence across regions or by steadily widening interregional differentials of income. The final outcome is in turn a function of the behavioral and technological parameters of the model. In particular, diverging growth is more likely the more significant is the scope for economies of scale and the higher is the mobility of labor. The first result is certainly not unexpected. Strongly increasing returns to scale are certainly likely to
favor regional concentration. The second result is somewhat less intuitive but can be explained as follows. In our model, given the assumption that \((1 - \beta - \phi r) > 0\), the return to capital is a decreasing function of the capital stock in each region. If a region grows too fast, further growth will be checked by the existence of diminishing returns to capital. With a fixed supply of labor, wages will grow depressing the returns to capital. What migration does in this context is to relax the labor supply constraint in the North and avoid a precipitous fall in the marginal productivity of capital. \(^{19}\) As Eq. (23) shows, if labor mobility, as measured by \(\epsilon\), is large enough, the return to capital will be an increasing function of the capital stock, despite the assumption of diminishing returns to capital. Growth in the North is limited by the availability of migrant labor from the South.

Our model provides therefore a simple empirical prediction. With high labor mobility, growth in the North will not be immediately checked by diminishing returns to capital and the patterns of regional growth will tend to diverge. If labor, on the other hand, is sufficiently immobile, full convergence between the North and the South should be the rule. To get more detailed results, one would need more specific assumptions on how the mobility of labor changes over time and, in particular, responds to income changes. Suppose for instance that the degree of labor mobility, for a given interregional wage differential, is negatively related to the wage levels in the sending region. Theoretical and empirical evidence in support of this conjecture is provided by Faini and Venturini (1994), who argue that if income increases in the sending region, agents will be less propense to migrate and more willing to consume the greater amenities in their own region. In other words, migration is an inferior good and the propensity to migrate will decline with absolute income growth in the home region, even with unchanged wage differentials. Under this approach, provided that increasing interregional differentials are nonetheless associated with absolute income growth in the South, we may well have a pattern of diverging regional growth in an initial phase when labor mobility is high, followed by a period of low labor mobility where the backward region would catch up with the richer areas. This framework can therefore provide some theoretical underpinning to the findings of Williamson (1965).

4. Conclusions

This paper shows that the link between convergence, growth and factor mobility is a complex one. First, even in a model with increasing returns, we may

\(^{19}\) The analogies between this interpretation of the North–South relationship and the classical analysis of Lewis is remarkable. "When capital accumulation catches up with the labor supply, wages begin to rise above the subsistence level, and the capitalist surplus is adversely affected. However, if there is still surplus labor in other countries, the capitalists can avoid this in one of two ways, by encouraging immigration or by exporting their capital ..." (Lewis, 1954, p. 436).
witness a full long-run convergence of regional per-capita incomes. Second, the assumption of diminishing returns to the reproducible factor, and thus the absence of a process of self-sustaining endogenous growth, does not rule out the possibility that two regional economies may diverge. In general, we show that whether convergence occurs will depend on a number of critical technological and behavioral parameters.

Some extensions of the model are probably worth exploring. It would be useful, in particular, to assess the interaction of trade with growth and factor mobility (as in Panagariya, 1992), by allowing for a different pattern of specialization in the two regions. In the context of our model, for instance, the North may specialize in relatively high service-intensive productions. The model also lends itself to some relevant policy experiments. Suppose in particular that we introduce a national trade union. It has been argued (Burda and Funke, 1991) that a national trade union will induce a reduction in the interregional wage differential. By reducing the incentive to migrate, however, this may, somewhat paradoxically, favor the process of regional convergence.

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