Migration Selectivity and The Evolution of Spatial Inequality

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Abstract[1]

The basic neoclassical model of migration suggests that migration is induced by real income differentials across locations and will, ceteris paribus, serve to reduce those differentials. And yet the evidence on growing spatial inequality is clear, despite increased migration from poorer to richer areas. At a theoretical level, one route to addressing this potential inconsistency is to introduce agglomeration effects into the standard neoclassical setup. This paper explores an alternative route, based on a theoretical and empirical proposition of the migration literature, namely, that migration is a selective process. Focusing on skilled migration, the paper demonstrates the different forces in play that make selective migration a force for both divergence and convergence, and characterizes where each set of forces dominates. Finally, it explores the consequences for convergence of combining both migration selectivity and agglomeration effects arising from migrant networks.

Keywords: Migration, migration selectivity, human capital formation, convergence

Classification JEL: F22, J24, O15.

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1. Introduction

Despite continued migration from poorer to richer countries, and from poorer to richer areas within countries, spatial inequalities in incomes seem to persist. Indeed, there is evidence that they have been growing in the last two decades. On the face of it, this is a challenge to economists' basic neoclassical instincts, which suggest that migration which is induced by income differentials will, other things being equal, serve to reduce those differentials as the relative labor scarcity which started the process is mitigated by the migration. In this basic model, long run persistent real income differentials can only reflect costs of migration, be they natural or policy induced.

Of course, other things may not be equal, and we may be observing movements in real income caused by other processes, with migration forever playing catch up. Nevertheless, the empirical observation of persistent differentials in the face of migration poses a theoretical challenge—can the phenomenon be modeled without recourse to the processes driving technical progress staying a step ahead of migration?[2] In other words, could migration itself be causally linked to forces leading to a widening of differentials?

One route to addressing this challenge is to bring in agglomeration effects, as is done in the new economic geography.[3] In these models, as labor migrates in response to a real wage differential the size of the market grows in the destination region and, through a variety of mechanisms related to scale economies, the real wage in the destination region increases rather than decreases. The origin region is usually modeled "conventionally", with no agglomeration effects and perhaps even a fixed real wage. Thus as migration proceeds in this fashion, real income differentials between origin and destination region begin to grow. Eventually congestion costs do set in and dominate agglomeration benefits, so that the long run equilibrium in these models is still zero migration with equality of real wages. But at least over some ranges, the model generates the outcome that migration that is induced by income differentials serves to widen these differentials.

In this paper we follow a second route to addressing the theoretical challenge posed above, and we do so by focusing on the origin rather than the destination region. And we draw inspiration not from the new economic geography but from the heart of the migration literature itself. A central theme in this literature is that migration is a selective process.

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[2] Of course, we can also have models where regions converge without any migration taking place at all. Two isolated regions described by a Solow growth model with identical parameters will eventually converge to the same per capita income levels. In trade models, if the conditions for the factor price equalization are met, then wages will equalize even without labor (or capital) migration.

Potential migrants are heterogeneous, and the incentives to migrate affect the heterogeneous population differentially, so that the pool of migrants is not simply a statistically representative cross section of the origin population. Thus what is left behind after migration is not the composition that was there before, and this compositional effect can influence the growth of incomes in the origin region. If it can be shown that this effect is negative, at least over some ranges, we have another theoretical possibility for income differentials between origin and destination region to increase despite migration. Indeed, they increase despite migration.

This paper uses the metaphor of education selectivity in migration from poor to rich countries to illustrate our basic line of argument. Specifically, we ask the question—if educated (or skilled) migration is made easier from poorer or richer countries, is the outcome good or bad for poorer countries? The "brain drain" literature of the 1970s and 1980s suggested the outcome would be bad and, ceteris paribus, such migration would worsen income differentials between rich and poor areas. More recent literature has argued otherwise. We attempt to put the forces identified in these strands in a common framework and identify conditions under which one or other outcome is more likely. In addition we consider the effects of agglomeration effects in the destination area, not on real incomes in the destination region but in the area of origin, adding a new twist to the agglomeration effects channel. Although we will sue the language of inter-country migration, it should be clear that our analysis applies to migration between areas within a country as well.

Section 2 of the paper provides an assessment of the literature to date on skilled migration from poor to rich countries, focusing in particular on the consequences of such selectivity for poor countries. On the basis of this review of the literature, particularly its empirical findings, Section 3 develops a model of migration from rich to poor countries in which the education decision is endogenous to migration propensity. The effects of increasing migration propensity are then analyzed, and it shown that there are specific ranges where such an increase benefits the poor country, and specific ranges where it does not. The model is further extended to allow for migrant agglomeration effects in the destination region. Section 4 concludes the paper.

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[3] See Krugman (1991), Fujita, Krugman and Venables (1999), and, more recently, Venables (2003) and Henderson (2003).

2. Skilled Migration from Poor to Rich Countries: An Assessment

2.1. Background

Clearly, migrants do not constitute a representative sample of their origin country's population but tend to self-select according to specific characteristics. Although there is currently a controversy regarding a possible decline in the quality of immigration to the U.S., positive self-selection remains the rule. For example, Davis and Weinstein (2002) show that capital, skilled labor and unskilled labor flow to the US more or less according to existing factor shares in the US economy. Borjas (1999) submits that immigrants are in average less skilled than US natives after a reversal in the quality of immigration occurred in the course of the second "great migration" of the 1980s and on. However, if the reference group is the population remaining in the origin countries, it is clear that the typical immigrant is carrying with him or her much more human capital than the typical stayer after controlling for relevant characteristics (e.g., age, ethnic group, etc). Summarizing the data from the US 1990 Census, Carrington and Detragiache (1998) noted that: « The first striking feature of the US migration data is that immigration flows of individuals with no more than a primary education are quite small… Migrants to the United States tend to be better educated than the average person in their home and the proportion of very highly educated people who migrate is particularly high ».

These trends seem to have accelerated since the 1960s. In 1975, the United Nations estimated the total number of highly skilled South-North migrants for 1961-72 at only 300,000. Less than a generation later, in 1990, the U.S. Census revealed that there were more than 2.5 million highly educated immigrants from developing countries residing in the U.S. alone, excluding students! For that same year, the International Labor Organization estimated the total cumulative loss of "brains" by region at 15% (of the remaining stock of people with tertiary education) for Central America, 6% for Africa, 3% for South America, and 5% for Asia. Country studies commissioned by the ILO also showed that nearly 40% of Philippines' emigrants are college educated, and, more surprisingly, that Mexico in 1990 was the world's third largest exporter of tertiary educated migrants (ILO, 2001).

Although the numbers may be disputable, it is clear that the brain drain has increased dramatically over the last two decades.[4] This is due partly to the introduction of 'quality-selective' immigration policies in most OECD countries: screening was gradually introduced in these countries since the 1980s; point-systems favoring educated migrants were first put in

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[4] See Commander et al. (2003) for a review of the evidence and theoretical literature on the brain drain.

place in Australia and Canada in the early 1980s, and it has been argued that such point-systems explain the higher quality of immigrants to Canada or Australia compared to the US, even after controlling for country of origin (Antecol et al., 2000). The US has also introduced programs to raise the number of skilled professionals and highly educated migrants (H1-B visa programs in the late 1980s), but immigration policy is still dominantly targeted towards family reunion and asylum seekers. Policy debates on the quality of immigration, however, are gaining momentum in the US, and vibrant calls are heard to reform immigration policy towards more quality selection on the ground that the current pattern brings about marginal efficiency gains and contributes to increased inequality within the US (Borjas, 1999). From our perspective, however, the crucial point is that such screening devices, alongside self-selection effects, further distort the emigration structure of developing countries toward the upper end of the skills distribution. The question we may want to ask, therefore, is whether such migration patterns contribute to a worsening of inequality at the international level.

2.2. Traditional versus new economic approaches

The conventional view on highly skilled emigration from developing to developed countries is extremely negative and presents the emigration of its "best and brightest" as a curse for source countries. This view, developed notably by Jagdish Bhagwati and his co-authors in the early 1970s, submits that : i) the brain drain is basically a negative externality imposed on those left behind; ii) it amounts to a zero-sum game, with the rich countries getting richer and the poor countries getting poorer; and, iii) at a policy level, the international community should implement a mechanism whereby international transfers could compensate the sending countries for the losses incurred as a result of the brain drain; for example, through an income "tax on brains" (also coined the « Bhagwati tax ») to be redistributed internationally.[5] Such a view, still dominant in most international forums, is perfectly illustrated in the following citation from a classical textbook in development economics:

> *"The irony of international migration today is that … many of the people who migrate legally from poor to richer lands are the very ones that Third World countries can least afford to lose: the highly educated and skilled. Since the great majority of these migrants move on a permanent basis, this perverse brain drain not only represents a loss of valuable human resources but could prove to be a serious constraint on the future economic progress of Third World nations"* (Todaro, 1996: 119).

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[5] See Bhagwati and Hamada (1974) and the special issue of the Journal of Public Economics edited by Bhagwati on "Income taxation in the presence of international personal mobility", August 1982.

Obviously, the brain drain may also induce positive feedback effects such as remittances and return migration after additional skills have been acquired abroad. However, such potential positive feedbacks are known to be negligible in the case of highly-skilled migrants. In the case of remittances, we know from household surveys that transfers from educated migrants are not necessarily higher than for uneducated migrants; the former have higher earnings potentials, but migrate on a more permanent basis (with family) and, hence, tend to remit relatively less than their unskilled compatriots. This is confirmed at an aggregate level by Faini (2002), who shows that migrants' remittances decrease with the proportion of skilled individuals among emigrants and concludes that "this result suggests that the negative impact of the brain drain cannot be counterbalanced by higher remittances" (Faini, 2002, p. 86).

We also know that in general, return migration is not significant for the highly educated. In fact, return migration is characterized by « negative selection » (Borjas and Bratsberg, 1996) and is very unlikely in the case of highly skilled migrants unless sustained growth preceded return. For example, less than a fifth of Taiwanese PhDs who graduated from US universities in the 1970s returned to Taiwan (Kwok and Leland, 1982) or Korea, a proportion that rose to about two-thirds in the 1990s, after two decades of impressive growth in these countries. Similarly, Saxeenian (2001) shows that despite the quick rise of the Indian software industry, only a fraction of Indian engineers in Bangalore are returnees.

Finally, another channel whereby highly skilled emigration may positively affect the source country is through the creation of business and trade networks; such a "Diaspora externality" has long been recognized in the sociological literature. The argument is that emigration creates trade and business networks, and promotes technology diffusion. There is strong evidence that immigration indeed increases bilateral trade (Gould, 1994), and more so for trade in differentiated products where migration networks allow for overcoming information asymmetries (Rauch and Trindade 2002, Rauch and Casella, 2003). It has also been argued that immigration-induced business networks favor FDI and technology diffusion. On this second channel, which would seem to be potentially relevant to highly-skilled migration, however, and apart from very specific cases (such as Bangalore as India's Silicon Valley), the evidence is too limited to undermine the strongly negative view of the brain drain that has prevailed until very recently.

With the emergence of new growth theories and the strong emphasis put on human capital as a source of growth (Lucas, 1988), there has been a renewed interest in the study of the growth effects of the brain drain. Building on the idea that any depletion of a country's

stock of human capital is detrimental to its current *and* future economic performance, it is unsurprising that the first models to address the issue of the brain drain in an endogenous growth framework all emphasized its negative effects (Miyagiwa, 1991, Haque and Kim, 1995, Reichlin and Rustichini, 1998, Wong and Yip, 1999). More recently, a series of studies have tried to promote the simple idea that one should also look at *how* a given stock of human capital is built up (Mountford, 1997, Stark *et al*., 1997 and 1998, Vidal, 1998, Beine *et al*., 2001). In particular, it is likely that in the presence of huge inter-country wage differentials, as is the case between developing and developed countries, the prospect for migration deeply modifies the incentive structure faced by developing countries' residents when making their education decisions. The idea that education investments are impacted by migration prospects is not new, however, and may be traced back in the brain drain literature at least to McCullock and Yellen (1977). The novelty lies in the introduction of uncertainty into the migration process, which creates the possibility of a gain for the source country. In short, this theoretical literature argues that in the presence of inter-country wage differentials, emigration prospects may well foster human capital formation at home even after netting out emigration.

The basic mechanism at work in these models is best illustrated by a numerical example: assume that the expected annual wage premium for someone with tertiary education is $5,000 in the home country and $30,000 in the United States; then, even a relatively small probability of immigration to the US (of, say, 20%) has a huge effect on the expected return to human capital (in this numerical example, it is exactly doubled assuming a zero emigration probability for an unskilled individual) and, therefore, if correctly anticipated, is likely to foster domestic enrollment in education significantly. When this incentive effect dominates the emigration effect, the country's stock of human capital is in fact increased.

The first study to attempt at estimating the growth effects of the brain drain is due to Beine et al. (2001); in a cross-section of 37 developing countries, they found that migration prospects have a positive and significant impact on human capital formation, especially for countries with low initial GDP per capita levels. The main drawback of this study, however, was that due to the lack of comparative data on international migration by education level, they used gross migration rates as a proxy for the brain drain. Then, in a subsequent study, Beine et al. (2002) used the above-mentioned Carrington and Detragiache (1998) data on emigration rates by education levels; again, they found a positive and highly significant effect of migration prospects on human capital formation in a cross-section of 50 developing countries. They also computed country-specific effects, with the following results:

- First, the countries that experience an overall positive effect of the brain drain (the "winners") generally combine low levels of human capital and low migration rates, whereas the "losers" are typically characterized by high migration rates and/or high enrollment rates in higher education.

- Second, except for extreme cases, the growth effects of the brain drain are relatively limited: +/- a maximum of 0.20% in terms of annual GDP per capita growth; this is not negligible, however, from a dynamic perspective.

- Finally, it is also striking that while there are more losers than winners, the winners include the largest countries in terms of demographic size and represent more than 80% of the total population of the sample.

These empirical results show that the traditional view according to which highly skilled emigration is detrimental to the source country may be seriously questioned and challenged. We turn now to a specific framework in which the traditional view and the new perspectives can be combined and viewed as the basis of two forces that will balance out in determining the outcomes.

3. Skilled Labor Migration and Poor Country Human Capital Stock

From a theory viewpoint, we are left with two main ways for dealing with the impact of highly skilled migration on those left behind. In a static framework, a natural way to deal with this issue is through the complementarity between skilled and unskilled labor. Without entering into formal arguments on the elasticity of substitution between factors in the production function, the main criticism one may address to such a line of analysis is that factor endowments are exogenously given while we would like to see the partitioning of the population between skilled and unskilled workers to have microeconomic foundations. An alternative framework, more in the New Growth spirit, is to consider homogenous labor but heterogeneity among workers as to the number of efficiency units of labor offered on the labor market. Normalizing the number of efficiency units supplied by an unskilled worker to 1, skilled workers could then be defined as those supplying more than one efficiency unit of labor. In such a setting, we lose the complementarity between skilled and unskilled labor but it can be implicitly be accounted for by introducing intragenerational and/or intergenerational externalities. In addition, we gain a tractable dynamic framework allowing us to examine the

conditions under which highly-skilled emigration may generate incentive and network effects that may – or may not - contribute to international convergence.

In this section we propose a simple model that allows simultaneously for the detrimental effects of emigration on human capital emphasized in the traditional view and the incentive effect of migration prospects put forward in the new brain drain economic literature. The model below is in the spirit of the above-cited literature on migration and incentives to human capital formation (Mountford, 1997, Stark *et al*., 1997 and 1998, Vidal, 1998, Beine *et al*., 2001). We derive precise ranges of the migration propensity for which emigration is beneficial (detrimental) to growth. In addition, we extend the framework to allow for network effects both at origin and destination.

The main assumptions of the model are the following: it is a two-country, two-factor (capital and labor), one-good model. The sending country is a small open developing economy: it is "open" in that it takes the world interest rate as given, and "developing" in that there is a technological gap captured by a relative wage-premium on education in the destination country. The foreign return to education – net of migration costs - is denoted by *w*, *w>1*. For the sake of simplicity, and given the fact that we focus on skilled migration, this foreign return is assumed to apply only to the fraction of an individual's human capital acquired through education. There is a constant returns to scale technology and markets are competitive; this, combined with the small open economy assumption, makes the wage rate in the origin country constant. Without loss of generality, the domestic wage (i.e., the domestic return to a unit of human capital), w^d, is set at 1. [6]

Agents live two periods. At birth, each individual *i* from generation *t* is endowed with a given stock of human capital, h_t, inherited from the previous generation and equally distributed across individuals, and an individual ability, a_t^i, uniformly distributed on the

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[6] Using a Cobb-Douglass production function, we may simply write: $Y(K,L) = AK^\alpha L^{1-\alpha}$. The competitive markets assumption assures that: $MPK = A\alpha K^{\alpha-1}L^{1-\alpha} = r = r* = cst$. With $k = \dfrac{K}{L}$, this gives $A\alpha k^{\alpha-1} = r* \Leftrightarrow k = \left(\dfrac{r*}{A\alpha}\right)^{\frac{1}{\alpha-1}} = cst$, and $MPL = (1-\alpha)AK^\alpha L^{-\alpha} = (1-\alpha)k^\alpha = w$. Given the above expression of *k*, this becomes: $w^d = (1-\alpha)\left(\dfrac{r*}{A\alpha}\right)^{\frac{\alpha}{\alpha-1}} = cst$. Hence, with constant returns to scale and competitive markets, the domestic wage in a small open economy is itself constant (i.e., unaffected by migration, since any in or out labor-migration would generate capital mobility so as to maintain the capital-to-labor ratio constant). Normalizing the domestic wage to unity simply requires sertting the total factor productivity parameter *A* appropriately.

ability space [0,1]. This individual ability is interpreted as a learning ability, i.e. as the individual's ability to transform the time spent in the education system into productive skills.

There is only one educational program, e, expressed as a fraction of the first period duration ($0<e<1$). The expected return to education for an individual depends on his or her personal ability (for simplicity we shall assume a linear form), on the foreign premium on education, and on the probability p, $p>0$, that an educated individual from country A will move to country B (without loss of generality, we set to zero the emigration probability for the non-educated). There is no inter-temporal discounting of income. Finally, since the developed country is '"big", its wage structure is unaffected by immigration.

The condition for investing in education is that the expected lifetime income with education is higher than the lifetime income without education. Formally, agent i opts for education if:

$$(1-e)h_t + (1-p)(1+a^i)h_t + p(1+wa^i)h_t > 2h_t \qquad (1)$$

After straightforward simplifications, this is equivalent to:

$$a^i > a^E \equiv \frac{e}{1+p(w-1)} \qquad (2)$$

Note that if $p=0$ (case of a closed economy), the critical agent is given by $a^F = e$.

Our focus is on the proportion of educated in the remaining population, P^E. Although we do not do this explicitly here, this can easily be modeled as positively influencing the level and (in endogenous growth models) the rate of growth of origin per capita income. Indeed, it is concern about this causality that has motivated the brain drain literature and its successors. Thus is this proportion increases we will think of this as being a good outcome for the poor origin country and, other things beign equal, a force for reducing inequality between rich and poor countries.

In the closed economy, the proportion of educated is given by $P^F = 1 - a^F = 1 - e$. In the open economy it is given by:

$$P^E = \frac{(1-p)(1-a^E)}{a^E + (1-p)(1-a^E)} \qquad (3)$$

At this stage, we may ask two questions:

1. Is there a possibility of a "beneficial brain drain" (BBD)? The answer is positive if $P^E > P^F$. After simple manipulations, this is equivalent to the condition:

$$p < p^c \equiv \frac{w + e - 2}{w - 1} \qquad (4).$$

Note that p^c may be negative and that this critical probability is a convex function of w ($\partial p^c / \partial w = \frac{1 - e}{(w-1)^2} > 0$ and $\partial^2 p^c / \partial w^2 = -\frac{2(1-e)}{(w-1)^3} < 0$), meaning that when the wage differential is high, the country can "afford" a relatively high emigration rate before the brain drain becomes detrimental.

2. What is the optimal migration probability? It is derived from:

$$\underset{p}{Max}\ P^E = \frac{(1 - p)(1 - a^E)}{a^E + (1 - p)(1 - a^E)} \qquad (5).$$

Plugging (2) into (5) and deriving gives:

$$p^* = Max \left\{ 0; \frac{w + e - 2}{2(w - 1)} = \frac{1}{2} p^c \right\} \qquad (6).$$

We may therefore distinguish the following cases:

Case 1: $p^c < 0$ (i.e., $w < 2\text{-}e$). The country loses from the brain drain, which contributes to rising inequality at the international level. In fact, the country would benefit from a total ban on international migration.

Case 2: $0 < p^* < p^c < p$. The country also loses from the brain drain. There is too much migration, but a ban on international migration would be sub-optimal (the optimal migration probability is positive).

Case 3: $0 < p^* < p < p^c$. The overall effect of the brain drain is positive, but the country would gain from reducing the emigration outflow.

Case 4: $p < p*$. The overall effect of the brain drain is positive, and the country would even benefit from increased emigration.

The diagrammatic representation of this model is extremely simple, as is apparent from Figure 1, which presents the net effect and shows the ranges of the migration probability for which skilled emigration is beneficial or detrimental to human capital formation. It is readily seen that the range over which the "conventional view" that greater skilled migration would widen differentials is valid, is greater the higher are education costs in the origin area, and the larger is the education premium in the destination country.

Figure 1: The net effect of skilled emigration on human capital formation (wih w>2-e)
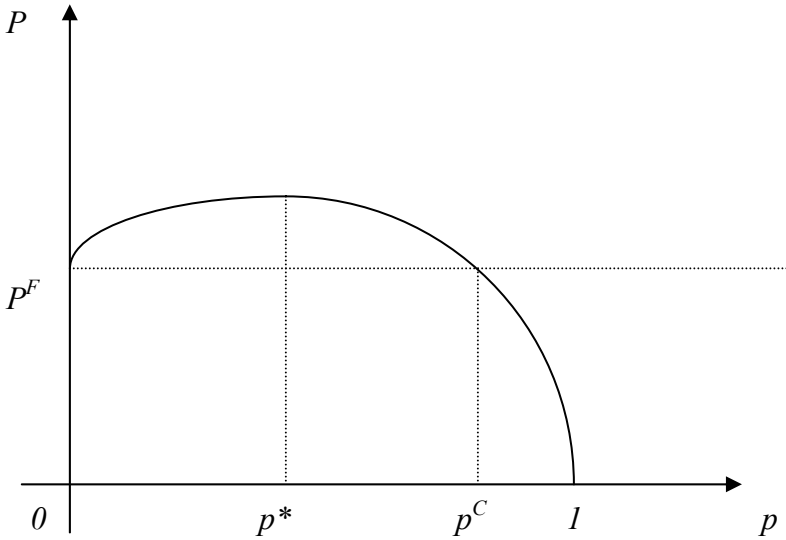
This basic model may be extended in two directions so as to capture the dynamics of migration, human capital formation, and convergence. A first natural extension is to introduce network effects at destination. As is standard in the migration networks literature, we may simply assume that migration costs are decreasing with the size of the network at destination, i.e., with the number of migrants already emigrated abroad (e.g., Carrington et al., 1996). Alternatively, we may assume that the constitution of immigrant networks allows newcomers to access higher-wage jobs (Munshi, 2003). The common justification for such networks effects is that networks diffuse information on jobs availability and provide hospitality and help in job search activities, thereby decreasing information costs. In addition, and given the fact that most OECD countries consider family reunion as a key criterion of their immigration policy, having relatives already settled in the host country has another advantage from the

perspective of those left behind: this increases their personal chances of receiving an entry visa in the host country. Hence, past migration favors current migration in two ways: through bettering jobs and wages at destination, and through easing entry restrictions to the host country. In the following, and to keep things analytically solvable, these two effects and their dynamic impact at origin are analyzed separately.

Assume, therefore, that the initial migrant network is of size *0* at time *t-1*; the argument on migrant networks and wages at destination implies that emigration within generation *t* raises *w* for the next generation;[7] recall that since we defined *w* as the foreign premium on education *net of migration costs*, it is indifferent from our perspective whether network effects manifest themselves through decreased migration costs, higher wages, or a combination of both. Hence, *w* becomes endogenous once network effects are introduced:

$$w_t = w(p(1 - a_{t-1}^E))$$
(7),[8]

with $w_t \in [\underline{w}, \overline{w}]$, $w(0) = \underline{w}$ and $w(1) = \overline{w}$.

Second, an intragenerational externality may also be introduced, whereby the domestic return to education is a function of the proportion of educated within a generation of working adults (Lucas, 1988). A common way to account for this is to assume a threshold externality (Azariadis and Drazen, 1990) such that the domestic return to education remains $\underline{w}^d = 1 < \underline{w}$ as long as the proportion of educated in the remaining adult population is lower than a given threshold $\widetilde{P}$ and becomes equal to $\overline{w}^d \geq \overline{w}$ for $P \geq \widetilde{P}$.

With these understandings, the education decision is taken considering the following conditions:

$$\begin{cases} 1 - e + p[1 + aw)] + (1 - p)(1 + aw^d) \geq 2 \text{ when } w^d < w_t \\ 1 - e + 1 + aw^d \text{ when } w^d \geq w_t \end{cases}$$
(8),

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[7] For example, it may be assumed that people live a third period of retirement where they were active as adults. Retired compatriots may still provide networking services to newcomers. In addition, this is consistent with Munshi's (2003) findings on Mexican migrant networks, which show that it is the "old network" that seems to be instrumental in improving contemporaneous migrants' labor market outcomes.

[8] For simplicity – and given the fact that highly-skilled migrants generally represent only a fraction of a country's total population, we neglect the possible impact of emigration on the number and quality of newborns in the source country (i.e., we assume that the ability distribution is constant and that demographic growth strictly compensates for emigration).

The critical agent is therefore given by:

$$a^E = \begin{cases} \dfrac{e}{pw + (1-p)w^d} & \text{if } w^d < w_t \\[2mm] \dfrac{e}{w^d} & \text{if } w^d \geq w_t \end{cases} \qquad (9),$$

and the proportion of educated in the remaining adult population by:

$$P = \begin{cases} \dfrac{(1-p)(1-a^E)}{a^E + (1-p)(1-a^E)} = \dfrac{(1-p).[pw + (1-p)w^d - e]}{e + (1-p).[pw + (1-p)w^d - e]} & \text{if } w_t > w^d \\[2mm] 1 - a = 1 - \dfrac{e}{w^d} & \text{if } w^d \geq w_t \end{cases} \qquad (10).$$

Note that as long as $P < \tilde{P}$, $w_t = w(p(1 - a^E_{t-1})) = w\left(\dfrac{p[pw_{t-1} + (1-p) - e]}{pw_{t-1} + (1-p)} \right)$, with:

$$\frac{\partial w_t}{\partial w_{t-1}} = w'. \frac{p^2 e}{(pw_{t-1} + 1 - p)^2} > 0 .\,[9]$$

Now, assume that we are in an initial situation where there is a wage differential and the brain drain is detrimental (cases 1 or 2 above). As network effects start to operate, w is increased ($w_{t+1} > w_t$). This raises p^c and, simultaneously, decreases a^E. Intuitively, if these two effects are of small magnitude, then there is a further deterioration (otherwise we fall into case 3 or 4 above). However, since a^E is lower than within the previous generation, this also means that there are more migrants within generation $t+1$ than within generation t. This further raises w ($w_{t+2} > w_{t+1}$), which further decreases p^c, etc. Whether the country can reach or surpass its initial performance depends on the magnitude of the initial detrimental effect and the strength of the network effect for future generations. In the case where the brain drain is beneficial for the first generation with migrants (cases 2 and 3 above), as w is increased, the next periods are also characterized by a beneficial brain drain. Whether the country can reach the intragenerational threshold externality such that emigration comes to an end depends on the strength of the network effect and the value of $\tilde{P}$. The dynamics of migration networks and human capital formation may therefore be represented as in Figure 2.:

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[9] Recall that the size and ability distribution of each new generation is assumed independent of past migration.

Fig. 2a. With an initial Beneficial Brain Drain
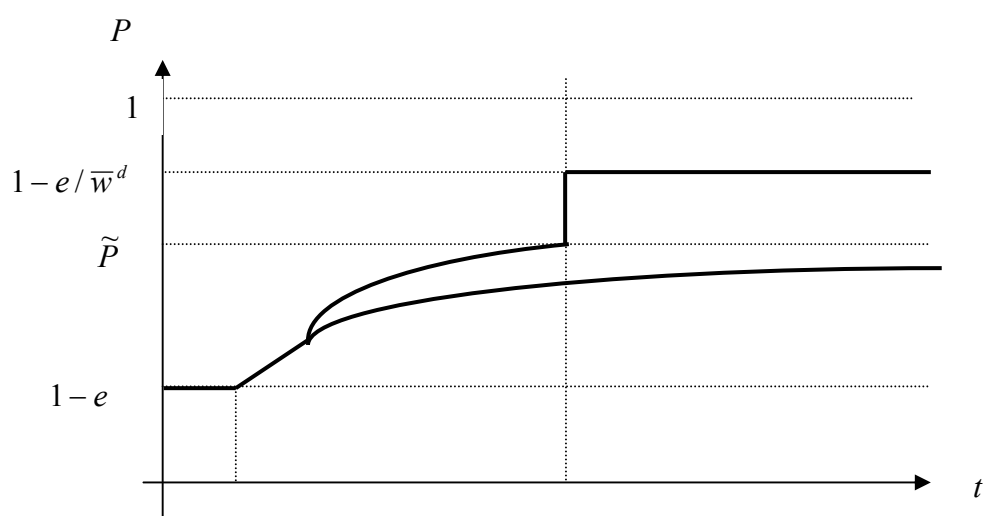
Fig. 2b. With an initial Detrimental Brain Drain
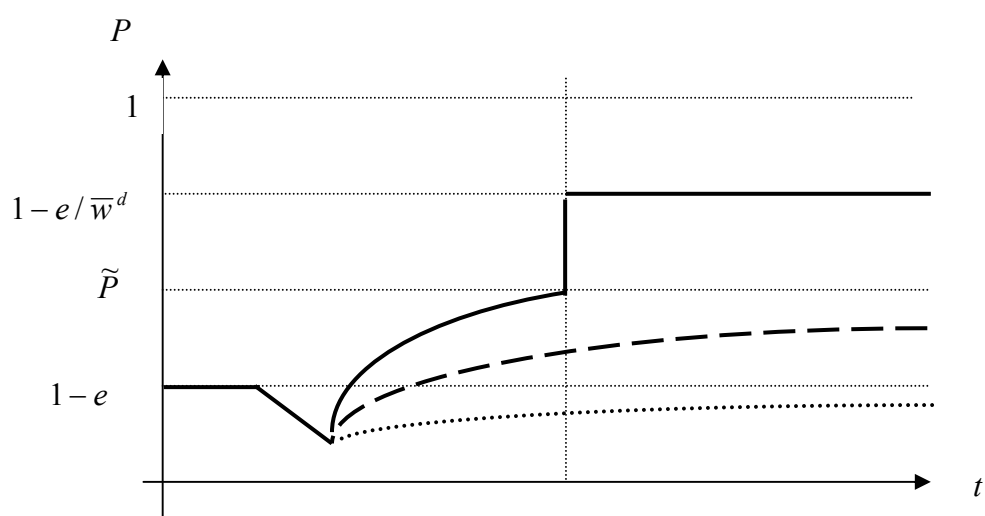
For a given initial detrimental brain drain, the country may never reach its initial level of human capital (see the doted line in Fig. 2b), end up with a higher stock of human capital and permanent emigration (see the dashed line in Fig. 2b), or achieve the critical human capital threshold (see the solid line in Fig. 2b). If there is a beneficial brain drain right from the beginning, the stock of human capital will keep increasing and the critical threshold may or may not be attained (see the two possibilities of Fig. 2a).

As explained above, another effect of past migration is to increase the chances of those with family members abroad to access to the destination country. While the wage effect plays at a community level, this second effect is restricted to one's family. Still, from a

macroeconomic viewpoint, such an increase in the probability of emigration for some individuals must be factored in to assess the impact of emigration on education. Assuming wage differentials to remain constant, the emigration probability for a representative educated individual may be expressed as a function of previous migration:

$$p_t=p[p_{t-1}(1-a^e_{t-1})] \qquad\qquad (11).$$

The equation of the proportion of educated in the remaining population has the same expression as in (10), except that time subscripts must be added to the migration probability. Since $p_t>p_{t-1}$, and for sufficiently small changes in the migration probability, we will have:

$$P_t>P_{t-1} \;\; if \;\; p_{t-1}<p^*$$
$$P_t<P_{t-1} \;\; if \;\; p_{t-1}>p^*$$

Hence, as may be seen from Figure 4, increased emigration opportunities thanks to earlier migration of family members may induce a further depletion of the origin country's stock of human capital (see the doted line in Fig. 3), offset the effects of an initially beneficial brain drain (see the dashed line in Fig. 3) or generate additional benefits in terms of human capital formation, at least as long as the contemporaneous emigration probability remains sub-optimal or the threshold externality P^{tilta} is attained (see the two solid lines in Fig. 3). Combining the positive effect of migrants' networks through better net wages at destination and the negative effect (at least in the long run) of increased immigration opportunities thanks to family ties abroad give the total impact of past emigration on human capital formation.

Figure 3: The dynamics of migration networks and human capital formation:
The role of increased migration opportunities
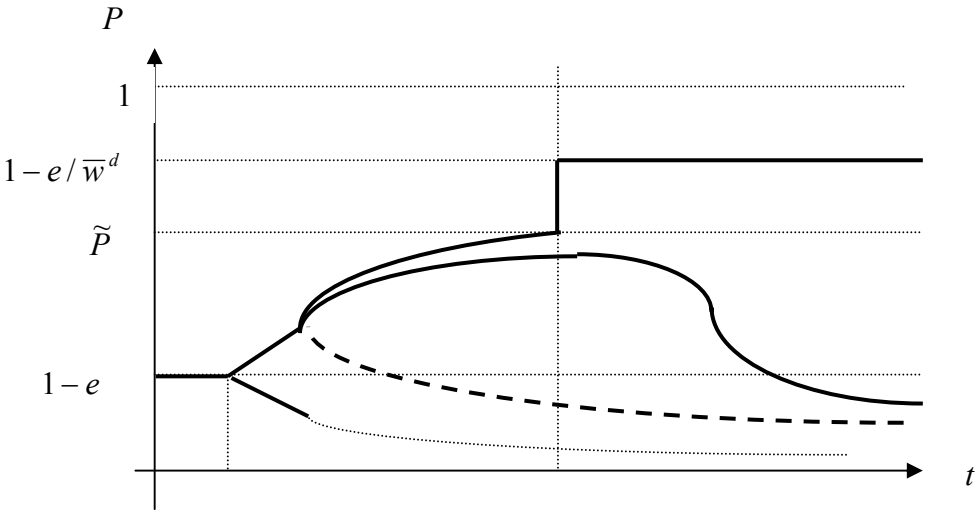
4. Conclusion

Spatial inequalities in real incomes seem remarkably persistent in the face of signifcant migration in the direction of the differential. A natural question that arises then is whether the migration process itself serves to exacerbate differentials, at least over some ranges, rather than always to narrow them as basic neo-classical models would suggest. While agglomeration effects in the destination region may lead migration to widen differentials by increase wages further in the destination area, as suggested by some new economic geography models, this paper has focused on the origin region, and the effects of migration selctivity on real incomes there.

In the simple model developed in this paper, selectivity by education drives the analysis. With education decisions exogenous, an increase in migration propensities reduces the proportion of educated people in the origin area and thus, through a number of channels standard in the literature, would widen the differential in both static or endogenous growth settings. However, when the education decision is endogenous, then raising the proportion of educated migrants, i.e., increasing the reallocation in the direction of the differential, can induce the acquiring of more education and this acts as a counteracting force. Our simple model shows how these forces balance out, determining the parameter ranges over which migration increases differentials and those over which it does not. We further extend the analysis to allow for network effects whereby past migration increases the incentives for current prospective migrants to move out. All of these models display ranges where increased migration in the direction of an income differential tends to widen that differential. Together with other factors discussed only briefly in this paper, the modeling developed here thus has the potential to be a building block in the explanation for why spatial inequalities seem to persist despite continued migration from poor to rich areas.

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