EDUCATION, UNEMPLOYMENT AND MIGRATION

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CESIFO WORKING PAPER NO. 2119
CATEGORY 4: LABOUR MARKETS
OCTOBER 2007

PRESENTED AT CESIFO AREA CONFERENCE ON EMPLOYMENT AND SOCIAL PROTECTION, MAY 2007
SUPPORT BY THE WGL LEIBNIZ ASSOCIATION WITHIN THE PROJECT "HOW TO CONSTRUCT EUROPE"

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CESifo *Working Paper No. 2119*

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Abstract

This paper studies a two-region model in which unemployment, education decisions and interregional migration are endogenous. The poorer region exhibits both lower wages and higher unemployment rates, and migrants to the richer region are disproportionally skilled. The brain drain from the poor to the rich region is accompanied by stronger incentives to acquire skills even for immobile workers. Regional shocks tend to affect both regions in a symmetric fashion, and skilled-biased technological change reduces wages of the unskilled. Both education and migration decisions are distorted by a uniform unemployment compensation, which justifies a corrective subsidization.

JEL Code: H23, I20, J61, J64, R10.

Keywords: education, unemployment, interregional migration, externalities, brain drain.

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September 28, 2007

1 Introduction

This paper studies the interaction of education, migration and unemployment in an interregional context. In particular, we are interested in the consequences of having free migration between regions for educational decisions, wage levels, and unemployment in both the sending and the receiving region. We explore the mechanisms driving a brain drain out of the poor sending region and identify channels how those left behind in the poor region may experience a counteracting brain gain via higher propensities to acquire human capital. Moreover, we would like to know how regional and national economic shocks affect educational decisions and interregional migration. From a political perspective, the main objective is to rationalize various sorts of active labor market policies that are pursued in lots of countries. Our discussion of the relevant externalities casts doubt on the efficiency of lots of these policies. We argue that some subsidies for both education and migration can be justified, while subsidies for education and training programs at a rate of one hundred per cent seem doubtful.

It is frequently observed that substantial interregional wage differentials within a country exist, where the low-wage regions are also characterized by comparatively high unemployment rates. For example, in Germany unit labor costs in the East were at 65 per cent of the national average in 2004 while the unemployment rate in East Germany of around 20 per cent exceeded the national unemployment rate by more than 8 percentage points (Institut der deutschen Wirtschaft, 2006). Similar relations have been observed for one decade, without any clear tendency of convergence. At the same time, a higher formal qualification is always associated with a reduced unemployment risk. Finally, the propensity to migrate is typically stronger for high-skilled individuals than for the low-skilled.

Our model captures all these stylized facts. Unemployment arises according to an efficiency wage argument of the shirking type. Migration and educational decisions are endogenous, as there is a distribution of costs of human capital acquisition and migration across individuals. Migration will arise in only one direction, from the poor to the rich region. It is a mechanism that reduces the interregional wage and unemployment differentials, albeit not in a perfect fashion. There is a persistent technological gap between the regions that is not explained.

From an allocative perspective, the presence of unemployment tends to distort the decisions of individuals. Due to the unemployment rate differential across skill groups within a region and across regions for a given skill group, the incentives to acquire human capital and to migrate to the rich region both tend to be too strong, as measured by the productivity differentials of employed workers. This observation suggests to tax rather than to subsidize education and migration. However, it turns out that the differentials in unemployment levels will also be taken into account in any second-best allocation. Only changes of unemployment rates represent externalities of education and migration decisions. By contrast, unemployment benefits will reduce the incentive to become a skilled worker and lower interregional mobility. Correcting for the latter distortions may require an education subsidy and some mobility premium.

Our paper is related to different strands of the literature. Several reasons have been given to explain the observation that individuals with a high level of education face a relatively low unemployment risk. Skilled workers have a wider range of employment opportunities (McKenna, 1996), and the existence of sunk costs of investing in firm-specific human capital makes it less likely to lay off skilled workers (Becker, 1993). Moreover, insiders may be able to introduce barriers to entry for unemployed (Lindbeck and Snower, 1988; Zwick, 1998). However, the stable size of differentials in skill-specific unemployment rates may be altered at least in the short run by external shocks, such as increasing average education drastically (Puhani, 2004) or by immigration waves (Card, 1990).

Unemployment causes distortions of the individual decision to invest in education. It may induce overinvestment in education, as unemployment differentials lead individuals to qualification efforts although the productivity gain lies below costs of education (Kodde, 1988). A similar outcome follows when education raises workers' outside opportunities and gives them a stronger position in the wage bargain (Charlot et al., 2005). Finally, in a segmented labor market the relative increase in skilled labor may cause a strong increase in unemployment among the remaining low-skilled (Albrecht and Vroman, 2002). On the other hand, substantial forces toward underinvestment in education due to unemployment exist. The unemployment insurance disproportionately benefits the low-skilled (Dellas, 1997), and workers often cannot fully appropriate the productivity gains from their education investments (Laing et al., 1995; Acemoglu, 1996). The additional investment incentive created by the unemployment rate differential may therefore induce a welfare gain in the presence of such positive externalities (Cahuc and Michel, 1996; Cubitt and Hargreaves Heap, 1999).

Few attempts have been undertaken to study the impact of education policy on unemployment theoretically. When skill-specific wages depend on the respective unemployment rates, an increase in the relative supply of skilled workers will not only increase total output, but also both skill-specific unemployment rates. As the share of individuals with the lower unemployment rate increases, aggregate unemployment may move in either direction (Saint-Paul, 1994, 1996). Hence, education policy has a negative general equilibrium effect that may more than offset the immediate gain in reducing unemployment. However, capital inflows as a response to the increasing average education level can mitigate or even neutralize such negative general equilibrium effects (Bräuninger, 2000).

The empirical literature is mainly concerned with the direct employment impacts of active labor market progams on the participants. As a general impression, these direct effects are typically negative before the program starts due to reduced search efforts, insignificant in the first few months after completion (Heckman et al., 1999; Bergemann et al., 2004), but positive in the medium and longer run (Lechner et al., 2005). The unusual large "knowledge lift" education programme for low-skilled workers in Sweden 1997-2000 in which around 10% of the workforce participated led to positive impacts on employment probabilities only for young men, and impacts on average income of program participants were ambiguous (Albrecht et al., 2005).

Another strand of the literature is concerned with the interaction of education and migration. From an individual perspective, migration has to be considered as an investment into human capital (Sjaastad, 1962). Returns from migration are the higher, the younger and the more able or educated a person is (Borjas, 2000). A quite different mechanism has been suggested by Wildasin (2000) who argues that human capital investment increases specialization. Skilled workers could face problems finding appropriate jobs, unless they are interregionally mobile which increases their probability of a successful match. Hence, the share of skilled workers among emigrants will typically exceed the corresponding share of those left behind in the sending region. If this happens, sending regions can be harmed by such a *brain drain* as returns from public investment in education are lost. On the other hand, it has often been argued that the option to migrate to a richer region or country stimulates human capital investment also for those who ultimately do not emigrate. In this way, the brain drain of the poor region is also associated with a brain gain that may raise growth (Mountford, 1997; Stark et al., 1997, 1998; Vidal, 1998; Beine et al., 2001). We identify a new channel for a brain gain that has been neglected in the literature up to now. In our model, emigration pushes up both wages and the skill premium in the poor region. Although the emigrants are disproportionally skilled, the share of skilled workers among those staying in the poor region may increase, and skill-specific unemployment rates will always fall. The old brain drain literature discusses some elements of this story in models with a traditional and a modern sector (Bhagwati and Hamada, 1974; Mc Culloch and Yellen, 1975; Rodriguez, 1975), but remains somewhat more pessimistic.

Finally, the interrelations between unemployment and migration have been studied in several papers. Immigration typically has a short-run negative impact on the unemployment rate of directly competing natives, while the effects are often insignificant for the receiving region as a whole and for longer time spans (Borjas, 1994). In a sending region, the possibility of emigration will increase wage demands, which tends to perpetuate the interregional unemployment differential (Bhagwati and Hamada, 1974; Uhlig, 2006). Immigration may even bring natives' unemployment down as firms will create more vacancies in view of more profitable matches (Ortega, 2000).

The evidence on the impact of the incidence of unemployment on migration is mixed. In the US where interregional migration is substantial as a mechanism of adjustment in the labor market, unemployed workers have been found to be very mobile between regions (Pissarides and Wadsworth, 1989). By contrast, European regional labor markets show stronger changes in participation rates (Blanchard and Katz, 1992; Decressin and Fatás, 1995; Obstfeld and Peri, 1998), and interregional migration sets in later (Möller, 2001). The skill level also affects the reaction to unemployment: Skilled workers tend to move to another region while the unskilled tend to drop out of the labor force (Mauro and Spilimbergo, 1999).

The remainder of the paper is organized as follows. After introducing the model in Section 2, the following Section 3 characterizes equilibria and investigates issues of stability and the interaction of wages. Section 4 analyzes the impacts of the population and technical parameters on the wages in the regions. Section 5 is concerned with a welfare analysis of the equilibria and discusses policies to overcome the resulting inefficiencies. Finally, Section 6 concludes and indicates directions for future research.

2 The model

We consider two regions. Without loss of generality, A is the high-wage region and B the low-wage region. There are two skill groups, low-skilled (type L) and high-skilled workers (type H). An individual of skill type k working in region i in period t receives the wage w_{it}^k. Individuals are characterized by their place of birth, their idiosyncratic cost of acquiring human capital $c \in [0, \overline{c}]$, and their cost of migration to the other region $d \in \left[0, \overline{d}\right]$. Initially, the density function $\varphi(c, d)$ that describes the distribution of costs is the same in both regions, and c and d are statistically independent. Thus, $F(c) = \int_0^c f(x)dx$ is the conditional cumulative density function with respect to the human capital acquisition cost c for any given migration cost $d \in \left[0, \overline{d}\right]$. The total initial number of individuals in each region is N_i.

We analyze a framework in which production starts after educational and migration decisions have taken place. Individuals first decide on acquiring skills in the home region, and afterwards on migration to the other region, where they possess perfect foresight with respect to wages and unemployment rates in equilibrium. Jobs are randomly allocated among all workers supplying labor of a specific type in a given region.

Let p_i^k be the unemployment probability of an individual of skill type k living in region i in this period. The unemployment rate of skilled workers, $\theta_i := p_i^H$ will always fall short of the unemployment rate of unskilled workers in the same region $\psi_i := p_i^L$. Suppose that unemployed regardless of their skill type receive a uniform unemployment benefit $\overline{w}$. The utility function u satisfies the properties $u(0) = 0$, $u' > 0$, and $u'' \leq 0$. The value of living in region j as an individual of skill type k is

$$V_j^k = \left[\left(1 - p_j^k\right)\left[u(w_j^k) - e\right] + p_j^k u(\overline{w})\right], \tag{1}$$

where $e > 0$ is effort exerted at the workplace, being identical for all jobs. An individual of type k will migrate from his birth region i to the other region j if and only if $V_j^k - V_i^k > d$.

In the first stage, the individual being born in region i decides on acquiring higher skills at an idiosyncratic cost c. He will invest in education if and only if

$$\max\left\{V_i^H, V_j^H - d\right\} - \max\left\{V_i^L, V_j^L - d\right\} > c. \tag{2}$$

This defines a cutoff level of $\widetilde{c}$, which may depend on the migration cost d. In particular, if $\max\left\{V_i^H, V_j^H - d\right\} = V_j^H - d$ and $\max\left\{V_i^L, V_j^L - d\right\} = V_i^L$, the cutoff level $\widetilde{c}$ decreases with a higher cost of migration d. This situation may arise if the absolute wage interregional differential of skilled workers exceeds the corresponding wage differential of unskilled workers. If c_i denotes the threshold education cost of those born in region i with the maximum migration cost, all individuals with a higher cost of education $c > c_i$ who do nevertheless acquire skills will migrate to the other region.

Let U_i and S_i denote total employment of low-skilled and high-skilled labor in region i, respectively. The production function is given by $G_i(S_i, U_i) = \beta_i G(S_i, U_i)$ with $\beta_A > \beta_B > 0$, where G is a strictly concave function with decreasing returns to scale. Without migration, wages in region A will always exceed the corresponding type-specific wages in region B.

We consider the standard shirking model of Shapiro and Stiglitz (1984). Employed workers choose whether or not to shirk. The probability that a shirker is caught and fired immediately is given by q. Workers are infinitely lived, where r denotes the discount rate, b is the exogenous separation rate, and a is the job acquisition rate. The asset equations of employed shirkers, employed non-shirkers and unemployed are respectively given by

$$rW^S = u(w) + (b+q)\left[W^U - W^S\right], \tag{3}$$
$$rW^N = u(w) - e + b\left[W^U - W^S\right], \tag{4}$$
$$rW^U = u(\overline{w}) + a\left[W^E - W^U\right], \tag{5}$$

with $W^i, i \in \{S, N, U\}$ representing the value of being in state i, and $W^E = \max\left\{W^N, W^S\right\}$. Rearranging terms and utilizing the flow equilibrium condition $ap = b(1-p)$, the no-shirking condition, describing the minimum wage to induce effort, can be derived from $W^N \geq W^S$ as

$$u(w) - e \geq u(\overline{w}) + r\frac{e}{q} + \frac{be}{qp}. \tag{6}$$

If (6) holds with equality, the inverse relationship of wage and unemployment can be seen from

$$\frac{dp}{dw} = -\frac{u'(w)p^2}{be/q} < 0, \tag{7}$$

It is obvious from (3) and (4) that employed workers earn the information rent $W^E - W^U = \frac{e}{q}$ when the no-shirking condition holds with equality. Noting (1) and (6), expected utility can be written as function of the wage, $V(w) = u(w) - e - p(w)\left[r\frac{e}{q} - \frac{be}{qp(w)}\right]$ where $\frac{dV}{dw} = u'(w) - p'(w)r\frac{e}{q} > 0$.

Note that the same no-shirking curve holds for skilled and unskilled workers. Workers are hired until their respective marginal product is equal to their wage. Hence, we have

$$\frac{\partial G_i(S_i,U_i)}{\partial S_i} - w_i^H = 0, \tag{8}$$

$$\frac{\partial G_i(S_i,U_i)}{\partial U_i} - w_i^L = 0. \tag{9}$$

As skilled workers have a higher marginal productivity than unskilled workers at any given combination of employment of skilled and unskilled workers ($G_S(S,U) > G_U(S,U)$), the unemployment rate of skilled workers always falls short of the unemployment rate of unskilled workers. It may be useful to distinguish some cases. When skilled and unskilled workers are perfect substitutes such that a low-skilled worker supplies one efficiency unit of labor while a skilled worker supplies $\sigma > 1$ units, we always have $G_S(S,U) = \sigma G_U(S,U)$. The two types of labor are substitutes if $G_{SU} < 0$. They would be complements when $G_{SU} > 0$.

Threshold costs Let D_i, $i \in \{A,B\}$ denote the differential in expected utility between high skilled and low skilled in region i, that is,

$$\begin{aligned} D_i \quad : &= (1-\theta_i)\left[u(w_i^H) - e\right] + \theta_i u\left(\overline{w}\right) \\ &\quad - \left[(1-\psi_i)\left[u(w_i^L) - e\right] + \psi_i u\left(\overline{w}\right)\right]. \end{aligned} \tag{10}$$

Similarly, let D^j, $j \in \{H,L\}$ be the differential in expected utility for workers of type j between countries A and B, that is,

$$\begin{aligned} D^H \quad : &= (1-\theta_A)\left[u(w_A^H) - e\right] + \theta_A u\left(\overline{w}\right) \\ &\quad - \left[(1-\theta_B)\left[u(w_B^H) - e\right] + \theta_B u\left(\overline{w}\right)\right] \end{aligned} \tag{11}$$

and

$$\begin{aligned} D^L \quad : &= \left[(1-\psi_A)\left[u(w_A^L) - e\right] + \psi_A u\left(\overline{w}\right)\right] \\ &\quad - \left[(1-\psi_B)\left[u(w_B^L) - e\right] + \psi_B u\left(\overline{w}\right)\right]. \end{aligned} \tag{12}$$

Given that there is only migration from region B to region A, the type-specific threshold migration cost that separates the migrants from the stayers is given by $D^L - d^L = 0$ and $D^H - d^H = 0$. In region A, all individuals with human capital acquisition cost below c_A will choose to become a skilled worker, where c_A satisfies $D_A - c_A = 0$. Similarly, for individuals with a migration cost above d^H, those with a human capital acquisition cost below c_B obtain the qualification of a skilled worker, with $D_B - c_B = 0$. Those with a migration cost $d < d^H$ may nevertheless choose to become a skilled worker when $c < c_B^m(d)$ with $c_B^m(d) = D_B + D^H - d$. However, it turns out to be more attractive to migrate as a low-skilled worker if $D^L > D_B + D^H - c$. As $D_B + D^H = D_A + D^L$ is valid by definition, the inequality is equivalent to $c > D_A$. Hence, those with cost of human capital acquisition $c \in [c_B, D_A]$ and cost of migration $d < \widetilde{d}(c)$ with $\widetilde{d}(c) = d^H + c_B - c$ will choose to become educated only due to the perspective to migrate as a skilled worker later on. Otherwise, the decision to acquire skills would not be worthwhile.

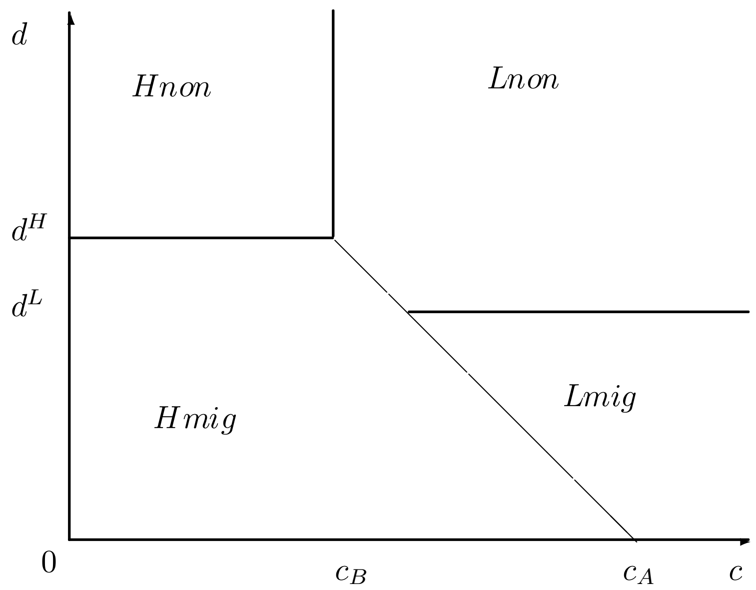

Figure 1. Migration and education thresholds

Figure 1 depicts the structure of decisions in region B. Individuals with low costs of migration and education will become skilled and migrate thereafter (field $Hmig$). Workers with characteristics associated with field $Hnon$ will acquire skills while staying in region B afterwards due to high costs of migration. In field $Lnon$, both costs are high, such that it is optimal to remain an unskilled worker in the home region B. Finally, those with high costs of education and low costs of migration will migrate as low-skilled workers to region A.

Choosing between staying as low-skilled worker in the poor region B or becoming high-skilled worker in region A is governed by the sum of the two costs c and d. For individuals with a higher sum of these costs and a low cost of migration, migrating as a low-skilled worker is superior to these two alternatives. This explains the diagonal in Figure 1 with a slope of -1 between fields $Lnon$ and $Lmig$ to the right, and $Hmig$ to the left. Furthermore, Lemma 1 shows that $c_A = c_B + d^H$ has to hold, such that the diagonal in Figure 1 contains the points $\left(c_B, d^H\right)$ and $(c_A, 0)$. Hence, it is impossible to change one of these three threshold values independent of the two other ones.

Lemma 1: *The threshold values satisfy* $c_A = c_B + d^H$.

Proof. See Appendix A. □

Lemma 2 collects the results on the shares of skilled workers in the two economies.

Lemma 2: *(i) The share of individuals acquiring skills in region B is smaller than in region A. (ii) Considering the individuals born in region B, the share of skilled workers among the migrants to region A exceeds the share of skilled workers remaining in region B. (iii) The share of skilled workers among those staying in region B is smaller than the corresponding share among the natives in region A. (iv) In a migration equilibrium, the share of skilled workers in region A is higher than the corresponding share in region B.*

Proof. See Appendix B. □

The incentive to acquire skills is stronger in the rich region due to a higher absolute expected wage premium. The larger weighted wage differential is also relevant for the migrants to the rich region and corresponds with a stronger migration incentive for skilled workers. Therefore, a smaller share of individuals born in the poor region become skilled workers, and the share of skilled workers among those left behind falls short of the share of skilled workers among the migrants to the rich region. The migrants represent a positive selection in terms of qualification from the original population of the poor region. Taken this selection effect together with the result that the share of educated workers among the natives of region A exceeds the corresponding share of those being born in region B, explains why this relation also holds in any migation equilibrium.

While Lemma 1 depicts some clear-cut properties of any equilibrium, it is not obvious whether the native population of region A is less or more skill-intensive than the immigrants. On the one hand, the initial population of region B is less skilled on average than the natives in region A. On the other hand, the selectivity of migrants may offset this difference in human capital per worker. Hence, there is no immediate prediction on the "quality" (Borjas, 1985) of immigrants compared to the natives in the receiving region.

At given education and migration thresholds it can be argued that the poor region suffers from a brain drain, marked by the higher average skill level of the emigrants. Moreover, with a fixed education threshold c_B, the share of unskilled workers in the poor region is higher in the migration equilibrium than in the absence of migration. However, migration from the poor to the rich region makes labor scarcer in the poor region. Consequently, wages and the expected absolute wage premium of skilled workers in the poor region will be driven upwards. As this yields a higher education threshold, the brain drain will be associated with a brain gain. This channel of a brain gain has previously been neglected in the literature. The standard argument of a brain gain states that the expected skill premium rises with the possibility of emigration when people expect to migrate with some positive probability. While this line of reasoning remains true, even those who know beforehand that they will remain in the poor region tend to have a higher incentive to become skilled due to general equilibrium effects affecting the structure of wages. These effects may even be more pronounced when skilled labor and unskilled labor are complements, as the brain drain then also increases the relative wage premium.

3 Equilibria, stability, and wage effects

In the following we confine our attention to the structure in which the two types of labor are perfect substitutes, that is, one unit of skilled labor is equivalent to $\sigma > 1$ units of unskilled labor. Let H_i and L_i denote total labor supply of high-skilled and low-skilled workers in region i in a post-migration situation. The no-shirking equations are identical for each type and region. Thus, w_i, the wage rate of low-skilled workers in region i, determines θ_i and ψ_i, the unemployment rates of skilled and unskilled workers in region i. Consequently, the threshold values are functions of the respective wage rates. Hence, we have $\theta_i(w_i), \psi_i(w_i), c_A(w_A)$, $c_B(w_B)$, $d^H(w_A, w_B)$ and $d^L(w_A, w_B)$. It then turns out that the model boils down to a system of two equilibrium conditions $f_1(w_A, w_B) = 0$ and $f_2(w_A, w_B) = 0$ with

$$\begin{aligned} f_1 &= \beta_A G' \left\{ (1-\theta_A) \sigma H_A \left(N_A, N_B, c_A, c_B, d^H \right) \right. & (13) \\ &\quad \left. + (1-\psi_A) L_A \left(N_A, N_B, c_A, c_B, d^H, d^L \right) \right\} - w_A, \\ f_2 &= \beta_B G' \left\{ (1-\theta_B) \sigma H_B \left(N_B, c_B, d^H \right) \right. & (14) \\ &\quad \left. + (1-\psi_B) L_B \left(N_B, c_B, d^H, d^L \right) \right\} - w_B. \end{aligned}$$

The dynamics of the system is described by

$$\dot{w}_A = h_1 \left[f_1(w_A, w_B) \right] \quad (15)$$
$$\dot{w}_B = h_2 \left[f_2(w_A, w_B) \right] \quad (16)$$

with $h_1(0) = h_2(0) = 0$, $h_1' > 0$ and $h_2' > 0$.

Thus, the wage rate in a region moves upward when the marginal product of labor exceeds the wage rate, and vice versa. The equilibrium (w_A, w_B) of the system of equations (15)-(16) is locally asymptotically stable only if $\frac{\partial \dot{w}_A}{\partial w_A} \leq 0$, $\frac{\partial \dot{w}_B}{\partial w_B} \leq 0$, and $\frac{\partial \dot{w}_A}{\partial w_A}\frac{\partial \dot{w}_B}{\partial w_B} - \frac{\partial \dot{w}_A}{\partial w_B}\frac{\partial \dot{w}_B}{\partial w_A} \geq 0$ hold at the equilibrium point.

These conditions are equivalent to $\frac{\partial G_A'}{\partial w_A} - 1 \leq 0$, $\frac{\partial G_B'}{\partial w_B} - 1 \leq 0$, and

$$\Delta := \left[\frac{\partial G_A'}{\partial w_A} - 1 \right] \left[\frac{\partial G_B'}{\partial w_B} - 1 \right] - \frac{\partial G_A'}{\partial w_B} \frac{\partial G_B'}{\partial w_A} \geq 0. \quad (17)$$

The cross derivatives are

$$\begin{aligned}\frac{\partial G'_A}{\partial w_B} &= G''_A\left[(1-\theta_A)\left[\frac{\partial H_A}{\partial c_B}\frac{\partial c_B}{\partial w_B}+\frac{\partial H_A}{\partial d^H}\frac{\partial d^H}{\partial w_B}\right]\right. \\ &\quad \left.+(1-\psi_A)\left[\frac{\partial L_A}{\partial c_B}\frac{\partial c_B}{\partial w_B}+\frac{\partial L_A}{\partial d^H}\frac{\partial d^H}{\partial w_B}+\frac{\partial L_A}{\partial d^L}\frac{\partial d^L}{\partial w_B}\right]\right] \\ &> 0,\end{aligned} \tag{18}$$

$$\begin{aligned}\frac{\partial G'_B}{\partial w_A} &= G''_B\left[(1-\theta_B)\left[\frac{\partial H_B}{\partial d^H}\frac{\partial d^H}{\partial w_A}\right]\right. \\ &\quad \left.+(1-\psi_B)\left[\frac{\partial L_B}{\partial d^H}\frac{\partial d^H}{\partial w_A}+\frac{\partial L_B}{\partial d^L}\frac{\partial d^L}{\partial w_A}\right]\right] \\ &> 0.\end{aligned} \tag{19}$$

Notice that $\frac{\partial H_A}{\partial c_B} > 0 > \frac{\partial L_A}{\partial c_B}$ and $\frac{\partial H_A}{\partial c_B} + \frac{\partial L_A}{\partial c_B} > 0$ are valid (see Figure 1). Furthermore, we have $\frac{\partial H_B}{\partial d^H} < 0$, $\frac{\partial L_B}{\partial d^H} < 0$, $\frac{\partial H_A}{\partial d^H} > 0 > \frac{\partial L_A}{\partial d^H}$ and $\frac{\partial H_A}{\partial d^H} + \frac{\partial L_A}{\partial d^H} > 0$. Finally, $\frac{\partial L_B}{\partial d^L} < 0$, $\frac{\partial H_A}{\partial d^L} = 0$ and $\frac{\partial L_A}{\partial d^L} > 0$ hold. It is obvious that the migration thresholds decrease with a smaller wage differential. Thus, $\frac{\partial d^k}{\partial w_A} > 0$ and $\frac{\partial d^k}{\partial w_B} < 0$ for $k \in \{H, L\}$. Further, Lemma 1 implies that the impact of w_i on c_i at fixed w_j, $j \neq i$ must be positive. When $c_B(w_B) + d^H(w_A, w_B) = c_A(w_A)$ always holds, the properties $\frac{\partial d^H}{\partial w_A} > 0$ and $\frac{\partial d^L}{\partial w_B} < 0$ imply that $c'_A > 0$ and $c'_B > 0$.

The impact of a higher wage in the rich region A on the wage in the poor region B is unambiguously positive. The rising interregional wage differentials increase the migration incentives for both high-skilled and low-skilled workers. In addition, some individuals will choose to become educated and to migrate as high-skilled worker rather than staying as low-skilled worker in the poor region. This reduces the supply of both types of workers in the poor region.

The impacts of a higher wage in the poor region B on the wage in the rich region A are a bit more complex. In Figure 1, the education threshold cost c_B increases, and the migration threshold costs d^L and d^H decrease, where the intersection (c_B,d^H) moves down the diagonal towards $(c_A, 0)$. In sum, the supply of both low-skilled and high-skilled migrants falls, which increases the marginal producticvity of labor in region A. The number of high-skilled migrants falls because the stronger propensity to become skilled in the poor region does not compensate for the reduced migration incentive.

4 Comparative statics

Proposition 1 deals with the impacts of a population increase in one region, which may best be interpreted as migration from abroad that is regionally concentrated. Such a concentration can occur due to the possible existence of networks for migrants in only one region.

Proposition 1: *A higher initial population in the rich or the poor region, N_A or N_B, will induce (i) lower wages, (ii) higher skill-specific unemployment rates, and (iii) smaller education cost thresholds in both regions.*

Proof. See Appendix C. □

At given education and migration thresholds and fixed unemployment rates, an increasing population in the rich region A raises employment of workers of both types in this region, reducing the wage rate w_A. The falling wage reduces the migration thresholds and the threshold education cost in region B. While the former effect contributes to a rising labor supply in region B, the latter impact works in the opposite direction. It turns out that the wage in the poor region falls because the reduction of migration is the decisive factor. Since the no-shirking condition dictates that wage cuts are always associated with more unemployment, all skill-specific unemployment rates rise.

A rising population in the poor region B at given migration thresholds directly increases employment of both types of labor in both regions, implying a falling wage in both regions. The cross effects of wages on each other are always positive, reinforcing the downward pressure. This in turn increases the skill-specific unemployment rates and reduces the education thresholds.

The next proposition summarizes the impacts of technological shocks. These may be specific to a region by affecting the technological factor β_i. Another possibility is an increase in the productivity factor σ of high-skilled workers, which can be interpreted as skill-biased technological change.

Proposition 2: *A rising productivity factor in the rich or the poor region, β_A or β_B, yields an increase of the wage rate and smaller group unemployment rate in both regions. A rising productivity factor of skilled workers σ*

will decrease the wage of low-skilled workers in the both regions and increase their regional unemployment rates.

Proof. See Appendix D. □

A higher productivity of workers in the rich region directly increases the wage there. This wage increase yields stronger migration incentives in the poor region, leading to an outflow of workers of both types. Due to the reduction in labor supply, the wage rate in the poor region will also go up. Hence, workers in the poor region will be affected by a technological shock occuring in the high-wage region in the same direction. If the productivity of labor in the poor region increases, for example due to a successful imitation, there is a direct positive effect on the wage in the poor region. This wage increase reduces the migration incentive to the high-wage region, which contributes to rising wages across the board.

If the productivity of high-skilled workers increases, this yields more employment in both regions at given decision thresholds, leading to a lower wage for the low-skilled. The increasing wage differential between workers of different skill types implies rising propensities to acquire skills in both regions. Again, this tends to increase employment of labor in efficiency units and to decrease wages. All these effects are reinforced by the positive interdependence of wages across regions. The regional unemployment rates of the low-skilled rise because the motive to replace low-skilled workers by high-skilled workers to avoid shirking is strengthened.

5 Welfare analysis

Taking as given that the flat unemployment benefit $\overline{w}$ exists, it may be asked whether the individuals' economic decisions in combination yield an efficient allocation. In the following, the marginal utility of consumption is set constant to keep the analysis as simple as possible. The unemployment rates that occur due to avoid shirking do not reflect a market failure. The social planner maximizes total output,

$$\beta_A G((1-\theta_A)\,\sigma H_A + (1-\psi_A)\,L_A) + \beta_B G((1-\theta_B)\,\sigma H_B + (1-\psi_B)\,L_B), \quad (20)$$

net of costs of effort, education and migration, subject to the no-shirking constraints.The latter can be expressed by explaining the group unemployment rates as increasing functions of labor supply in that region, that is

$p_i^k(L_i, \sigma H_i)$ with $\dfrac{\partial p_i^k}{\partial H_i} = \dfrac{(1-\theta_i)\,\sigma}{(1-\psi_i)} \dfrac{\partial p_i^k}{\partial L_i} > 0$. From a social point of view, education should be purchased if the cost of acquiring human capital is justified by the weighted gain in utility, corrected for general equilibrium externalities. An analogous consideration holds for migration decisions. The general equilibrium externalities are derived from impacts of changes in unemployment rates caused by changes in regional aggregate labor supply. By contrast, the changing wages in itself turn out to be irrelevant. Considering education in region i, the general equilibrium externality in terms of utility reads

$$\begin{aligned} \Gamma_i &= -\left\{ \left[\frac{\partial \theta_i}{\partial H_i} - \frac{\partial \theta_i}{\partial L_i} \right] [\sigma u(w_i) - e]\, H_i \right. \\ &\quad \left. + \left[\frac{\partial \psi_i}{\partial H_i} - \frac{\partial \psi_i}{\partial L_i} \right] [u(w_i) - e]\, L_i \right\} \\ &< 0. \end{aligned} \tag{21}$$

When a worker acquires skills, aggregate labor supply in efficiency units in the region increases. At given group unemployment rates, total employment increases, depressing the marginal product of labor. Due to the no-shirking conditions the resulting falling wages will be accompanied by higher group unemployment rates.

Migration of a worker of type $X \epsilon \{L, H\}$ from region B to region A yields a net general equilibrium externality

$$\begin{aligned} \Gamma^X &= \frac{\partial \theta_B}{\partial X_B} [\sigma u(w_B) - e]\, H_B + \frac{\partial \psi_B}{\partial X_B} [u(w_B) - e]\, L_B \\ &\quad - \frac{\partial \theta_A}{\partial X_A} [\sigma u(w_A) - e]\, H_A - \frac{\partial \psi_A}{\partial X_A} [u(w_A) - e]\, L_A. \end{aligned} \tag{22}$$

The sign of Γ^X is uncertain. While the reaction of the unemployment rate to an increase in labor supply tends to be larger in the poorer region, the expected loss in utility from an additional unemployed is higher in the rich region. Migration reduces skill-specific unemployment rates in the sending region and increases these group unemployment rates in the receiving region.

Thus, migration of an individual of type k from region B to region A is efficient if

$$\left(1 - p_A^k\right) \left[u(w_A^k) - e\right] - \left(1 - p_B^k\right) \left[u(w_B^k) - e\right] - d + \Gamma^k > 0. \tag{23}$$

Similarly, the social planner will choose to qualify those workers being born in region A for whom

$$(1-\theta_A)\left[u(w_A^H)-e\right]-(1-\psi_A)\left[u(w_A^L)-e\right]-c+\Gamma_A>0 \qquad (24)$$

is valid. Finally, a worker born in region B should acquire human capital if

$$\max\left\{\begin{array}{c}(1-\theta_B)\left[u(w_B^H)-e\right]-(1-\psi_B)\left[u(w_B^L)-e\right]\\ -c+\Gamma_B,\\ (1-\theta_A)\left[u(w_A^H)-e\right]-(1-\psi_B)\left[u(w_B^L)-e\right]\\ -c-d+\Gamma_B+\Gamma^H\end{array}\right\}>0 \qquad (25)$$

holds. Comparing these conditions to the individuals' criteria reveals that the unemployment benefit is a source of distortion. As the probability of receiving this benefit is higher for low-skilled workers, the number of workers who acquire skills is too small. As with given skills the share of unemployed is higher in the poor region, the number of migrants is also too small from a social point of view. This consideration is slightly modified by the general equilibrium externalities.

Proposition 3 characterizes the optimal subsidies.

Proposition 3: *A corrective region-specific education subsidy σ_j that achieves a perfect internalization is characterized by $\sigma_j=\left(\psi_j-\theta_j\right)u(\overline{w})+\Gamma_j$, while the optimum type-specific migration subsidy ρ^i can be written as $\rho^i=(p_B^i-p_A^i)\,u(\overline{w})+\Gamma^i$. The level of the respective subsidy always falls short of the full education or migration cost of the marginal individual.*

Proof. See Appendix E. □

Neglecting the presumably small general equilibrium externalities, Proposition 3 can be interpreted as follows. The higher the unemployment differential across skill groups or regions is, the higher the optimal subsidy will be. As a reduction in the overall unemployment rate will typically decrease these differentials, we may also expect that such subsidies tend to be higher in countries with a higher national unemployment rate.

The second part of Proposition 3 shows that the marginal individual will always have to bear part of the investment or migration cost. This is of course a natural consequence of the fact that each type of human capital investment decision is always associated with a gain in expected wage income. However, it also indicates that it generally does not make sense to subsidize education and migration at a rate of 100% for the individuals with the highest cost level. Otherwise, we would end up with only skilled workers, who all choose to live in the rich region A.

This observation casts some doubts on active labor market policies pursued in several countries. It is not unusual that education and training programs for the unemployed are sponsored by the national employment agency at a rate of 100%. When reinterpreting our distribution of education costs as distribution of success probabilities, we should expect that too many people participate in highly subsidized education and training programs. Thus, it is not astonishing that evaluation studies often find zero or small impacts of such programs on subsequent employment probabilities and earnings of the participants.

Under a perfect information scenario, it is always possible to achieve a Pareto improvement on the resulting allocation without subsidies. This is obviously true because total output net of all costs increases. The Pareto improvement would be implemented by taxing residual income and distributing the proceeds as type-specific transfers to workers, where changes in unemployment contributions are to be taken into account. Neglecting the changes in residual income and unemployment contributions, all workers in the rich region lose by moving to an allocation with efficient investment levels. The necessary transfers to ensure the status quo level of expected utility will be highest for the marginal types who still invest in education or migration. It cannot be excluded that negative minimum transfers arise for individuals in the poor region who do not change their education decision.

By contrast, if the government cannot observe the type of the individual, it will generally no longer be possible to implement a self-financing mechanism that induces all individuals to take the efficient investment decisions and makes everybody better off (see Kolmar and Meier, 2005, for a more general discussion). In this situation, transfers for revealing the type or inducing particular decisions have to be high enough to ensure a gain in expected utility for the most unfortunate type. Unlike the perfect information scenario, low-cost types cannot be deterred from taking up these high transfers. In other words, education and migration subsidies cannot be restricted to individuals close to the threshold levels. Thus, due to the windfall profits arising for individuals with a low cost of education or a low cost of migration, it is generally impossible to design a tax-transfer system that induces efficient decisions and is preferred by everyone to the status quo.

6 Conclusions

We have developed a framework that mirrors the stylized facts of regional wage and employment patterns, where the low-wage regions display disproportionally high unemployment rates. The possibility of migration to a richer region encourages human capital acquisition. As the absolute skill premium adjusted by the incidence of unemployment and unemployment benefits is higher in richer regions, the interregional adjusted wage differentials will be higher for skilled individuals. This yields some brain drain out of poor regions. The outflow of labor then drives the skill premium in poor regions up and increases incentives for human capital acquisition also for those who choose not to migrate.

Regional shocks tend to be distributed symmetrically across all regions. Additional international migration to rich regions will offset interregional migration. Hence, labor supply, wages and unemployment rates tend to display similar reactions in all regions. Skill-biased technological change tends to yield stronger incentives for human capital accumulation and interregional migration and will bring down wages of the unskilled.

In a political perspective, apart from presumably small general equilibrium effects, unemployment yields two distortions on human capital acquisition and migration that work in opposite directions. The skill-specific and interregional unemployment differentials cause too strong incentives, compared to a full employment situation. These are not relevant for politics when unemployment is not associated with externalities. In contrast, unemployment benefits can be received with a higher probability when being unskilled or located in poorer regions. As savings on aggregate unemployment benefits are not taken into account by individuals, education and migration incentives are associated with positive fiscal externalities. The existence of such externalities call for some subsidization of education and migration. At the same time, the extremely high subsidies in some education and training programs of active labor market policies seem to be exaggerated.

An obvious alternative to the current setup would be a framework with a stochastic success of education. People would then be differentiated according to their success probability instead of their cost of education. Such a change is not expected to bring about qualitatively different results, however. A more serious shortcoming may be seen in the absence of savings decisions and changes of technology. Imitation and investment in physical capital may reduce interregional differences in the productivity of labor, which would bring down both unemployment rates and interrregional migration. On the other hand, technological progress will primarily be achieved in rich regions due to the concentration of skilled labor, which in turn also attracts investment of physical capital. Hence, while integrating such dynamic factors tends to bring aggregate unemployment down, it is unclear in advance how they affect the size of interregional differences.

Appendix

A: Proof of Lemma 1

Suppose that $c_A > d^H + c_B$. Consider a cost combination (c, d) with $c_B < c + d < c_A$ and $d > d^H$. As $c > c_B$ and $d > d^H$, we would have a situation in which remaining a low-skilled worker in region B is superior to becoming a high-skilled worker in region B and the latter option is preferable to becoming a high-skilled worker and migrating to the rich region. These two claims contradict the implication of $c+d < c_A$, that becoming a high-skilled worker and migrating to region A is preferable to staying as a low-skilled worker in region B.

Suppose that $c_A < d^H + c_B$. Consider a cost combination (c, d) with $c + d > c_A$, $d < d^H$ and $c < c_B$. As $c < c_B$ and $d < d^H$, remaining a low-skilled worker in region B is inferior to becoming a high-skilled worker in region B, and the latter option is inferior to becoming a high-skilled worker and migrating to the rich region. These two claims contradict the implication of $c + d > c_A$, that becoming a high-skilled worker and migrating to region A is inferior to staying as a low-skilled worker in region B.

B: Proof of Lemma 2

Claim (i) is a consequence of $\widetilde{c}_B(d) = c_A$ for $d = 0$, while $\widetilde{c}_B(d) < c_A$ for any $d > 0$. Claim (ii) is immediate from $\widetilde{c}_B(d) = c_B$ for $d \geq d^H$, while $\widetilde{c}_B(d) > c_B$ for any $d < d^H$. Taking into account the independence of the variables c and d, the share of skilled workers among the stayers is bounded from above by $F(c_B) = \int_0^{c_B} f(c)dc$. The share of skilled workers among the natives in region A is $F(c_A)$. Recalling that $c_A > c_B$ and $f(c) > 0$ for $c \in [c_B, c_A]$ then proves claim (iii). Finally, claim (iv) is true because the properties (ii) and (iii) are valid.

C: Proof of Proposition 1

According to the implicit function theorem we get $\frac{dw_i}{dN_j} = -\frac{\Delta_{N_j w_i}}{\Delta}$, where $\Delta_{N_j w_i}$ is the determinant of the Jacobian of the system (13)-(14), where the column vector of derivatives with respect to w_i has been replaced by the column vector of derivatives with respect to N_j. The latter column vectors are

$$\begin{bmatrix} G''_A\left[(1-\theta_A)\,\sigma\frac{\partial H_A}{\partial N_A} + (1-\psi_A)\,\frac{\partial L_A}{\partial N_A}\right] \\ 0 \end{bmatrix}$$

and

$$\begin{bmatrix} G''_A\left[(1-\theta_A)\,\sigma\frac{\partial H_A}{\partial N_B} + (1-\psi_A)\,\frac{\partial L_A}{\partial N_B}\right] \\ G''_B\left[(1-\theta_B)\,\sigma\frac{\partial H_B}{\partial N_B} + (1-\psi_B)\,\frac{\partial L_B}{\partial N_B}\right] \end{bmatrix},$$

for derivatives with respect to N_A and N_B, respectively. As $\frac{\partial G'_B}{\partial w_B} - 1 < 0$ and $\Delta > 0$ are required by the stability conditions where the boundary cases $\Delta = 0$ and $\frac{\partial G'_B}{\partial w_B} = 1$ are ignored, it follows that

$$\begin{aligned}
sgn\left[\frac{\partial w_A}{\partial N_A}\right] &= sgn\left\{G''_A\left[(1-\theta_A)\,\sigma\frac{\partial H_A}{\partial N_A} + (1-\psi_A)\,\frac{\partial L_A}{\partial N_A}\right]\right\} < 0, \\
sgn\left[\frac{\partial w_B}{\partial N_A}\right] &= sgn\left\{G''_A\left[(1-\theta_A)\,\sigma\frac{\partial H_A}{\partial N_A} + (1-\psi_A)\,\frac{\partial L_A}{\partial N_A}\right]\frac{\partial G'_B}{\partial w_A}\right\} \\
&= -sgn\left[\frac{\partial G'_B}{\partial w_A}\right] < 0, \\
sgn\left[\frac{\partial w_A}{\partial N_B}\right] &= -sgn\left\{G''_A\left[(1-\theta_A)\,\sigma\frac{\partial H_A}{\partial N_B} + (1-\psi_A)\,\frac{\partial L_A}{\partial N_B}\right]\left[\frac{\partial G'_B}{\partial w_B} - 1\right]\right. \\
&\quad \left. -G''_B\left[(1-\theta_B)\,\sigma\frac{\partial H_B}{\partial N_B} + (1-\psi_B)\,\frac{\partial L_B}{\partial N_B}\right]\frac{\partial G'_A}{\partial w_B}\right\} < 0, \\
sgn\left[\frac{\partial w_B}{\partial N_B}\right] &= -sgn\Delta_{N_B w_B} < 0.
\end{aligned}$$

Unemployment rates change inversely to the wage rates according to (7). Further, Lemma 1 implies that c_i decreases with a falling wage w_i.

D: Proof of Proposition 2

The column vectors of derivatives of the system of equations (13)-(14) with respect to β_A, β_B, and σ are

$$\begin{bmatrix} G'\left(\left(1-\theta_A\right)\sigma H_A + \left(1-\psi_A\right)L_A\right) \\ 0 \end{bmatrix},$$

$$\begin{bmatrix} 0 \\ G'\left(\left(1-\theta_B\right)\sigma H_B + \left(1-\psi_B\right)L_B\right) \end{bmatrix},$$

$$\begin{bmatrix} G''_A\left[\left(1-\theta_A\right)H_A\right] \\ G''_B\left[\left(1-\theta_B\right)H_B\right] \end{bmatrix}.$$

Taking into account the stability conditions, the implicit function theorem yields

$$\begin{aligned}
sgn\left[\frac{\partial w_A}{\partial \beta_A}\right] &= sgn\left[G'\left(\left(1-\theta_A\right)\sigma H_A + \left(1-\psi_A\right)L_A\right)\right] > 0, \\
sgn\left[\frac{\partial w_B}{\partial \beta_A}\right] &= sgn\left[\frac{\partial G'_B}{\partial w_A} G'\left(\left(1-\theta_A\right)\sigma H_A + \left(1-\psi_A\right)L_A\right)\right] > 0, \\
sgn\left[\frac{\partial w_A}{\partial \beta_B}\right] &= sgn\left[\frac{\partial G'_A}{\partial w_B} G'\left(\left(1-\theta_B\right)\sigma H_B + \left(1-\psi_B\right)L_B\right)\right] > 0, \\
sgn\left[\frac{\partial w_B}{\partial \beta_B}\right] &= sgn\left[G'\left(\left(1-\theta_B\right)\sigma H_B + \left(1-\psi_B\right)L_B\right)\right] > 0, \\
sgn\left[\frac{\partial w_A}{\partial \sigma}\right] &= sgn\left[\frac{\partial G'_A}{\partial w_B} G''_B\left[\left(1-\theta_B\right)H_B\right]\right. \\
&\quad \left. -\left(\frac{\partial G'_B}{\partial w_B} - 1\right) G''_A\left[\left(1-\theta_A\right)H_A\right]\right] < 0, \\
sgn\left[\frac{\partial w_B}{\partial \sigma}\right] &= sgn\left[\frac{\partial G'_B}{\partial w_A} G''_A\left[\left(1-\theta_A\right)H_A\right]\right. \\
&\quad \left. -\left(\frac{\partial G'_A}{\partial w_A} - 1\right) G''_B\left[\left(1-\theta_B\right)H_B\right]\right] < 0.
\end{aligned}$$

Unemployment rates change inversely to the wage rates according to (7).

E: Proof of Proposition 3

Comparing the individuals' choice criteria to the conditions describing the socially optimal investment in education and migration immediately shows that σ_j and ρ^i exactly offset the distortions. The threshold costs in the social optimum are defined by

$$c_j^* = (1 - \theta_j) \left[u(w_j^H) - e\right] - \left(1 - \psi_j\right) \left[u(w_j^L) - e\right] + \sigma_j \tag{26}$$

and

$$d^{i*} = \left(1 - p_A^i\right) \left[u(w_A^i) - e\right] - \left(1 - p_B^i\right) \left[u(w_B^i) - e\right] + \rho^i. \tag{27}$$

As we always have $\theta_j < \psi_j$, $p_A^i < p_B^i$, $w_j^H > w_j^L$, and $w_A^i > w_B^i$, it follows that $0 < \sigma_j < c_j^*$ and $0 < \rho^i < d^{i*}$.

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