ENDOGENOUS SKILL FORMATION AND THE SOURCE COUNTRY EFFECTS OF INTERNATIONAL LABOR MARKET INTEGRATION

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Abstract

With endogenous skills and given technology, labor market integration necessarily lowers welfare of the left-behind in a poor sending country, even if all agents face identical emigration probabilities. This is in sharp contrast to the case of exogenous skill supply.

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1 Introduction

There is a well-established literature on the interplay between globalization and human capital formation. While previous studies have focused on the nexus between education and trade liberalization[1], the role of skill formation in the process of labor market integration has received less attention.[2] This is surprising for two reasons: first, there is persuasive empirical evidence on the increasing importance of international labor mobility (see Docquier and Marfouk, 2006) and, second, labor market integration clearly exhibits an effect on expected wage rates and thus on education incentives.

This note sheds light on the consequences of labor market integration for per capita income and welfare of the left-behind source country population. It also determines the distributional consequences within this group. To highlight the role of endogenous education choices, we model emigration as the outcome of a lottery with the same probability of emigration for all skill groups.[3] In this case, and if skills are exogenous, GDP per capita and welfare of the left-behind do not depend on the emigration rate. However, if changes in the emigration probability lead to adjustments in the skill composition, both GDP per capita and welfare of the left-behind must fall. The reason is that labor market integration dissociates *ex ante* education incentives of potential emigrants and the *ex post* skill intensity which would be optimal for non-migrants. This is a fairly general result that does not hinge on specific assumptions on the production technology or on the distribution of innate ability in the population.

In the next section, we set up our theoretical framework. The results are derived in

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[1]See Findlay and Kierzkowski (1983) for an early contribution, and Janeba (2003) for more recent work.

[2]Recent theoretical work on the brain drain is an exception (see Stark *et al.* 1998, and Beine *et al.*, 2007, and the references therein).

[3]Docquier and Marfouk (2006) estimate rates of emigration into OECD countries by skill group. On average, educated workers are more mobile. However, the degree of heterogeneity is high: In the two largest source countries, Mexico and Turkey, emigration rates do not depend on skills. In addition emigration rates for low-skilled workers may be substantially underestimated, as the data ignores low-skilled illegal immigrants). In a supplement, which is attached to this working paper, we account for the case of brain drain where only high-skilled workers may emigrate. It turns out that our main results do not depend on the assumption of identical emigration probabilities across skill groups.

Section 3. Section 4 briefly discusses the robustness of our findings.

2   Model setup

We consider a small one-sector economy, 'South'. The representative firm employs high-skilled (H) and low-skilled labor (L) to manufacture a homogeneous good Y, according to a linear-homogeneous production function, which we write in intensive form as $Y = Lf(h)$, where $h \equiv H/L$. $f(\cdot)$ has the usual properties $f'(\cdot) > 0$ and $f''(\cdot) < 0$ and satisfies the Inada conditions. All markets are perfectly competitive and workers are paid their marginal products.

The population size in the small economy is normalised to one. The local supply of high-skilled and low-skilled labor is endogenous and depends on two things: the education decision of individuals and the emigration rate of high-skilled and low-skilled workers. Individuals differ with respect to their innate learning ability $a \in [0,1]$ which is distributed according to some c.d.f. $G(a)$, with $G'(a) > 0$. Educated agents supply a efficiency units of high-skilled labor H, while uneducated ones supply one unit of low-skilled labor L. Hence, $1-a$ describes the private cost of education in terms of lower working time. Risk neutral agents maximize expected income by choosing whether or not to get educated. The expected income depends on learning abilities, wages and the propensity to emigrate for the two skill types. Throughout our analysis, we focus on the empirically relevant case and assume that Southern total factor productivity (TFP) is so low that both skill types benefit from emigration to the large, rich 'North', whose wages are exogenous from the Southern perspective. Following Stark *et al.* (1998), Beine *et al.* (2001, 2007), emigration is modeled as a lottery outcome. All individuals face the same probability of successful emigration, $p \in (0,1)$.

Using subscripts to denote skill classes and an asterisk for Northern magnitudes, *expected wages per efficiency unit* are given by $w_H^e = pw_H^* + (1-p)\,w_H$ and $w_L^e = pw_L^* + (1-p)\,w_L$. The marginal individual $\bar{a}$, that is indifferent between education and non-education, is determined by the condition $\bar{a} = 1/\omega^e$, where $\omega^e \equiv w_H^e/w_L^e$ is the expected skill premium. One can rewrite that condition in terms of *within-country wage*

inequality measures $\omega \equiv w_H/w_L$ and $\omega^* \equiv w_H^*/w_L^*$, and *between-country income inequality* $q \equiv w_L^*/w_L$:

$$\bar{a} = \frac{1}{\omega^e} = \frac{1 - p + pq}{(1 - p)\,\omega + p\omega^* q}. \tag{1}$$

The supply of low-skilled and high-skilled (non-emigrated) labor is given by $L^s = (1 - p)G(\bar{a})$, and $H^s = (1 - p)\int_{\bar{a}}^1 a dG(a)$, respectively. Labor market clearing implies that the skill intensity of Southern production is given by

$$h(\bar{a}) \equiv \frac{\int_{\bar{a}}^1 a dG(a)}{G(\bar{a})}, \tag{2}$$

where $\lim_{\bar{a}\to 0^+} h(\bar{a}) = \infty, \lim_{\bar{a}\to 1^-} h(\bar{a}) = 0$, and $dh(\bar{a})/d\bar{a} < 0$. Clearly, without a skill-bias in the emigration probability, any shock that improves the incentives for education results in higher h.

The competitive wage premium in South and between country income inequality are given by

$$\omega = \frac{f'(h(\bar{a}))}{f(h(\bar{a})) - h(\bar{a})f'(h(\bar{a}))} \text{ and } q = \frac{w_L^*}{f(h(\bar{a})) - h(\bar{a})f'(h(\bar{a}))} \tag{3}$$

where the first expression implies a positive relationship between ω and $\bar{a}$. The equilibrium cut-off ability, skill intensity, and wage inequality are jointly determined by equations (1)-(3). Figure 1 illustrates the equilibrium in $1/\omega^e, \bar{a}$-space. The upward-sloping 45-degree line depicts the left-hand-side of (1). Substituting (2) into (3) and using the resulting expression in (1), the right-hand-side of (1) gives a function $\Omega(\bar{a}) > 0$ with $\Omega'(\bar{a}) < 0$ and $\lim_{\bar{a}\to 0} \Omega(\bar{a}) = \infty$. Hence, there exists a unique equilibrium, with the equilibrium cutoff ability level being denoted by $\bar{a}_p$ to indicate the dependence of the cutoff level on the prevailing emigration rate, p.

From Figure 1, we can also read off the comparative-static effects of a change in p on $\bar{a}_p$. Noting $\partial\Omega(\cdot)/\partial p >, =, < 0$ if $\omega >, =, < \omega^*$ and $\Omega'(\cdot) < 0$ (from above), it follows from the implicit function theorem that an increase in p shifts, for a given ω^e, the Ω-locus in figure 1 to the right (to the left) if $\omega > \omega^*$ ($\omega < \omega^*$), leading to a higher (lower) cutoff ability level $\bar{a}_p$.[4] Hence, the *incentive effect* of the emigration lottery depends on a

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[4]In the borderline case of $\omega = \omega^*$, the position of the Ω-locus remains unaffected and $\bar{a}_p$ becomes independent of p.
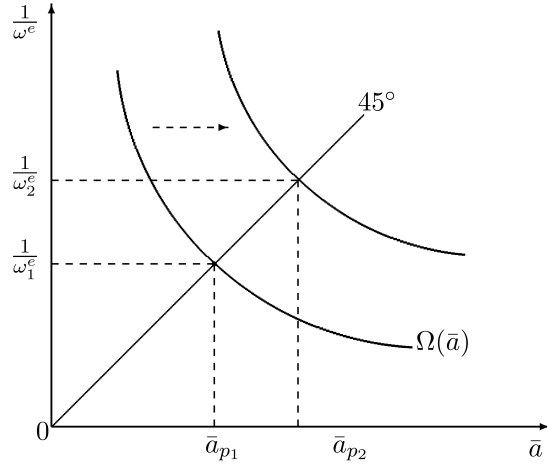
Figure 1: Determination of equilibrium and comparative statics if $\omega > \omega^*$.

comparison of within-country wage inequality measures. Recent empirical evidence shows that the Theil coefficient of *wage* inequality is 0.07 in the 119 poorest countries while it is 0.03 in the richest 25 (Galbraith and Lu, 2001).[5] This indicates that wage inequality is substantially larger in poor source countries of emigration relative to rich (mainly OECD) destination countries. Hence, in the empirically relevant case, we can expect a higher probability of successful emigration to have a positive impact on $\bar{a}_p$ and thus a negative impact on the incentives for education.[6] However, our main welfare results do not require any assumption on the relation between ω and ω^*.

3 Welfare and distribution effects of an emigration lottery

For the welfare analysis, we look at Southern non-migrants and use changes of their total income as the relevant welfare criterion. Total income of this group is given by $(1 - p)y(\bar{a}_p) = (1 - p)G(\bar{a}_p)f(h(\bar{a}_p))$, where $y(\bar{a}_p)$ denotes GDP per capita and $(1 - p)G(\bar{a}_p) =$

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[5]Similar comparisons hold for *overall* inequality, see Deininger and Squire (1996).

[6]This outcome differs substantially from the findings in the brain drain literature, where the additional education incentives from an increase in the emigration probability has been put forward as a source for a brain gain in the presence of a brain drain (see Stark *et al.*, 1998; Beine *et al.*, 2001).

$(1-p)L^S$ is domestic low-skilled labor supply in equilibrium. The impact of a change in the emigration probability from (p_1 to p_2) on income of the left-behind population can then be written as $V(p_1, p_2) = (1-p_2)[y(\bar{a}_{p_2}) - y(\bar{a}_{p_1})]$.[7] This implies that we can focus on the effect of a change in p on GDP per capita, $y(\bar{a}_p)$, in order to determine the respective welfare effects for non-migrants. Then, the following result is immediate.

Proposition 1. *An increase in the emigration probability p leaves GDP per capita and total income of non-migrants unaffected if cutoff ability level $\bar{a}_p$ and thus the relative skill supply $h(\bar{a}_p)$ are constant. If the increase in p leads to an adjustment of $\bar{a}_p$ and thus $h(\bar{a}_p)$, then both GDP per capita and total income of non-migrants must decline ($V(p_1, p_2) < 0$).*

Proof. We can write $dy(\bar{a}_p)/dp = [dy(\bar{a}_p)/d\bar{a}_p] \times [d\bar{a}_p/dp]$, where $dy(\bar{a}_p)/d\bar{a}_p = G'(\bar{a}_p) f(h(\bar{a}_p)) + G(\bar{a}_p) f'(h(\bar{a}_p)) h'(\bar{a}_p)$. Substituting $h'(\bar{a}_p) \times [G(\bar{a}_p)/h(\bar{a}_p)] = -G'(\bar{a})[1 + \bar{a}_p/h(\bar{a}_p)]$, according to (2), implies

$$\frac{dy(\bar{a}_p)}{d\bar{a}_p} = G'(\bar{a}_p) \left[f(\cdot) - f'(\cdot)h(\bar{a}_p) \left(1 + \frac{\bar{a}_p}{h(\bar{a}_p)} \right) \right],$$

Using (3) and (1), we obtain

$$\frac{dy(\bar{a}_p)}{d\bar{a}_p} = G'(\bar{a}_p) f'(\cdot) \left[\frac{pq}{\omega[(1-p)\omega + p\omega^* q]} \right] (\omega^* - \omega).$$

Noting from Section 2 that $d\bar{a}_p/dp >, =, < 0$ if $\omega >, =, < \omega^*$, we can conclude that $dy(\bar{a}_p)/dp < 0$ if $\omega \neq \omega^*$ and $dy(\bar{a}_p)/dp = 0$ if $\omega = \omega^*$. Substituting this result in V completes the proof of Proposition 1. $\square$

Labor market integration implies that the incentives for education in the South become increasingly dependent on Northern relative factor prices. However, only local technological conditions are relevant for maximizing GDP per capita (and thus overall income of Southern non-migrants). An increase in p widens the gap between incentives and the optimal relative Southern skill intensity, as long as the factor price differential in the North and the

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[7]The income of the *ex post* non-migrants prior to the change in p is given by $(1-p_1)y(\bar{a}_{p_1}) - (p_2 - p_1)y(\bar{a}_{p_1})$, where $(p_2 - p_1)y(\bar{a}_{p_1})$ denotes the income of *ex post* migrants prior to the change in p. Rearranging terms, the income of the *ex post* non-migrants prior to the change in p can then be written as $(1-p_2)y(\bar{a}_{p_1})$, while the respective income of this group is given by $(1-p_2)y(\bar{a}_{p_2})$ after the change in p.

South do not coincide (i.e., $\omega^* \neq \omega$). If the incentives for education do not change, i.e. if $\bar{a}$ is constant, the relative skill supply remains remains unaffected and so do GDP per capita and total income of the left-behind population. Hence, the negative welfare consequences of labor market integration do not arise in a model with exogenous skill supply, where the skill intensity of production remains unaffected if the emigration probability increases in a skill-neutral way.

Beyond the welfare consequences of emigration within non-migrants, we can also determine the distributional effects in the Southern economy. While the analysis in Section 2 suggests a trivial link between ω and p, education decisions also affect the number of efficiency units provided by the *average* high-skilled worker, so that distribution is also affected by a *compositional* factor. Denote the ratio of average high-skilled and low-skilled factor income by

$$R\left(\bar{a}_p\right) \equiv \omega\rho(\bar{a}_p), \text{ where } \rho(\bar{a}_p) = \frac{\int_{\bar{a}_p}^1 adG(a)}{1 - G(\bar{a}_p)}, \tag{4}$$

corrects ω for the time costs of education. Then, the following Proposition can be derived.

Proposition 2. *An increase in migration probability p raises (reduces) the factor income ratio $R(\bar{a}_p)$, if wage inequality in the South is higher (lower) than wage inequality in the North, i.e. if $\omega > (<)\omega^*$.*

Proof. We can use $h'(\bar{a}_p) < 0$, according to (2), and $d\omega/dh < 0$, according to (3). This implies $d\omega/d\bar{a}_p > 0$. Furthermore, we have $d\rho(\bar{a}_p)/d\bar{a}_p = \left[G'(\bar{a}_p)\int_{\bar{a}_p}^1 (a - \bar{a}_p)dG(a)\right]\Big/[1 - G(\bar{a}_p)]^2 > 0$. Putting together, we obtain $dR(\bar{a}_p)/d\bar{a}_p > 0$. Noting finally $d\bar{a}_p/dp >, =, < 0$ if $\omega >, =, < \omega^*$ from the analysis in Section 2, completes the proof of Proposition 2. $\square$

According to Proposition 2, the distributional consequences of emigration depend on whether wage inequality in the South is more or less pronounced than wage inequality in the North. Emigration into an egalitarian economy raises both wage inequality ω and average high-skilled relative to average low-skilled factor income $R(\bar{a}_p)$ in the South. The opposite holds true for emigration into a non-egalitarian country (with $\omega^* > \omega$). As empirical stylized facts indicate that wage inequality in the South is higher than wage

inequality in the North, we can conclude that (skill-neutral) emigration not only lowers overall income of the left-behind but it also raises inequality by increasing $R(\bar{a}_p)$.

4 Robustness and concluding remarks

Before concluding, we consider two simple extensions to check the robustness of our results.

First, in virtually all countries some part of education is provided by the public sector. Denote by D the *fixed* amount of public education spending, which is financed by a proportional tax $\tau \in (0,1)$ on local wage income. With respect to the education technology, we abstract from rivalry and let an educated worker with ability a supply aD efficiency units of high-skilled labor. The government budget constraint is

$$D = \tau(1-p)G(\bar{a}_p)f\left(h\left(\bar{a}_p\right)\right). \tag{5}$$

Proposition 1 states that, if $\omega \neq \omega^*$, emigration lowers GDP per capita, $y(\bar{a}_p) = G(\bar{a}_p)f(h(\bar{a}_p))$. Hence, with D constant, equation (5) implies that the tax burden for non-migrants increases. All other things equal, this reinforces the negative effects of a migration lottery on the group of non-migrants.[8]

Second, there may be a positive externality of a better educated workforce. To account for this channel of influence let total factor productivity (TFP; A) depend on overall skill intensity in Southern production $h(\bar{a}_p)$, so that $y = A\left(h\left(\bar{a}_p\right)\right) G\left(\bar{a}_p\right) f\left(h\left(\bar{a}_p\right)\right)$. Then, with $\omega^* > \omega$, an increase in p would stimulate education and result in a higher skill intensity of Southern production. This leads to a higher TFP level and therefore counteracts the negative income effects described in Proposition 1. Depending on the strength of this externality it cannot be generally excluded that a higher emigration rate makes the left-behind population better off. However, in the empirically relevant case with $\omega^* < \omega$, the welfare loss materializes *a fortiori*.

To conclude, this note argues that labor market integration is likely to hurt non-migrants in poor countries and, to the extent that rich destination countries are relatively

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[8]In the presence of migration, the Southern policy makers may want to cut back on D. This incentive is taken into account in Egger *et al.* (2007).

egalitarian, it tends to raise inequality in source countries.

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Supplement

Quality-selective migration lottery

In sections 2 and 3, we have studied the implications of a non-discriminatory migration lottery. In this section, we will briefly discuss the consequences of "quality-selective" migration policies, by assuming $p_H > p_L = 0$. For the purpose of tractability, we consider a Cobb-Douglas production technology: $Y = G(\bar{a})h_E^\alpha$, with $h_E \equiv (1 - p_H)h(\bar{a})$ and $\alpha \in (0, 1)$. Then the following Proposition can be formulated.

Proposition 3. *Under a Cobb-Douglas production technology, introduction of a quality-selective migration policy (with $p_H > p_L = 0$) reduces cutoff ability $\bar{a}$, GDP per capita y and total income of non-migrants in the Southern economy.*

Proof. A formal proof of Proposition 3 is presented below. □

If the North introduces a quality-selective migration policy, high-skilled workers face an emigration probability $p_H > 0$, while all low-skilled workers remain immobile. All other things equal, this raises the expected skill premium per efficiency unit ω^e (as $w_H^* > w_H$ has been assumed) and therefore provides additional incentives for acquiring education. As a consequence, cutoff ability $\bar{a}$ declines. Similar to the baseline scenario with identical emigration probabilities across skill groups, a positive emigration probability, $p_H > 0$, drives a wedge between the *ex ante* education incentives of potential emigrants and the *ex post* skill-intensity which would be optimal for non-migrants. This reduces GDP per capita and total income of non-migrants.

While it is unambiguous that the overall impact of a quality selective migration lottery on non-migrants is negative, its distributional consequences are less clear. This has the following reason. In the case of a Cobb-Douglas production technology, the skill premium is given by $\omega = [\alpha/(1 - \alpha)][(1 - p_H)h(\bar{a})]^{-1}$. Noting $h'(\bar{a}) < 0$, according to (2), there are two counteracting effects of a marginal p_H increase on skill premium ω. On the one hand, for a given $\bar{a}$, the outflow of high-skilled workers reduces the skill intensity of Southern production and therefore raises the skill premium. On the other hand, a decline in the

cutoff ability level implies that more people acquire education, so that high-skilled labor becomes a less scarce resource. For a given p_H this leads to a lower skill premium. It is in general not clear, which of the two effects dominates. However, it is intuitive that the second effect is stronger if the elasticity of labor supply with respect to cutoff ability $\bar{a}$ is sufficiently high. As the impact of a p_H increase on the skill premium per efficiency unit turns out to be ambiguous, it is not surprising that its impact on relative factor return Ω is ambiguous, as well. The compositional effect, however, reinforces the indirect negative effect on ω, so that a decline in the skill premium is sufficient for a decline in relative factor return Ω.

Proof of Proposition 3

Consider $p_H > p_L = 0$ and $f(h_E) = h_E^\alpha$. Then, the equilibrium cutoff ability level is implicitly determined by

$$\Gamma(\bar{a}, p_H) \equiv \frac{(1-\alpha)h_E^\alpha}{p_H w_H^* + (1-p_H)\alpha h_E^{\alpha-1}} - \bar{a}, \tag{S1}$$

with $h_E = (1-p_H)h(\bar{a})$. Applying the implict function theorem, we obtain

$$\frac{d\bar{a}}{dp_H} = -\frac{\partial\Gamma/\partial h_E \times (1-p_H)dh(\bar{a})/d\bar{a} - 1}{\partial\Gamma/\partial p_H - \partial\Gamma/\partial h_E \times h(\bar{a})}. \tag{S2}$$

Noting $\partial\Gamma/\partial h_E > 0$, $\partial\Gamma/\partial p_H < 0$ (due to $w_H^* > w_H$) and $h'(\bar{a}) < 0$ (from (2)), proves $d\bar{a}/dp_H < 0$.

Let us next consider the impact of p_H on GDP per capita. For his purpose, we consider

$$y = \frac{G(\bar{a})[(1-p_H)h(\bar{a})]^\alpha}{1-p_H(1-G(\bar{a}))} \equiv \tilde{y}(\bar{a}, p_H). \tag{S3}$$

Differentiating $\tilde{y}(\cdot)$ with respect to $\bar{a}$ gives

$$\frac{\partial\tilde{y}(\cdot)}{\partial\bar{a}} = \frac{G'(\bar{a})y\xi(\bar{a}, p_H)}{G(\bar{a})[1-p_H(1-G(\bar{a}))]}, \tag{S4}$$

with $g(a) = dG(a)/da$ and

$$\xi(\bar{a}, p_H) \equiv (1-p_H) - \alpha\left[1-p_H(1-G(\bar{a}))\right]\frac{h(\bar{a})+\bar{a}}{h(\bar{a})}. \tag{S5}$$

Noting $\lim_{\bar{a} \to 0^+} \xi(\cdot) = (1-\alpha)(1-p_H)$, $\lim_{\bar{a} \to 1^-} \xi(\cdot) = -\infty$ and $\partial \xi / \partial \bar{a} < 0$, it is obvious that, for any $p_H \in [0, 1)$, there exists a unique $\bar{a}^*(p_H) \in (0, 1)$ that maximizes $\tilde{y}(\cdot)$.

Differentiating $\tilde{y}(\cdot)$ with respect to p_H, we further obtain

$$\frac{\partial \tilde{y}(\cdot)}{\partial p_H} = \frac{(1-G(\bar{a}))y\psi(\bar{a}, p_H)}{(1-p_H)[1-p_H(1-G(\bar{a}))]}, \tag{S6}$$

with

$$\psi(\bar{a}, p_H) \equiv (1-p_H) - \alpha[1-p_H(1-G(\bar{a}))]\frac{1}{1-G(\bar{a})}. \tag{S7}$$

Comparing (S5) and (S7), we see that

$$\xi(\cdot) >, =, < \psi(\cdot) \quad \Longleftrightarrow \quad G(\bar{a})h(\bar{a}) >, =, < (1-G(\bar{a}))\bar{a}. \tag{S8}$$

Noting $G(\bar{a})h(\bar{a}) - (1-G(\bar{a}))\bar{a} = \int_{\bar{a}}^1 (a - \bar{a})dG(\bar{a}) > 0$, according to (2), we can therefore conclude that $\xi(\cdot) > \psi(\cdot)$. This, however, implies that $\partial \tilde{y}/\partial p_H|_{\bar{a}=\bar{a}^*} < 0$. Consider a lottery with $p_H^0 \in (0, 1)$ (and $p_L = 0$) and denote by $\bar{a}_0$ the respective cutoff ability level under decentralized education decisions. Then, it follows from eqs. (S4) and (S5) that there exists a $\bar{a}^*(p_H^0) \in (0, 1)$ which leads to $\tilde{y}(\bar{a}^*, p_H^0) \geq \tilde{y}(\bar{a}_0, p_H^0)$ – where a strict inequality holds if $\bar{a}^* \neq \bar{a}_0$. Furthermore, it follows from eqs. (S6)-(S8) that there exists a $p_H^1 < p_H^0$, such that $\tilde{y}(\bar{a}^*, p_H^1) > \tilde{y}(\bar{a}^*, p_H^0)$. Noting that $\bar{a}^* = \bar{a}_0$ if $p_H^0 = 0$, this proves that introduction of a quality-selective migration lottery with $p_H > p_L = 0$ reduces GDP per capita in the Southern economy.[9]

In a final step, we have to show that a quality-selective migration lottery with $p_H > p_L = 0$ lowers total income of Southern non-migrants. We use indices 1 and 0 to refer to a situation with and without migration, respectively. Then, $w_H^0 H_0^S + w_L^0 L_0^S$ denotes total Southern factor income in the absence of migration. Furthermore, $p_H w_H^0 H_0^S + p_H w_L^0 (L_0^S - L_1^S)$ denotes wage payments to workers who emigrate after introduction of a quality-selective migration lottery. Finally, total wage income of non-migrants after introduction

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[9]Evaluating (S1) at $p_H = 0$ gives $\bar{a} = [(1-\alpha)/\alpha]h(\bar{a})$. Furthermore, substituting (S5) into (S4) end evaluating the resulting expression at $p_H = 0$ gives $\partial \tilde{y}(\cdot)/\partial \bar{a} = G'(\bar{a})f(h(\bar{a}))[(1-\alpha) - \alpha\bar{a}/h(\bar{a})]$. This proves that the decentralized education decisions maximize GDP per capita if $p_H = 0$, implying $\bar{a}^* = \bar{a}_0$ in this case.

of a migration lottery is given by $(1 - p_H)w_H^1 H_1^S + w_L^1 L_1^S$. Hence, the introduction of a migration lottery has a negative (positive) impact on total income of non-migants if

$$w_H^0 H_0^S + w_L^0 L_0^S - p_H w_H^0 H_0^S - p_H w_L^0 (L_0^S - L_1^S) > (<)(1 - p_H)w_H^1 H_1^S + w_L^1 L_1^S. \quad \text{(S9)}$$

Rearranging terms, we can rewrite inequality (S9) in the following way:

$$\underbrace{(1 - p_H)H_1^S(w_H^0 - w_H^1) + (w_L^0 - w_L^1)L_1^S}_{\equiv T_1}$$

$$+ \underbrace{(1 - p_H)\left[w_H^0(H_0^S - H_1^S) + w_L^0(L_0^S - L_1^S)\right]}_{\equiv T_2} > (<)0 \quad \text{(S10)}$$

Let us consider the sign of T_1 first. From (S10), it follows that

$$T_1 >, =, < 0 \quad \Longleftrightarrow \quad \frac{(1 - p_H)H_1^S w_H^1}{L_1^S w_L^1}\left(\frac{w_H^0}{w_H^1} - 1\right) >, =, < 1 - \frac{w_L^0}{w_L^1}$$

Noting $f'(h_E) = \alpha h_E^{\alpha-1} = w_H$, $f(h_E) - f'(h_E)h_E = (1-\alpha)h_E^\alpha = w_L$ and $h_E = (1 - p_H)H^S/L^S$, we obtain $(1 - p_H)H_1^S w_H^1/(L_1^S w_L^1) = \alpha/(1 - \alpha)$. This implies $T_1 >, =, < 0$ $\Leftrightarrow \alpha w_H^0/w_H^1 + (1 - \alpha)w_L^0/w_L^1 >, =, < 1$. Noting further that $w_H^0/w_H^1 = (h_E^0/h_E^1)^{\alpha-1}$, $w_L^0/w_L^1 = (h_E^0/h_E^1)^\alpha$ and using $\eta \equiv h_E^0/h_E^1$, we can therefore conclude:

$$T_1 >, =, < 0 \quad \Longleftrightarrow \quad \eta^\alpha\left[\alpha\eta^{-1} + (1 - \alpha)\right] >, =, < 1. \quad \text{(S11)}$$

Differentiating $\zeta(\eta) \equiv \eta^\alpha\left[\alpha\eta^{-1} + (1 - \alpha)\right]$, we see that $\zeta'(\eta) < 0$ if $\eta \in (0, 1)$, while $\zeta'(\eta) > 0$ if $\eta > 1$. Put differently, $\zeta(\eta)$ has a minimum at $\eta = 1$. According to (S11), this implies $T_1 \geq 0$ (with a strict inequality if $\eta \neq 1$).

To determine the sign of T_2, we use $H_1^S - H_0^S = \int_{\bar{a}_1}^{\bar{a}_0} a\, dG(a)$ and $L_0^S - L_1^S = \int_{\bar{a}_1}^{\bar{a}_0} 1\, dG(a)$. Noting further $w_L^0 = \bar{a}_0 w_H^0$ from (1), we obtain $T_2 = (1 - p)w_H^0 \int_{\bar{a}_1}^{\bar{a}_0}(\bar{a}_0 - a)\, dG(a)$, which is strictly positive as $\bar{a}_0 > \bar{a}_1$ if $p_H > p_L = 0$ and $w_H^* > \max(w_H^0, w_H^1)$ (see above). As a consequence, we have $T_1 + T_2 > 0$, so that non-migrants are worse off after introduction of a quality-selective migration lottery. This completes the proof of Proposition 3. *QED.*

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