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Abstract

This work focuses on a temporary guest-worker-type migration of individuals from the middle class of the wealth distribution. The article demonstrates that the possibility of a low-skilled guest-worker employment in a higher wage foreign country lowers the relative attractiveness of the skilled employment in the home country. Thus it prevents a fraction of individuals from acquiring human capital. Therefore, even if all individuals who acquired education remain in the home country, the actual number of educated workers in the source economy decreases, and the aggregate level of human capital in this economy would thus be negatively affected.

JEL-Code: F220, F430, J130, J240, J610, O150.

Keywords: migration, human capital, fertility, brain drain, economic growth.

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1. Introduction

From 1970s onward, the classical brain drain literature has considered international migration as a detrimental factor to the development of poor countries. This literature has argued that the level of human capital in developing countries is growing slowly because the developed countries "siphon off" their highly educated workers, thus increasing the productivity of developed world at the expense of the developing countries (Bhagwati and Wilson, 1989).

This view has recently been challenged in a range of theoretical publications, such as, for example, Mountford (1997), Stark et al. (1997, 1998), Vidal (1998), Beine et al. (2001, 2008), Stark and Wang (2002), Fan and Stark (2007), among others.[1] This rapidly growing new literature has argued that the possibility of migration to a higher wage foreign country raises the return to education, thus leading to an increase in human capital formation, which can outweigh the negative effect of brain drain in the source economies.[2] More recently, Mountford and Rapoport (2009) demonstrated that a positive effect of a limited brain drain emigration can be found in the model with endogenous fertility as well.[3]

The present paper is related to both these strands of the literature. As in the literature on beneficial brain drain, in the present model an economy open to out-migration differs from an economy closed to migration in the structure of the incentives for acquiring human capital. But, in contrast to this literature, the present model does not assume that the possibility of migration to a higher wage foreign country necessarily raises the return to education. As in the classical brain drain literature, in the present model international migration is a detrimental factor to development in poor countries. But, in contrast to this literature, the present model does not assume that the source of this negative effect is necessarily the out-migration of the most educated workers.

[1] Beine et al. (2008) also provide some empirical evidence in support of this theory.
[2] In contrast, Lien and Wang (2005) suggest that a migration probability may lead to an over-investment in the host-country-specific skills at the expense of an under-investment in the general education, thus leading to a decrease in human capital formation in the source economy.
[3] In a parallel work, Chen (2009) argued that an increase in the probability of out-migration for high-skilled workers creates brain gain as long as it does not cause a significant decrease in the relative fraction of the skilled in the total population.

In this work, I focus on migration of individuals from the middle class of the wealth distribution in the source countries, which represents the majority of international migration for many countries, but has been largely ignored in the discussion of the brain drain. The major contribution of the present paper is to show that the possibility of a low-skilled guest-worker employment in higher wage countries may reduce the relative attractiveness of acquiring education, thus reducing human capital accumulation and economic growth in the source economies. I also expand the brain drain literature toward temporary migration, which represents a significant fraction of international migration (see Borjas and Bratsberg, 1996; Dustmann, 2003; Dustmann and Weiss, 2007 and references therein),[4] although the results of the present paper can be easily generalized for permanent migration.

The present article is motivated by temporary migration for work like migration from Mexico to the United States. Migration flows from Mexico to the US are substantial. Millions of aliens from Mexico work in the US annually. Many of them migrate to the US only temporarily and after some period of stay return to Mexico. Thus, for example, as data reported by the Mexican Migration Project (MMP) indicate, almost 30% of Mexican men of working age interviewed in Mexico reported that they ever worked in the US (Orrenieus and Zavodny, 2005; McKenzie and Rapoport, 2007). Approximately 50 percent of all Mexican migrants have made more than one trip, with a mean 2.8 trips per migrant (McKenzie and Rapoport, 2011).

As has been argued in the literature, these migrants come preponderantly from the middle class of the wealth (and skill) distribution (Chiquiar and Hansen, 2005; Orrenieus and Zavodny, 2005; Hansen, 2006; Mishra, 2007; McKenzie and Rapoport, 2007 and references therein). To explain this pattern of migration, researchers usually argue that the least-skilled individuals do not migrate because they do not have enough resources to pay the costs of migration, while the most skilled individuals – college graduates – do not migrate because the relative return to skill is higher in Mexico than in the US. In the US most of these Mexican guest-workers are employed in relatively low-skilled occupations. Within this context, it has also been shown that the possibility of migration to the US

[4] Several recent publications, including World Bank (2005), advocate more temporary labor migration from low-income to high-income countries through new guest worker programs. See Ruhs and Martin (2008) for

lowers the incentive to acquire education for prospective Mexican immigrants (Antman, 2010; McKenzie and Rapoport, 2011).[5]

Temporary migration from Mexico is not limited to migration to the US. Thus, the Seasonal Agricultural Workers Program that has been in operation since 1974 provides an example of temporary migration from Mexico for work in a low-skilled sector in another higher wage country. Under this program Mexican workers have gone to Canada to work in agriculture for part of the year then returning to Mexico with a possibility to be rehired if their performance is considered satisfactory (see Ruhs and Martin, 2008 for details and references). Sizable temporary immigration to fill low-skilled jobs is also well established in Southeast Asia, with Singapore being a notorious example, and many of the Gulf States (Ruhs and Martin, 2008).[6]

Although little research has been done to date, it seems likely that large guest-worker migration from the former republics of the old Soviet Union to Russia is also similar to Mexican migration to the US. Thus, for example, Grigorian and Melkonyan (2011), who found a strong negative effect of remittances on educational spending in Armenia, argue (p. 147) that "members of remittances-receiving households are likely to later migrate themselves and, therefore, do not value the local education that much". They also point out that most Armenian migrants belong to the middle class. Likewise, popular newspapers in Moldova often complain that Moldovan tend to prefer working in construction in Russia to employment as engineers in Moldova.

Finally, de Brauw and Giles (2006) found that opportunity for migration to urban areas, associated with an increase in the relative return to unskilled labor, has a strong negative effect on the high school enrollment in rural China. Moreover, they show that the effect is stronger in middle class families, in which parents are professionals or had

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further references.

[5] This negative effect of migration on school attendance and the total years of schooling is consistent with the broadly observed low return to foreign education in the US (Friedberg, 2000; Bratsberg and Ragan, 2002; Gonzales, 2003).

[6] See Kaur (2007) for an excellent survey of international labor migration in Southeast Asia. For more detail on the Gulf Cooperation Council (GCC) countries, see, for example, Kapiszewski (2006). It should also be noted that in these regions of the world, migrants also generally do not come from the poorest categories, since, as researchers broadly argue, they are able to cover the costs of migration and, in some cases, are required to satisfy several minimum education criteria.

significant off-farm work experience, which is consistent with the prediction of the present model.

Based on the above empirical background evidence, I present a two-country growth model with endogenous fertility, which borrows elements from Galor and Zeira (1993), Dahan and Tsiddon (1998), Azarnert (2004).[7] The basic idea may be stated as follows. Consider an economy populated with agents who decide whether to invest in human capital or not. If the economy is open to out-migration, the local agents' decision is affected also by the opportunities that exist abroad. Thus, if a higher wage foreign country is interested in recruiting guest-workers for temporary work in a relatively low-skilled sector, where the wage is higher than that in the unskilled sector in a poor source country, the existence of a low-skilled guest-worker employment abroad would limit incentive for agents in the poor source country to acquire education. If the unskilled wage in the foreign country is not too generous relative to the skilled wage in the home country, individuals from the upper part of the wealth distribution will not find it worthwhile to give up their educational opportunities at home for the sake of the unskilled employment abroad. Likewise, if there is some cost of migration that must be paid in advance, and if in the home country credit markets are imperfect, the most poor in the source country will not be able to migrate for work to the foreign country due to their credit constraints. This makes migration optimal only for individuals from the middle class, as consistent with the findings of the large empirical literature.

This leads us to the main insight of the present paper. The possibility of a low-skilled guest-worker employment in a higher wage foreign country lowers a relative attractiveness of the skilled employment in the home country and thus prevents a fraction of individuals from acquiring human capital. Therefore, even if all individuals who acquired education remain in the home country, the actual number of educated workers in the source economy decreases, and the aggregate society-wide level of human capital in this economy would thus be adversely affected. Moreover, as follows from the external spillover effect of human capital, this negative effect can have long-lasting consequences for economic growth in the poor country. This allows us to conclude that the possibility

[7] For a survey of a recent literature on endogenous fertility and growth see Galor (2005); cf. also Azarnert (2009; 2010a).

of a low-skilled guest-worker employment in a higher wage country generates a non-trivial brain drain effect, which has not yet been established in the literature.

The present analysis also suggests that the guest-worker employment abroad increases fertility in the source country, via an income effect, as consistent with standard theory of endogenous fertility.[8] Therefore, it seems possible to hypothesize that guest-worker employment in higher wage developed countries can be considered as one of the reasons for the delay of the decline in population growth in the poor source countries.[9]

2. The Structure of the Economy

Consider a small, open, overlapping-generations economy in which agents live for three periods. In the first period of life, agents are children: each consumes a fixed quantity of his parents' time. In the second period of life individuals can either perform simple tasks (unskilled work) or invest in human capital.

The economy operates in the global world. The world consists of two entities: the home country and the rest of the world consolidated as "the foreign country". For some exogenous reason, the wages in the foreign country are higher than those in the home country. In the second period of their life, individuals can work a fraction of their time in the foreign country as guest workers. This work abroad is only temporary, so that guest workers cannot remain in the foreign country, but must return to their home country.

In the third period of life all individuals work in the home country. They either benefit from higher income, working in the skilled sector, if they invested in human capital, or work as unskilled workers for lower pay. In either case, they decide on their own consumption and the number of their offspring, become parents, and spend time bringing up their children.

[8] A migration-driven reduction in the investment in children's education, as found, for example, by de Brauw and Giles (2006), Antman (2010), Grigorian and Melkonyan (2011), McKenzie and Rapoport (2011), is also likely to shift the quality–quantity tradeoff in favor of quantity.

[9] In some sense, this result echoes the findings of Galor and Mountford (2008) who argue that, while in the developed countries the gains from international trade have been directed primarily toward investment in education and growth of output per capita, a greater proportion of the gains from trade in the developing economies has been channeled toward higher fertility and population growth. Azarnert (2008) suggests that through income effect humanitarian foreign aid increases fertility in the recipient countries.

2.1. Production

In period $t+1$ production of the same aggregate output is performed in two sectors, in which labor is complemented with capital in a Cobb-Douglas form. In the unskilled sector, the level of technology is fixed, while in the skilled sector, the level of technology can change over time.

In the unskilled sector, the output is:

$$Y_t^u = A^u K_t^\alpha (L_t^u)^{1-\alpha}, \quad (1)$$

where L_t^u is the number of the unskilled workers in period t and A^u is the fixed level of technology in this sector.

In the skilled sector, the output is:

$$Y_t^s = A_t K_t^\alpha (L_t^s)^{1-\alpha}, \quad (2)$$

where L_t^s is the total number of skilled workers, and A_t is the level of technology in the skilled sector at time t.

The economy is open, the world interest rate is fixed at r, the firms can borrow at the world interest rate, and competition is perfect. Therefore, the wage of skilled workers (w_t^s) equals:

$$w_t^s = A_t(1-\alpha)(\alpha A_t / r)^{\alpha/1-\alpha}, \quad (3)$$

while the wage of the unskilled worker (w^u) is fixed at:

$$w^u = A^u(1-\alpha)(\alpha A^u / r)^{\alpha/1-\alpha}. \quad (4)$$

In this setting, wages of both skilled and unskilled workers are independent of the skill composition in the economy and do not change with population size. Changes in the wage differential between the skilled and the unskilled may result from changes in the parameters or from technological progress.

Suppose that technological progress is a function of a past society-wide stock of human capital. To capture this effect, assume that A_t is a function of the aggregate level of human capital in the economy in the previous period, $A_t = A(L_{t-1}^s)$. Since human capital per educated person is fixed by construction of this model, an aggregate change

comes out of an increase in the population of educated persons; $A(\cdot) > 0, A'(\cdot) > 0, A''(\cdot) < 0$. Suppose that $\forall t, A_t > A^u$, and therefore in every period $w_t^s > w^u$.

2.2. Utility Maximization

Agents derive utility from consumption in the third period, from leaving bequest behind them ("a direct bequest motive") and from the number of their living children. There is no uncertainty. The utility function of an individual born at time $t-2$ is

$$U_{t-2} = \alpha \ln(C_t) + \beta \ln(N_t) + \gamma \ln(B_t), \quad \alpha + \beta + \gamma = 1, \tag{5}$$

where C_t is third-period consumption, N_t is the number of children, and B_t is the total estate bequeathed.

Suppose that some parents are more altruistic toward their children than others. More altruistic parents put higher weight in their utility function on the estate bequeathed to their offspring, at the expense of the reduction in the weight given to their own consumption. Suppose that the relative weight given to bequest in the utility function is distributed over $[\gamma^{\min}, \gamma^{\max}]$. Thus, for more/ less altruistic parents, a relatively higher/ lower weight given to bequest (γ) is offset by a correspondingly lower/ higher weight given to the individual's own consumption (α), which, correspondingly, is also distributed over $[\alpha^{\min}, \alpha^{\max}]$, such that: $\gamma \overset{+}{\underset{-}{\gtrless}} \varepsilon + \alpha \overset{-}{\underset{+}{\gtrless}} \varepsilon + \beta = 1$. Suppose also that the parameters γ and α are transmitted from generation to generation within a dynasty and remain stationary across time.[10]

An individual's lifetime income (I_t) is spent on consumption, child rearing, and bequest. The cost of rearing children is measured in terms of work time foregone, at δ per child:

[10] This difference with respect to the relative weight given to bequest in the face of a positive cost of migration that has to be paid in advance, as specified in Section 2.3, is used here to generate an "intermediate" selection with respect to migration only and does not affect the main insight of the present work. In the utility function exploited in Galor and Moav (2002) individuals differ with respect to the relative weight given to the quality of their children, while in the utility function used in Azarnert (2010b) individuals differ with respect to the weight given to the child.

$$C_t^j + \delta N_t^j w_t^j + B_t^j = I_t^j, \text{ where } j = u, s, \quad (6)$$

where C_t^j is the third-period consumption of individual in the state of nature j, the second term is the cost of rearing children, w^u is the third period wage for an unskilled unit of work, w_t^s is the third period wage for a skilled unit of work, N_t^j is the corresponding number of children of parent in the state j, and δ is constant. B_t^j is the bequest that an individual in the state j leaves, and I_t^j is the lifetime income in terms of the third period (I_t^j is specified below in Section 2.3).

Each individual maximizes his utility subject to his budget constraint. He has three decision variables: consumption, number of children and bequest. For each generation *t*, the optimal level of each choice variable is

$$C_t^j = \alpha I_t^j, \quad N_t^j = (\beta / \delta w_t^j) I_t^j, \quad B_t^j = \gamma I_t^j, \text{ for } j = u, s. \quad (7)$$

Using (6), the (indirect) utility function at the optimum is

$$U_{t-2}^j = \ln(I_t^j) + \varepsilon_t^j, \quad j = u, s, \quad (8)$$

where

$$\varepsilon_t^j = \alpha \ln(\alpha) + \beta \ln(\beta) + \gamma \ln(\gamma) - \beta \ln(\delta w_t^j), \quad j = u, s.$$

Assuming that parents divide bequest equally among their heirs, one immediately observes that bequest per child is a function of third-period income only and not of the parent's total wealth:

$$(B_t^j / N_t^j) \equiv b_t^j = (\gamma / \beta) \delta w_t^j, \quad j = u, s. \quad (9)$$

Thus, once the choice is set to include the number of offspring, although the bequest is linked across periods through the distribution of the weight given to bequest (γ), system becomes block recursive and wealth per dynasty is not a state variable anymore. Suppose that the size of population is large enough and that bequest distribution is continuous.

2.3. Investment in Human Capital

After childhood each individual has one unit of time in each period of life. In the second period it can be used either for education or work. In the beginning of the second period each individual receives his share of his parent's bequest. Then, the individual decides

whether or not to invest in human capital. An individual who chooses to invest in education spends all his working time in the second period of life at school and pays for that education a constant fraction of the gross skilled wage $h_{t-1} = \theta w_{t-1}^s$. In the third period an adult individual works as a skilled worker, earning w_t^s. An individual who does not invest in human capital engages in unskilled labor in both periods. In the home country an unskilled individual can earn w^u each period.

Suppose that the direct cost of education is not too large: $\theta < (\gamma^{\min} / \beta)\delta$. This assumption guarantees that inheritance within the skilled dynasty is always larger than investment in human capital: $(\gamma^{\min} / \beta)\delta w_{t-1}^s > h_{t-1} = \theta w_{t-1}^s$. If the wedge between the skilled wage (w_t^s) and the unskilled wage (w^u) is large enough, this guarantees that the offspring of skilled parents always invest in education.

In contrast, the offspring of unskilled parents decide in the second period whether or not to invest in human capital. To characterize their decision, first recall that since $\forall\, t$, $w_t^s > w^u$, from equation (9), inheritance within the unskilled dynasty is always smaller than inheritance within the skilled dynasty. To simplify dynamics, suppose that inheritance within an unskilled dynasty is always smaller than the direct cost of investment in human capital: $\theta w_{t-1}^s > (\gamma^{\max} / \beta)\delta w^u$. Suppose also that an individual cannot borrow at the world rate of interest to invest in human capital, and that the rate of interest to borrowers (i) is always higher than the rate of interest to lender (r). Since borrowing rate exceeds the lending rate, an individual from an unskilled dynasty who chooses to invest in human capital borrows only the amount $\theta w_{t-1}^s - b_{t-1}$.

Recall that the economy operates in a global world. Suppose that individuals can work a fraction $F \in [0,1)$ of their time in the second period of life in a higher wage foreign country. Suppose that F is determined solely by the destination country and therefore is exogenously given for individuals in the source country.[11] Suppose also that guest workers can be employed only in the relatively unskilled occupations earning there

[11] A companion assumption that the probability of migration is determined solely by the destination country and thus is exogenous for individuals in the source country is commonly used in the literature (Mountford, 1997; Stark et al, 1998; Vidal, 1998; Beine et al., 2001; 2008; Stark and Wang, 2002; Lien and Wang, 2005; Fan and Stark, 2007; Chen, 2009; Mountford and Rapoport, 2009).

w^{uf}, which is higher than the unskilled wage in the home country ($w^{uf} > w^{u}$). Assume that the migration laws are strictly enforced and therefore guest workers cannot remain in the foreign country, but must return to the home country.

Suppose that in any period t, to migrate for work individuals must pay the amount M, which covers the costs of migration. Suppose also that an individual must pay the cost of migration in advance. This assumption is based on the fact that individuals, who migrate illegally, most commonly, pay a fraction of the smuggler's fee in advance (see Orrenius and Zavodny, 2005; Hansen, 2006 and references therein), while individuals who migrate legally also must pay to the hiring agency in advance. As common in the literature on migration, I assume that the migration costs cannot be financed by borrowing.[12]

Suppose that the wedge between the skilled wage in the home country and the unskilled wage abroad is large enough, and thus the offspring of skilled parents, who, by assumption, always have enough resources to invest in human capital, will not find it worthwhile to give up their educational opportunity at home for the sake of the unskilled work abroad.

As a consequence, in any period $t-1$, individuals, who do not invest in human capital in the second period of their life, migrate for work if and only if the following conditions hold:[13]

$$\begin{cases} Fw^{uf} > Fw^{u} + M \\ b_{t-1} = (\gamma/\beta)\delta w^{u} \geq M \end{cases}. \tag{10}$$

Using (9), for someone born at time $t-2$, the whole potential lifetime income in period three prices is one of the following forms:

$$I_t^u = w^u + w^u(1+(\gamma\delta/\beta))(1+r), \tag{11}$$

if the individual remains unskilled and works in both periods in the home country,

[12] This "cash in advance" constraint is commonly used in the literature on migration and is consistent with the observation that the most poor in the wealth distribution in the countries of origin, who do not have means to migrate, generally, do not migrate. See, for instance, Orrenius and Zavodny (2005), McKenzie and Rapoport (2007) and references therein.

[13] Since a guest worker, who works a fraction of time in the second period of life abroad, works in the third period of life as an unskilled worker in the home country, in this period he faces the same per-child cost of rearing children as an unskilled individual, who did not work abroad. As a result, the fertility-related component is cancelled out in optimization.

$$I_t^{gw} = w^u + ((\gamma\delta/\beta)w^u - M + Fw^{uf} + (1-F)w^u)(1+r), \tag{12}$$

if the individual remains unskilled, but works a fraction of time in period two abroad,

$$I_t^{us} = w_t^s + ((\gamma\delta/\beta)w^u - \theta w_{t-1}^s)(1+i), \tag{13}$$

if the unskilled borrows and invests in human capital,

$$I_t^s = w_t^s + ((\gamma\delta/\beta)w_{t-1}^j - \theta w_{t-1}^s)(1+r), \tag{14}$$

if all investment in human capital is from the individual's personal endowment.

According to equation (8), indirect utility is affected by two factors: one is the lifetime income, and another is the cost of rearing children. The human capital investment decision determines these two factors. It is therefore easy to infer who will choose to invest in human capital by comparing the indirect utility in two states of nature.

The utility of a poor individual who is born in period $t-2$, does not invest in human capital and does not work abroad is

$$U_{t-2}^u = \ln\{w^u + w^u(1+(\gamma\delta/\beta))(1+r)\} + \varepsilon_t^u, \tag{15}$$

while for a poor individual who is born in period $t-2$ and works a fraction F of the time in the second period of his life abroad, the indirect utility is

$$U_{t-2}^{gw} = \ln\{w^u + ((\gamma\delta/\beta)w^u - M + Fw^{uf} + (1-F)w^u)(1+r)\} + \varepsilon_t^u, \tag{16}$$

and for a poor individual who does borrow to invest in human capital, the utility is

$$U_{t-2}^{us} = \ln\{w_t^s + ((\gamma\delta/\beta)w^u - \theta w_{t-1}^s)(1+i)\} + \varepsilon_t^s. \tag{17}$$

Since the wealthy always have enough to invest in human capital, their utility is

$$U_{t-2}^s = \ln\{w_t^s + ((\gamma\delta/\beta)w_{t-1}^s - \theta w_{t-1}^s)(1+r)\} + \varepsilon_t^s. \tag{18}$$

While members of a skilled dynasty always invest in human capital, given the constraint (10), the poor invest in human capital only if the following condition holds:

$$\begin{aligned} &w_t^s + ((\gamma\delta/\beta)w^u - \theta w_{t-1}^s)(1+i) \\ &> (((\gamma\delta/\beta)w^u - M + Fw^{uf} + (1-F)w^u)(1+r) + w^u)(w_t^s/w^u)^\beta \end{aligned} \tag{19}$$

From equation (19), the minimal level of bequest necessary for investment in human capital ($\hat{b}_{t-1}$) is

$$\hat{b}_{t-1} = \frac{w^u + (Fw^{uf} + (1-F)w^u - M)(1+r) - (w_t^s - \theta w_{t-1}^s(1+i))(w^u/w_t^s)^\beta}{(1+i)(w^u/w_t^s)^\beta - (1+r)} \tag{20}$$

From equation (20), it is immediately clear that in any period $t-1$, the minimal size of bequest ($\hat{b}_{t-1}$) that suffices to guarantee investment in education increases with

(*a*) an increase in the wage that a guest worker can earn in the foreign country (w^{uf}),

(*b*) an increase in the fraction of time that a guest worker can work in the foreign country (F),

(*c*) a reduction in the cost of migration (M).

Therefore, the following proposition summarizes the main result of this section.

Proposition 1: *The possibility of a low-skilled guest-worker employment in the higher-wage foreign country increases the threshold level of bequest necessary for investment in education and thus prevents more people from investing in human capital.*

As to the other factors that determine the threshold level of bequest, aggravating capital market imperfections, as captured by an increase in the borrowing rate (i) relative to the lending rate (r), as well as an increase in the cost of education (θw_{t-1}^s), increases the critical value of $\hat{b}_{t-1}$. The effect of changes in the skilled (w_t^s) and unskilled (w^u) wages is twofold. Thus, an increase in w_t^s increases the return to human capital and, at the same time, it also increase the cost of time allocated to rearing children. However, given that $\beta \in (0,1)$, the former effect always dominates the latter, and, therefore, an increase in w_t^s reduces $\hat{b}_{t-1}$. An increase in the unskilled wage (w^u) acts in the opposite direction.

2.4. Fertility Choice

From equations (7) and (9), one can solve the number of children per parent in each state of nature. Since the bequest per child depends only on the third-period wage and not on total income (Eq. 9), individuals can potentially be in four states of nature: (1) u, the unskilled, who work only in the home country, (2) gw, the guest workers, who are unskilled and work a fraction of their time abroad, (3) s, the skilled offspring of skilled parents, and (4) us, skilled offspring of unskilled parents. Denoting by N_t^j the number of offspring of a parent born in period $t-2$, where $j = u, gw, s, us,$ these numbers are

$$N_t^u = \frac{\beta}{\delta}\left[\left(\frac{\gamma\delta}{\beta}+1\right)(1+r)+1\right], \tag{21}$$

$$N_t^{gw} = \frac{\beta}{\delta}\left[\left(\frac{\gamma\delta}{\beta}+\frac{Fw^{uf}-M}{w^u}+1-F\right)(1+r)+1\right], \tag{22}$$

$$N_t^s = \frac{\beta}{\delta}\left[\frac{w_{t-1}^s}{w_t^s}\left(\frac{\gamma\delta}{\beta}-\theta\right)(1+r)+1\right], \tag{23}$$

$$N_t^{us} = \frac{\beta}{\delta}\left[1-\frac{\theta w_{t-1}^s-(\gamma\delta/\beta)w^u}{w_t^s}(1+i)\right]. \tag{24}$$

Note that in period t, for all individuals, their income in the previous period $t-1$ and their wage in the current period t show up in their fertility decision. The previous income appears because it determines the current wealth, both through previous period work in the labor market (for the unskilled), and through bequest (for both skilled and unskilled), and the current wage represents the alternative cost or rearing children. While the current wealth has a positive income effect, the current wage has a negative price effect.

From equations (22) and (24), the gap between the number of offspring of an unskilled parent who work a fraction of time as a guest worker abroad and the number of offspring of an unskilled parent who works only in the home country is simply:

$$N_t^{gw} - N_t^u = \frac{\beta}{\delta}\left[\frac{F(w^{uf}-w^u)-M}{w^u}\right]. \tag{25}$$

Given the constraint (10), the following proposition summarizes the main result of this section.

Proposition 2: *The optimal fertility of unskilled individuals who work a fraction of time as guest workers abroad is higher than the optimal fertility of unskilled individuals who work only in the home country.*

Moreover, equation (22) demonstrates that among guest workers fertility increases with

(*a*) an increase in the wage that a guest worker can earn in the foreign country (w^{uf}),

(*b*) an increase in the fraction of time that a guest worker can work in the foreign country (F),

(*c*) a reduction in the cost of migration (M).

As in any standard model with endogenous fertility and quantity-quality tradeoff, the above equations also demonstrate that unskilled individuals have more children than skilled individuals and that fertility of skilled individuals whose own parents were skilled is higher than fertility of skilled individuals whose own parents were unskilled.

Next section focuses on the case when the reproduction rate of the unskilled (N_t^u) and the skilled (N_t^s) is larger than one, which implies that population growth in each of these groups is positive.[14]

2.5. Dynamic Path

This section considers the home economy as a whole. I first characterize the dynamic path of the economy, when a guest-worker employment abroad is not available. Next, I present and analyze the economy-wide consequences of the possibility of a guest-worker employment abroad.

2.5.1. The economy without a guest-worker employment abroad

Consider first an economy, for which a guest-worker employment abroad is not available. In this case, when the "gw" is no longer a choice, individuals can potentially be only in three states of nature: s, u, us.

Note that, when a guest-worker employment abroad is not available, the threshold level of bequest necessary for investment in human capital becomes:

$$\hat{b}_{t-1}^{ngw} = \frac{w^u(2+r) - (w_t^s - \theta w_{t-1}^s(1+i))(w^u/w_t^s)^\beta}{(1+i)(w^u/w_t^s)^\beta - (1+r)}. \qquad (26)$$

Note that given the constraint (10), this threshold is unambiguously lower than the threshold when a guest-worker employment abroad is available (Eq. 20); $\hat{b}_{t-1} > \hat{b}_{t-1}^{ngw}$.

[14] Formally, for $N_t^s > 1$, it is enough to assume that $(A_{t-1}/A_t)^{1/1-\alpha}(\gamma\delta - \beta\theta)(1+r) > \delta - \beta$ holds, while for $N_t^u > 1$, it is enough to assume that $(\gamma\delta + \beta)(1+r) > \delta - \beta$. Note also that $\gamma\delta > \beta\theta$, as follows from the assumption in Section 2.3.

To characterize the dynamic path of this economy, recall that the wages of skilled workers are positively related to the aggregate level of human capital in the society in the previous period (Eq. 3). Since human capital per educated person is fixed by construction in this model, an aggregate change comes out of an increase in the population of educated persons. Thus, when fertility among skilled is larger than one, wages of skilled grow, while wages earned by unskilled workers do not change (Eq. 4). The increase in skilled workers' wages increases the return to education and therefore drives down the threshold level of bequest necessary to induce investment in human capital (Eq. 26). However, although this threshold is decreasing with time, it may take time before $\hat{b}_{t-1}^{ngw}$ decreases sufficiently to induce the poor to invest in human capital.

Recall also that the relative weight given to bequest in the utility function is distributed over $[\gamma^{\min}, \gamma^{\max}]$. This implies that in the case of the offspring of unskilled individuals with higher γ's, the actual bequest they receive from their parents, as shown in equation (9), reaches the critical value of the threshold $\hat{b}_{t-1}^{ngw}$ earlier than in the case of the offspring of unskilled individuals with lower γ's. Therefore, at the point when the critical value of bequest $\hat{b}_{t-1}^{ngw}$ deceases enough to reach the actual bequest inherited by the offspring of the poor from dynasties with the maximal γ's ($\gamma^{\max}$), it becomes lucrative for those poor to invest in human capital. This is the point whereupon the numbers N_t^u and N_t^s no longer suffice to characterize population dynamics. Once some of the poor choose to acquire education and switch to the *us* status, the population of those who remain poor increases by less than N_t^u. By the same token, the population of the skilled grow by more than N_t^s. According to the utility function (Eq. 5), the bequest per child is a constant fraction of the third period wage, so that once a person moves into the skilled group, his dynasty remains skilled. Given the particular form of the technological progress, as specified in Section 2.1, this increase in the population of educated persons and the resulting increase in the aggregate level of human capital in the economy brings about an increase in the rate of technological progress. This further increases productivity in the skilled sector thus increasing the attractiveness of investment in human capital for

individuals from dynasties with lower γ's who remain poor for a longer period of time and guarantees that even those with the minimal γ ($\gamma^{\min}$) will ultimately find it worthwhile to invest in education.

In addition, once some of the poor start investing in education, the increase in the total society-wide level of output also coincides with an increase in the level of income per capita, because this higher level of output is now distributed among a smaller number of individuals, since the overall fertility in the economy also has declined. Clearly, if fraction of the skilled in the economy is increasing it also implies that the rate of growth of income per capita is unambiguously increasing as well.

2.5.2. The consequences of the possibility of a guest-worker employment abroad

Now consider an economy, for which a guest-worker employment abroad is available. In this case, the "gw" is also a possible choice and therefore individuals can potentially be in four states of nature: s, u, gw, us.

Recall that in this case the offspring of the skilled by assumption always invest in education and are not interested in the guest-worker opportunities abroad. This allows us to postulate that this type of the guest-worker migration does not generate any classical brain drain effect.

As for the offspring of the unskilled, equation (20), as compared to equation (25), unambiguously demonstrates that the possibility of a low-skilled guest-worker employment abroad increases the threshold level of bequest necessary for investment in education ($\hat{b}_{t-1}$) and thereby generates a disincentive effect for human capital investment. Therefore, in this case, although the effect of an increase in the skilled wage on the threshold works through the same channel as described in the previous section, because $\hat{b}_{t-1} > \hat{b}_{t-1}^{ngw}$, it takes more time before $\hat{b}_{t-1}$ decreases sufficiently to induce the poor to invest in education.

Moreover, this is not the most poor who migrate for work to the foreign country. These migrants are rather from the middle of the wealth distribution. Given the constraint (10), individuals who migrate for work are the offspring of the unskilled whose bequest is

higher than the cost of migration (M), but lower than the threshold level of bequest $\hat{b}_{t-1}$. In the absence of the guest-worker employment abroad, some of these unskilled could potentially invest in education and switch to the skilled status.

This leads us to the following proposition.

Proposition 3: *In any period $t-1$, for the offspring of the unskilled whose bequest falls in the range of $[\hat{b}_{t-1}^{ngw}, \hat{b}_{t-1}]$, the guest-worker employment abroad is optimal, while, when the guest-worker employment abroad is not available, they will optimally choose to invest in education and switch to the skilled status.*

Clearly, if less offspring of the unskilled decide to acquire education and switch to the skilled status, the population of the skilled grows slower, than in the case when the guest-worker employment abroad is not available, thus reducing the increase in the aggregate level of human capital in the economy. This slows down the increase in the productivity in the skilled sector, thus reducing the attractiveness of investment in human capital for the poor from dynasties with lower γ's who will remain poor for an even longer period of time.

Likewise, the average level of human capital in this economy is unambiguously lower than in the case when the guest-worker employment abroad is not available, because the overall fertility in the economy has increased due to the higher fertility among the *gw* individuals than among the *us* individuals (Eq. 25). If some of the *gw* individuals inherit bequest that falls between $\hat{b}_{t-1}^{ngw}$ and $\hat{b}_{t-1}$, in the absence of the guest-worker employment abroad, they could also potentially acquire human capital, switch to the skilled status and, therefore, contribute to both, the increase in the society-wide level of human capital and the reduction in the overall fertility.

Therefore, the possibility of a guest-worker employment abroad generates a non-trivial brain drain effect, which is new to the literature. This is not that the level of human capital in a developing country is growing slowly because the developed world "siphons off" its highly educated workers. The process of human capital accumulation in the source country slows down because the possibility of a higher-wage low-skilled guest-worker employment abroad lowers the relative attractiveness of the skilled employment

in the home country. Therefore, fewer individuals find it worthwhile to acquire skills and, as a consequence, the very process of human capital accumulation is negatively affected.

The analysis also shows that the effect of the possibility of the guest-worker employment abroad on the incomes in the source economy is twofold. On the one hand, the short-run effect is clearly to increase the incomes of the guest workers. On the other hand, because of its negative effect on human capital accumulation, the possibility of the guest-worker employment abroad generates a negative effect on incomes in the source economy in the long run. Therefore, a reduction in the attractiveness of the guest-worker employment abroad, as a result of an increase in the cost of migration along with a reduction in the length of employment and a reduction in the real wage that a guest-worker can earn, would thus encourage the long-term economic growth in the source country.[15]

3. Conclusion

This work focuses on a temporary guest-worker-type migration of individuals from the middle class of the wealth distribution, which represents the majority of international migration for several countries, but has been largely ignored in the discussion of the brain drain. I have used a two-country growth model with endogenous fertility – the home country and the rest of the world consolidated as the foreign country – to show that the possibility of a low-skilled guest-worker employment in a higher wage foreign country lowers a relative attractiveness of the skilled employment in the home country and thus prevents more individuals from acquiring human capital. Therefore, even if all individuals who acquired education remain in the home country, the actual number of educated workers in the source economy decreases, and the aggregate society-wide level of human capital in this economy would thus be adversely affected. Moreover, as follows

[15] An increase in the cost of migration has long been emphasized in development economics as a useful instrument to reduce immigration of the unskilled (Chiquiar and Hansen, 2005; Orrenius and Zavodny, 2005; Hansen, 2006). The present analysis suggests that the effect of such policy is twofold. It not only reduces immigration of the unskilled, but, in addition, it also increases the relative attractiveness of the skilled employment in the home country, thus stimulating human capital accumulation in the source economy.

from the external spillover effect of human capital, this negative effect can have long lasting consequences for economic growth in the poor country.

The present analysis also suggests that the guest-worker employment in higher wage countries also increases fertility in the source countries, via an income effect, thus contributing to further polarization of population growth rates between the developed and developing countries.

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