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Endogenous Fertility, International Migration and Growth

by

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1. Introduction

This paper explores the relationships among fertility, international population movements and economic development. The U.N. Population Division estimates that 175 million people in the world live in a country other than where they were born, which represents about 3% of the world population. Most of the world migrants live in Europe (32%), Asia (29%) and North America (23%). In general, migrants tend to be young adults and between 40 and 60 percent are female.[1] Many of the key issues in the debate on immigration are economic.[2] In the economic literature on immigration policy, the potential adverse effect on the labour market outcomes of native-born workers has often been emphasised. Less attention, however, has been devoted to the possible benefits of immigration. We argue that the connection between migration and growth depends upon the circumstances of the receiving and the sending country and on the characteristics of the immigrant flow. International migrants are as diverse as their motivations to move. Some are settlers, while others move on a temporary basis; some are skilled, while others are unskilled. Although the empirical literature on this subject is vast, very few theoretical papers have analysed different types of migration within a single framework. One recent

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[1] See United Nations (2002). For a critical review of this report, concerning the data (including the report's headline figure of 175 million migrants!) as well as the analysis, a very interesting reading is Coleman (2003).

[2] Two recent and comprehensive surveys of the literature can be found in Ghatak, Levine and Price (1996) and Massey *et al* (1993).

contribution is Wong (1997), who develops an overlapping generations model where workers decide optimally about education and migration. By considering only homogeneous unskilled workers, however, the author neglects the selection process that guides the migration and return migration decisions. Haque and Kim (1995) and Beine et al. (2001) develop a similar model with heterogeneous agents, but focus their attention only on the case of brain drain. At the other extreme, Borjas and Bratsberg (1996) consider only the case of return migration. Lundborg and Segerstrom (2000, 2002) study the role of imbalances in labour supply and policy differences on international migration and growth. Dos Santos and Postel-Vinay (2003) study the effects of temporary and permanent migration in the sending country. By focusing on different types of migration (skilled and unskilled, temporary and permanent) and their effects on growth, and by considering heterogeneous agents, this paper distinguishes itself from much of the literature.

The paper raises another important topic: the relationship between fertility, migration and growth. This issue has so far received little attention in the empirical literature (see e.g. Lindstrom 2003; Cassen *et al* 1994, Ribe and Schultz 1980) and even less in the theoretical literature (however, see Zhang 2002 for a rural-urban migration case and the interesting chapter by Teitelbaum and Russel 1993 for a discussion of the links between fertility and migration). The macro long-run correlation between rural to urban migration and fertility is unequivocal: when the former increases the latter declines.[3] As far as international migration is concerned, demographic differentials are of special importance in South to North population movements. High immigration to low-fertility countries from countries with high fertility rates poses a number of challenging questions. First, what is the nature of the link between fertility and migration? Second, to what extent

[3] See e.g. Stark (1991, Ch.1).

is the fertility of international migrants itself affected by their mobility? Third, does a self-selection process operate whereby locational choices reflect pre-migration-formed fertility preferences? Fertility data for foreign-born or foreign nationals are weak, but it is often found that migrants who move from higher to lower fertility settings generally have fertility rates lower than those of co-nationals who remain at home.[4] This is clearly an important policy issue when considering replacement migration as a solution to population ageing in developed countries.[5] The underlying reasons for this different fertility could be the different relative prices and different income constraints in the new environment which may be less conducive to large families, the migrant's cultural adaptation to their new setting or, as suggested above, a self-selection process whereby migrants possess fertility preferences different from those of the overall population at the origin.[6] Of course, we are not arguing that high fertility is a necessary or a sufficient condition for international migration - as this is not true, for example, in the case of migration from Eastern to Western Europe (both areas of low fertility) - but only that fertility choice affects and is affected by migration, together with other variables like schooling of children, medical care and quality of life. By considering such variables, we develop a model that allows for return migration even though a reversal of the inter-country wage differential does not occur.

This paper also represents a contribution to the endogenous growth literature. It develops an Uzawa-Lucas (Uzawa, 1965; Lucas, 1988) type of model, where the source of growth is the unboundedness of human capital accumulation, but it focuses on an economy with labour mobility where labour movements can affect growth rates. This implies that policies that affect migration can have growth effects.

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[4] See e.g. U.S. Department of Commerce, Bureau of the Census (1993), Stephen and Bean (1992).
[5] See the recent report on replacement migration by the United Nations (2000). For a sceptical view on the role of immigration on preventing population ageing see Coleman (2002).
[6] For a discussion and a comparison of the alternative hypotheses see Hervitz (1985).

The model is set out in Section 2. The issue of the brain drain is analysed in Section 3. Section 4 considers the migration of unskilled labour. The growth consequences of migration are considered in Section 5. Concluding remarks are contained in Section 6.

2. The model

We consider a two-country overlapping generations economy, where each heterogeneous agent lives two periods, a homogeneous good is produced by a large number of competitive firms and output is a function of effective labour. A young agent in period *t*, immediately after birth, inherits the average level of general knowledge (i.e. the human capital) in the economy, h_t, and decides optimally on the location of his/her residence in both periods such that lifetime utility is maximised. Agents are endowed with differing abilities: the ability of an individual $j \in (0,1)$ is denoted by δ^j and agents are distributed according to ability with some density function $f(\delta)$ which is continuous and positive in the interval $(1, \delta^1)$. This distribution is assumed to be the same across countries. Each agent divides his/her time in the first period between working and education, and devotes the second period to work only. Education is provided free of charge by the government and agents take the prevailing wage rate per efficiency unit of labour w_t as given. Consumption takes place in both periods and credit markets are not considered, so that intertemporal consumption smoothing is possible only through the accumulation of human capital.

We assume that all agents have the same Cobb-Douglas utility function that depends on consumption and quantity and quality of children[7]:

$$U = \log(c_{t,t}\zeta) + \beta[\phi \log(c_{t,t+1}\zeta) + (1-\phi)\log(nm)] \tag{1}$$

[7] The log-linear specification of the utility function in consumption and number of children is not uncommon in the literature. For example see Galor and Weil (1996).

where $c_{t,T}$ is consumption at time *T* of an agent born in period t, β is the discount factor, *n* is the number of children, *m* is a parameter reflecting the quality (or survival rate) of children which depends on the location of residence and may be influenced by the government, and ζ is a location externality which takes the value of one if the agents consume in their country of birth and a value between zero and one if consumption takes place outside that country. Hence ζ summarises all factors which are locationally fixed and complementary to consumption, such as social relations, climate, family and friends. Thus we allow for the fact that agents may have a stronger preference for consumption at home than abroad.[8]

When young, the *j*th agent faces the following budget constraint:

$$c_{t,t} = \left[(1-\tau_d)w_t^d\left(1-l^j\right)h_t\right]L_t^j + \left[(1-\tau_f)w_t^f\left(1-l^j\right)h_t - \gamma h_t / \delta^j\right](1-L_t^j) \tag{2}$$

where the subscripts *d* and *f* denote domestic and foreign respectively, τ is the rate of wage tax and *l* is the amount of time devoted to education. The term L_t^j defines the locational choice and can either be one, if the agents stays at home or zero if they move abroad. Thus the first part of equation (2) is the budget constraint of an agent who chooses to stay in his/her own country and whose income is derived from after-tax wages, $(1-\tau_d)w_t^d\left(1-l^j\right)h_t$. If the agents decide to move abroad, they will face the cost of migration, $\gamma h_t / \delta$, assumed to be proportional to their level of human capital and inversely related to their ability. This feature captures the idea that more skilled agents can adjust to the new environment with less costs and that the cost of migration reflects factors such as foregone wages while searching for a job (which is proportional to human capital). Thus

[8] See e.g. Dustmann (1999), Djajic and Milbourne (1988), and Hill (1987)

the second part of equation (2), which refers to migrants, includes after-tax wages, $\left(1-\tau_f\right)w_t^f\left(1-l^j\right)h_t$, and the cost of migration, $\gamma h_t / \delta$.

In the second period of life the individual faces a similar budget constraint which now does not include education:

$$\begin{aligned} c_{t,t+1} = & \left[\left(1-\tau_d\right)w_{t+1}^d h_{t+1}^j (1-q_d n_d^j m_d^j) - \gamma_1\left(1-L_t^j\right)h_{t+1}^j n_d^j / \delta^j\right]L_{t+1}^j + \\ & \left[\left(1-\tau_f\right)w_{t+1}^f h_{t+1}^j b\left[L_t^j + \left(1-L_t^j\right)/ b\right](1-q_f n_f^j m_f) - \gamma L_t^j h_{t+1}^j n_f^j / \delta^j\right](1-L_{t+1}^j) \end{aligned} \quad (3)$$

where q represents the cost of raising children, which is assumed to be proportional to human capital and is therefore increasing with time (reflecting the idea, common in the literature, that child rearing is a time intensive household activity). As before, the term L_{t+1}^j captures the locational choice in the second period, the term $\gamma_{(1)}h_{t+1}^j / \delta^j$ is the cost of (return) migration (now also proportional to the number of children), and b is a parameter that reduces agents' productive capacity (because of language and other difficulties associated with adaptation) when they work in a country other than their own. The first part of this budget constraint refers to an agent living in the home country. After-tax labour income is reduced by the cost of raising children, which is proportional to a quality-adjusted index of fertility, $n_d^j m_d$ (e.g. the number of surviving children). It also includes the cost of return migration if the agent was living abroad when young (i.e. if $L_t^j = 0$). We consider this cost as being proportional to the number of (prospective) children in order to take into account both the higher costs of moving more people and the various costs associated with the adaptation of a larger family. The second part of the budget constraint refers to an old agent living in the foreign country. In this case the agent's productivity is reduced by the assimilation parameter, b, but only if he/she was in his/her home country in the first period (i.e. if $L_t^j = 1$).[9] Again, the individual will face a cost of migration if not living in the foreign country when young (i.e. if $L_t^j = 1$).

The key to growth in this economy is the accumulation of human capital. Following Lucas (1988), we assume that the efficiency level of labour in the next period depends on the fraction of time this period that each worker spends on education. We also include the parameter θ to distinguish the efficiency of education between the home and foreign country.

$$h_{t+1}^j = h_h\left(1 + \theta_d \delta^j l^j L_t^j + \theta_f \delta^j l^j (1 - L_t^j)\right) \tag{4}$$

The technology of the production sector is described by a constant returns to scale production function in effective labour:

$$y_t = Ah_t \tag{5}$$

where A is the marginal product of effective labour. Cost minimisation implies that the wage rate is equal to A and therefore constant over time. We allow for the possibility that the marginal product of labour is different between countries by assuming that $A^f = \lambda A$ where $\lambda \neq 1$ captures differences in technology. Hence, $w_t^d = A$ and $w_t^f = \lambda A$.

Finally the government is assumed to operate under a balance budget constraint and collects taxes to provide public goods.

The model is able to accommodate various types of migration scenario. Permanent migration occurs if an agent moves to the host country when young and dies there (i.e. when $L_t^j = L_{t+1}^j = 0$). Brain drain takes place when an agent receives education and works in the host country when young and moves abroad after graduation (that is when $L_t^j = 1$

[9] In this case the term $L_t^j + \left(1 - L_t^j\right)/b$ would be equal to 1. If $L_t^j = 0$, then the term in square brackets would be equal to $1/b$ thus eliminating the assimilation parameter from the equation.

and $L_{t+1}^{j}=0$). Temporary migration occurs when an agent gets education and works abroad when young and then returns to the source country when old (i.e. if $L_t^j=0$ and $L_{t+1}^{j}=1$). No migration occurs if $L_t^j=L_{t+1}^{j}=1$.

The decision problem of each household is to maximise equation (1) subject to the intertemporal budget constraints defined in equations (2) and (3). We begin by considering the location of residence as given. The first order conditions are:

$$1/c_{t,t}+\Psi_1=0 \tag{6}$$

$$\beta\phi c_{t,t+1}+\Psi_2=0 \tag{7}$$

$$\begin{aligned}&\Psi_1\left[\left(1-\tau_d\right)Ah_tL_t^j+\left(1-\tau_f\right)A\lambda bh_t(1-L_t^j)\right]-\\&\Psi_2\left\{A\delta^j h_t[\left(1-\tau_d\right)\left(\theta_dL_t^j+\theta_f(1-L_t^j)\right)\left(1-q_dn_d^jm_d\right)L_{t+1}^j+\right.\\&\left(1-\tau_f\right)\left(\theta_dL_t^j+\theta_f(1-L_t^j)\right)\lambda b[L_t^j+(1-L_t^j)/b](1-q_fn_f^jm_f)(1-L_{t+1}^j)]-\\&\left.\gamma L_t^jn_f^jh_t\theta_d(1-L_{t+1}^j)-\gamma_1(1-L_t^j)n_d^jh_t\theta_fL_{t+1}^j\right\}=0\end{aligned} \tag{8}$$

$$\begin{aligned}&\beta\left(1-\phi\right)/n^j+\Psi_2\left(1-\tau_d\right)Ah_t\left(1+\theta_d\delta^jl^jL_t^j+\theta_f\delta^jl^j(1-L_t^j)\right)q_dm_dL_{t+1}^j+\\&\Psi_2\left(1-\tau_f\right)Ah_t\left(1+\theta_d\delta^jl^jL_t^j+\theta_f\delta^jl^j(1-L_t^j)\right)\lambda b\left[L_t^j+(1-L_t^j)/b\right]q_fm_f(1-L_{t+1}^j)+\\&\Psi_2\gamma L_t^jh_t\left(1+\theta_d\delta^jl^j\right)(1-L_{t+1}^j)/\delta^j+\Psi_2\gamma_1\left(1-L_t^j\right)h_t\left(1+\theta_f\delta^jl^j\right)L_{t+1}^j/\delta^j=0\end{aligned} \tag{9}$$

where w_d^t and w_f^t have been replaced by A and λA respectively, and Ψ_1 and Ψ_2 are the Lagrangean multipliers associated with the constraints (2) and (3). Equations (6) and (7) are the optimality conditions with respect to $c_{t,t}$ and $c_{t,t+1}$. Equations (8) and (9) are the first order conditions with respect to l and n, equating the marginal benefits and marginal costs of an additional unit of time spent on education and an additional child, respectively.

3. Brain Drain

In our model, brain drain arises when individuals receive education and work when young in the source country but move abroad in the second period and work in the host country.[10] Thus agents live in their own country when young and decide optimally about their location of residence after graduation. We wish to compare this situation with the case of no migration. From equations (6)-(9), substituting $L_t^j = 1$ and $L_{t+1}^j = 0$ (for the case of brain drain), or $L_{t+1}^j = 1$ (for the case of no migration), we obtain:

$$n_{d,d}^j = \frac{1-\phi}{q_d m_d} \tag{10}$$

$$n_{d,f}^j = \frac{1-\phi}{q_f m_f + \gamma / \left[\delta^j (1-\tau_f) A\lambda b\right]} \tag{11}$$

$$l_1^j = \frac{\beta\phi(1-\tau_d)A}{(1-\tau_d)w_t(1+\phi\beta)} - \frac{1}{\theta_d \delta^j (1+\phi\beta)} \tag{12}$$

Thus, for the fertility rate of migrants, $n_{d,f}^j$, to be lower than that of co-nationals remaining in the home country, $n_{d,d}^j$, it is sufficient that $q_f m_f \geq q_d m_d$. Because this is likely to hold, given that *m* increases with economic development and *q* is not likely to decrease, the model is able to account for the empirical observation that $n_{d,f}^j < n_{d,d}^j$. The time spent on education, l_1^j, depends positively on the agent's ability, δ^j, on the efficiency parameter, θ_d, and on the tax rate, τ_d. The solution for relative consumption levels can be derived straightforwardly from equations (6)-(9), and will also depend on the location of residence in the second period of life:

$$\frac{c_{t,t+1}}{c_{t,t}} = \beta\phi\theta_d\delta^j \frac{(1-\tau_d)A\phi L_{t+1}^j + \left[(1-\tau_f)A\lambda b(1-q_f n_{d,f}^j m_f) - \gamma n_{d,f}^j / \delta^j\right](1-L_{t+1}^j)}{(1-\tau_d)A} \tag{13}$$

This equation expresses the familiar result that the change in consumption between periods depends on the time preference factor β. In addition, an increase in the education

[10] The analysis of brain drain in this section follows the same structure of Haque and Kim (1995).

efficiency parameter, θ_d, is associated with a reduction in $c_{t,t}$ relative to $c_{t,t+1}$, given that agents would prefer to spend more on education in the first period.

Given the above, we may write the expressions for the utility obtained under no migration and the utility obtained under migration, and find the optimal solution for the residence of the old depending on the relative level of utilities.

$$\begin{aligned} U_{d,d} &= (1+\beta\phi)\log h_t + \log\left[(1-\tau_d)A\left(1-l_1^j\right)\right] + \\ &\beta\phi\log\left[(1-\tau_d)A\left(1+\theta_d\delta^j l_1^j\right)\phi\right] + (1-\phi)\beta\log\left[(1-\phi)/q_d\right] \end{aligned} \tag{14}$$

$$\begin{aligned} U_{d,f} &= (1+\beta\phi)\log h_t + \log\zeta + \log\left[(1-\tau_d)A\left(1-l_1^j\right)\right] + \\ &\beta\phi\log\left[(1-\tau_f)A\left(1+\theta_d\delta^j l_1^j\right)\lambda b\left(1-n_{d,f}^j q_f m_f\right) - \gamma\left(1+\theta_d\delta^j l_1^j\right)n_{d,f}^j/\delta^j\right] + \\ &(1-\phi)\beta\log\left[n_{d,f}^j m_f\right] \end{aligned} \tag{15}$$

where $U_{d,d}$ and $U_{d,f}$ are the utility levels in the case of no migration and brain drain respectively. Whether an interior solution or a corner solution occurs depends on the size of the locational parameter, ζ, on the cost of moving, γ, and on the wage advantage abroad, $(1-\tau_f)\lambda b$. If $(1-\tau_d) > (1-\tau_f)\lambda b$ and $q_f \geq q_d$ then no migration would occur as the utility derived from migration, $U_{d,f}$, would be less than that when working at home, $U_{d,d}$, for all agents. On the other hand, if $(1-\tau_d) < (1-\tau_f)\lambda b$, $\zeta = 1$ and $\gamma = 0$ (i.e. if there is a wage advantage abroad, no complementarities between consumption and the location where it takes place, and no cost of moving), then all agents would migrate in the second period. In the general case, where wages abroad are higher and the parameters are in some intermediate range, some people would migrate and others would stay according to their level of ability. It can be shown that, for some intermediate values for the parameters, $U_{d,d} > U_{d,f}$ at $j = 0$ and $U_{d,d} < U_{d,f}$ at $j = 1$. It can also be shown that $U_{d,d}$ and $U_{d,f}$ are monotonic functions of j. Hence, there exists a $j^* \in (0,1)$ for which $U_{d,d} = U_{d,f}$, and

$U_{d,d} > (<) U_{d,f}$ if $j < (>) j^*$ (see Appendix). The term j^* is therefore the index for the individual at the margin who represents the cut-off between migrants and non-migrants.

The rationale for the migration of the most skilled lies in the fact that their increase in return to the human capital they have acquired is enough to compensate the various costs of migration, including the preference for consumption at home. Consequently different factors can influence j^* and hence the average level of human capital that remains in the economy, including factors that affect fertility and childbearing. In the Appendix, we show that the equilibrium value of j increases with the cost of migration, γ, the tax rate of the foreign country, τ_f, the child rearing costs in the foreign country, q_f, and the magnitude of $(1-\zeta)$ (i.e. the higher is the location preference). In fact, all these factors reduce the utility of moving abroad. Consequently, the equilibrium value of j decreases with the domestic tax rate, τ_d, the assimilation parameter, b, the technology parameter, λ, the child rearing costs in the home country, q_d and the child quality parameter, m_f. This is because an increase in these parameters will *ceteris paribus* increase the utility of a migrant.

4. Permanent Migration and Temporary Migration

This section focuses on permanent (lifetime) migration and temporary migration only, abstracting from brain drain. In our model, permanent migration occurs when workers in the home country move to the host country in the first period, receive education, work and die there. Temporary migration is when unskilled workers in the source country move to the host country when young and get education there, and then decide to return to their origin country when old and work (and die) there as skilled workers. Thus we focus on the choice of staying abroad in the second period after having moved when young versus the choice of return migration.

Although studies of international migration flows suggest the presence of large numbers of return migrants,[11] return migration has been the subject of very few papers, probably because little is known either conceptually or empirically about the selection process guiding this decision. A recent exception is Dustmann and Kirchkamp (2002) that studies optimal migration durations and activity choices (self-employed, salaried employed or retired) after return migration using a survey data set of Turkish immigrants to Germany. To keep the model simple and more focused we cannot consider this multiplicity of activities after returning, so we simplify the choices a migrant faces. Accordingly, return migration may result from a reversal of the wage differential of the two countries, as in the classical economic argument (and one of the mechanism operating in the aforementioned paper by Dustmann and Kirchkamp), or may have been planned as part of an optimal life-cycle residential location sequence whereby agents accumulate human capital in the host country and then return to the source country. Alternatively, it may result from "mistakes" in the initial migration decision despite persistently higher wages in the host country, changes in policies and other parameters affecting fertility decisions and changes in the subjective perception of the location (i.e. changes in ζ over time). From equations (6)-(9), substituting for $L_t^j = L_{t+1}^j = 0$ (for the case of permanent migration) and $L_t^j = 0$, $L_{t+1}^j = 1$ (for the case of temporary migration), we obtain:

$$n_{f,f}^j = \frac{1-\phi}{q_f m_f} \tag{16}$$

[11] Warren and Peck (1980) and Warren and Kraly (1985) estimate that about 30% of the foreign-born persons in the United States leave the country within a decade or two after their arrival.

$$n_{f,d}^{j} = \frac{1-\phi}{q_d m_d + \gamma_1 / \left[\delta^{j}\left(1-\tau_d\right)A\right]} \tag{17}$$

$$l_2^{j} = \frac{\beta\phi\left[\left(1-\tau_f\right)A\lambda b - \gamma/\delta^{j}\right]}{\left(1-\tau_f\right)A\lambda b\left(1+\beta_1\beta\right)} - \frac{1}{\theta_f \delta^{j}\left(1+\phi\beta\right)} \tag{18}$$

Hence the conclusions are the same as before, the only difference being that we are now talking about return migration. However, return migrants may not have a lower fertility rate ($n_{f,d}^{j}$) than co-nationals staying in the host country ($n_{f,f}^{j}$) because $q_d m_d$ might be well below $q_f m_f$. Intertemporal consumption may also be derived from the first order conditions and will depend on the locational choice:

$$\frac{c_{t,t+1}}{c_{t,t}} = \beta\phi\theta_f\delta^{j}\,\frac{\left(1-\tau_f\right)A\lambda\phi(1-L_{t+1}^{j}) + \left[\left(1-\tau_d\right)A\left(1-q_d n_{f,d}^{j} m_d\right) - \gamma_1 n_{f,d}^{j}/\delta^{j}\right]L_{t+1}^{j}}{\left(1-\tau_f\right)A\lambda b} \tag{19}$$

As before, we may compute the utility levels in the two cases:

$$\begin{aligned} U_{f,f} &= \left(1+\beta\phi\right)\left(\log\zeta + \log h_t\right) + \log\left[\left(1-\tau_f\right)A\lambda b\left(1-l_2^{j}\right) - \gamma/\delta^{j}\right] + \\ &\beta\phi\log\left[\left(1-\tau_f\right)A\left(1+\theta_f\delta^{j}l_2^{j}\right)\lambda\phi\right] + \left(1-\phi\right)\beta\log\left[\left(1-\phi\right)/q_f\right] \end{aligned} \tag{20}$$

$$\begin{aligned} U_{f,d} &= \left(1+\beta\phi\right)\log h_t + \log\zeta + \log\left[\left(1-\tau_f\right)A\lambda b\left(1-l_2^{j}\right) - \gamma/\delta^{j}\right] + \\ &\beta\phi\log\left[\left(1-\tau_d\right)A\left(1+\theta_f\delta^{j}l_2^{j}\right)\left(1-n_{f,d}^{j}q_d m_d\right) - \gamma_1\left(1+\theta_f\delta^{j}l_2^{j}\right)n_{f,d}^{j}/\delta^{j}\right] + \\ &\left(1-\phi\right)\beta\log\left[n_{f,d}^{j}m_d\right] \end{aligned} \tag{21}$$

A corner solution with permanent migration would emerge if $\left(1-\tau_f\right)\lambda b > \left(1-\tau_d\right)$, $q_d \geq q_f$ and $\zeta = 1$. On the other hand, if $\left(1-\tau_f\right)\lambda b < \left(1-\tau_d\right)$ and $\gamma_1 = 0$ then all migration will be temporary. As before, it can be shown that for some intermediate values for the parameters, $U_{f,f} > U_{f,d}$ at $j = 0$ and $U_{f,f} < U_{f,d}$ at $j = 1$. Hence migrants may choose to return, despite persistently higher wages in the host country because they simply enjoy living and consuming in their home country more than in the host country. Also, it can be shown that $U_{f,f}$ and $U_{f,d}$ are monotonic functions of j. Therefore, there exists a $j^{*} \in \left(0,1\right)$ for which

$U_{f,f} = U_{f,d}$, and $U_{f,f} > (<) U_{f,d}$ if $j < (>) j^*$. This result implies that reverse migration in our model is a process involving the most skilled migrants, i.e. those who can afford the various costs of moving.[12] It can be shown that the equilibrium return migration ratio $\left(1 - j^*\right)$ decreases with the cost of return migration, γ_1, the tax rate of the home country, τ_d, the child rearing costs in the home country, q_d, the location preference parameter, ζ, and the technology parameter, λ. It increases with the foreign tax rate, τ_f, the child rearing costs in the foreign country, q_f and the child quality parameter, m_d.

5. Growth Consequences

In this section we examine the growth effects on the receiving country and on the source country of the three types of migration considered. Let us consider first the effects of brain drain on the sending country. Following Haque and Kim (1995), the average level of human capital of the parents' generation in period $t+1$ in the country of emigration can be written as follows:

$$h_{t+1}^d = \frac{\int_0^{j^*} h_{t+1}^j \, dj}{j^*} \tag{22}$$

The corresponding per capita growth rate of the source country can be calculated as:

$$g_{t+1}^d = \frac{\int_0^{j^*} h_{t+1}^j \, dj}{\int_0^{j^*} h_t^j \, dj} - 1 = \frac{\int_0^{j^*} \left(1 + \theta_d \delta^j l_1^j\right) dj}{j^*} - 1 \tag{23}$$

[12] For a similar result, see Jasso and Rosenzweig (1988) and Jasso and Rosenzweig (1990). They found evidence that the most likely outmigrants are the most skilled workers among the foreign-born population.

This is an increasing function of j^*, i.e. a decreasing function of brain drain. Hence, brain drain generates a reduction of the growth rate in the home country. On the other hand, in the country of immigration the average level of human capital of old workers in period $t+1$ can be written as:

$$h_{t+1}^{f} = \frac{\int_0^1 h_{t+1}^{f,j} dj + \int_{j^*}^1 h_{t+1}^{d,j} dj}{1 + \left(1 - j^*\right)} \tag{24}$$

Thus, the country's per capita growth rate takes the form:

$$g_{t+1}^{f} = \frac{\int_0^1 h_{t+1}^{f,j} dj + \int_{j^*}^1 h_{t+1}^{d,j} dj}{\int_0^1 h_{t}^{f,j} dj + \int_{j^*}^1 h_{t}^{d,j} dj} - 1 = \frac{\int_0^1 \left(1 + \theta_f \delta^j l^j\right)}{1 + \left(1 - j^*\right)\left(h_t^d / h_t^f\right)} + \frac{\int_{j^*}^1 \left(1 + \theta_d \delta^j l_1^j\right)}{\left(h_t^f / h_t^d\right) + \left(1 - j^*\right)} - 1 \tag{25}$$

This expression shows that the growth effect of immigration varies over time depending on the dynamics of the ratios of the average levels of human capital. For instance, consider a case in which the average human capital level of the home country is higher than that of the foreign country. Immigration would raise the average level of human capital in the destination country, thus contributing to its growth. However, as $\left(h_t^d / h_t^f\right)$ declines, the foreign country's growth rate will also decrease. In the opposite case, of immigrants with a relatively low level of human capital, the growth rate of the immigration country will decelerate. However, as the destination country grows less rapidly than that of origin, $\left(h_t^d / h_t^f\right)$ will increase and hence the foreign country's growth rate will also increase. Therefore both growth rates converge to some steady state levels where $\left(h_t^d / h_t^f\right)$ is constant. These steady state growth rates depend on the parameters affecting j^* which we have already considered in our analysis above, such as the after tax wage differential, the cost of migration, fertility related variables and location preferences.

This analysis can be reversed when considering return migration. If the human capital level of return migrants is higher (lower) than that of co-nationals, then the source country will experience a higher (lower) growth rate. On the other hand, the foreign country's growth rate will diminish if return migrants have a higher human capital level relative to the indigenous population.

6. Conclusions

We have considered a simple two-country model where economic and demographic outcomes are the results of agents' optimisation decisions. Heterogeneous workers, endowed with different abilities, choose optimally the timing and length of emigration, their education investment, relative consumptions and number of children. It is shown that migration may be induced by locational externalities, wage differentials, fertility related variables, and human capital considerations. Another issue we have addressed is how international migration affects the fertility of migrants themselves, showing why migrants might have lower fertility rates than co-nationals who remain at home.

We have shown how international labour movements can affect the growth rates of economies so that policies that affect migration may have growth effects. In the case of an interior solution, the analysis suggests that, if the choice is between brain drain and no migration, the most skilled workers are those more likely to migrate. In the same way, when considering return migration, the most skilled workers are most likely to be outmigrants. Extending our analysis, one could also argue that if all types of migration were allowed, different types of migration could occur at the same time involving different segments of the ability distribution, as is likely to happen in real situations. However, we leave this extension to future research.

The results of this paper are consistent with the existing empirical literature on immigrant fertility compared to that of the native-born population (see, for example Stephen and Bean, 1992). The various theoretical mechanism considered in this model are similar to those emphasised by other analyses of migration like Haque and Kim (1995) for the case of brain drain, Borjas and Bratsberg (1996) for the case of return migration and Dos Santos and Postel-Vinay (2003) for the case of temporary and permanent migration and their effects on growth. The novelty of our approach is to consider a unified framework in which to analyse the effects of the various types of migration and their relationship with fertility.

Finally, there are other ways in which the analysis could be extended. We would like to incorporate a more complex age structure in the model and to find optimal rules for the policy variables. We have only focused on the welfare of the current generation because the definition of dynastic welfare, when migration is allowed, leaves unresolved conceptual problems. However this may be an important issue to study in the future.

APPENDIX

A. Derivation of Equilibrium Properties

Consider the brain drain case. In order to find j^* set $U_{d,d}$ from equation (14) equal to $U_{d,f}$ from equation (15):

$$\phi \log[(1-\tau_d)A\phi] + (1-\phi)\log\left(\frac{1-\phi}{q_d}\right) = \\ = \phi \log\left[(1-\tau_f)A\lambda b\left(1-n^j_{d,f}q_f m_f\right) - \frac{\gamma n^j_{d,f}}{\delta^j}\right] + (1-\phi)\log\left(n^j_{d,f} m_f\right) \quad \text{(A1)}$$

It is easy to show that the RHS is an increasing function of δ^j. Because $U_{d,d}$ and $U_{d,f}$ are increasing monotonic functions of j and $U_{d,d}$>(<) $U_{d,f}$ if *j*=0 (1), then j^* represents the divide between migrants and non-migrants. All individuals with higher abilities will find it convenient to migrate. This analysis can be reversed in the case of equations (20) and (21) for the choice between temporary and permanent migration.

B. Comparative statics

With regard to brain drain, the following results can be derived after some algebra, where RHS denotes the second part of equation (A1):

$$\frac{\partial RHS}{\partial \lambda} = \frac{\partial RHS}{\partial b} = \frac{\phi}{\lambda} + \frac{1-\phi}{q_f m_f \delta^j (1-\tau_f)A\lambda b + \gamma} > 0 \quad \text{(A2)}$$

$$\frac{\partial RHS}{\partial \gamma} = -\frac{(1-\phi)}{q_f m_f \delta^j (1-\tau_f)A\lambda b + \gamma} < 0 \quad \text{(A3)}$$

$$\frac{\partial RHS}{\partial q_f} = -\frac{2(1-\phi)\delta^j(1-\tau_f)A\lambda b m_f}{q_f m_f \delta^j (1-\tau_f)A\lambda b + \gamma} - \frac{\gamma \delta^j (1-\tau_f)A\lambda b(1-\phi)m_f}{\left[q_f m_f \delta^j (1-\tau_f)A\lambda b + \gamma\right]^2} + \\ + \frac{\delta^{j2}(1-\tau_f)^2 A^2 \lambda^2 b^2 (1-\phi) q_f m_f{}^2}{\left[q_f m_f \delta^j (1-\tau_f)A\lambda b + \gamma\right]^2} < 0 \quad \text{(A4)}$$

$$\frac{\partial RHS}{\partial m_f} = \frac{(1-\phi)}{q_f m_f \frac{\delta^j (1-\tau_f) A\lambda b}{\gamma} + 1} > 0 \qquad \text{(A5)}$$

It follows:

$$\frac{\partial j^*}{\partial \lambda} < 0; \frac{\partial j^*}{\partial b} < 0; \frac{\partial j^*}{\partial \gamma} > 0; \frac{\partial j^*}{\partial q_f} > 0; \frac{\partial j^*}{\partial m_f} < 0 \qquad \text{(A6)}$$

It is straightforward to derive the other results concerning q_d, τ_d, τ_f and ζ.

The comparative statics results in the second case can be derived in the same way.

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ABSTRACT

An endogenous growth model with heterogeneous agents and endogenous rates of fertility is developed to study the relationships between population growth, human capital, migration and economic development. A variety of patterns of migration, from the migration of the unskilled to the brain drain is considered, where the decision to migrate reflects agents' optimising behaviour. The analysis yields implications which accord with the empirical evidence on the relationships between demography and development. Macroeconomic policy can foster growth by influencing labour mobility through taxation and the provision of public goods such as social infrastructure, sanitation, environmental control and medical research that affect locational preferences and child quality.

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