The Brain Drain and the World Distribution of Income and Population*†

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Abstract

Over the last two decades immigration policies in OECD economies have become increasingly selective and the rate of skilled migration from low income economies has risen markedly. This paper analyzes the theoretical implications of this shift in migration patterns for the growth and distribution of world income and population using a model with endogenous education, fertility and migration decisions in both the sending and receiving economies. It shows that Brain Drain migration may cause fertility to fall and human capital accumulation to increase in both the sending and receiving economies. It also shows that the world economy may converge to a special kind of core-periphery equilibrium where increasing inequality between countries is fueled by Brain Drain migration but where, nonetheless, the welfare of agents in both the core and the periphery is increased. Thus Brain Drain migration may increase inequality between countries at the same time as reducing world poverty and increasing world growth.

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1 Introduction

The world distribution of income depends on the relative size of countries' population as well as on the distribution of income within and across countries. This paper analyzes the potential impact of the current trend towards predominantly skilled emigration from poor to rich countries on fertility, human capital formation and growth in both the sending and receiving countries, and hence on the world distribution of income. The paper shows that this trend towards a 'Brain Drain' pattern in international migration is likely to reinforce the current reduction in world inequality driven by the rise in GDP per capita in large, intermediate-income countries but also predicts a potential for divergence in the long run as poor countries grow larger in terms of population size.

Over the last 25 years migration has become increasingly skill biased. Emigration rates are three times higher than average among the highly skilled and twelve times higher for emigrants from poor countries, see Docquier and Marfouk (2005). This trend has been caused by both increasingly selective immigration policies in OECD countries on the demand side, together with the tendency for workers to positively self-select into migration on the supply side.[1] This significant development in the world economy gives rise to important economic questions. Is the phenomenon of Brain Drain emigration likely to be a transitory or a permanent feature of the world economy? Will this Brain Drain migration increase the rate of economic growth in the world economy? And in the sending and receiving economies? Will the Brain Drain promote convergence or divergence in the world distribution of income? Should the sending or receiving economies try to stop or limit this flow of people?

To answer these questions this paper develops a model with endogenous education, fertility and migration decisions by individual agents in both the sending and receiving economies. It shows that selective migration may improve the growth rate and reduce the fertility rate of all economies in the world economy. Furthermore even when both economies benefit from Brain Drain migration it is still possible that the advanced economies benefit more from this process and for an unbalanced 'core-periphery' growth equilibrium for the world economy to exist. Note however that this core periphery equilibrium need not imply decreases in the income of agents in the periphery. In such an equilibrium, increased inequality of income in the world may actually be good for world growth and also good for the absolute income levels of the poor.[2]

This paper contributes significantly to the brain drain literature in two ways. Firstly it

[1] See section 2.1 below for a discussion of the empirical trends.

[2] See Perotti (1993) and Benabou (1996) for discussion of the mechanism whereby inequality effects growth.

provides a dynamic analysis of the effects of the brain drain on both the sending and receiving economies. This allows for an analysis of the effects of brain drain migration on the growth and distribution of world income. This is an important contribution since the previous literature, from the seminal papers of Bhagwati and Hamada (1974, 1975) to the more recent models of Mountford (1997), Beine *et al.* (2001) or Kanbur and Rapoport (2005), have only analyzed the implications for the sending economy. The analysis is also important because it demonstrates that the effects of migration on the sending and receiving economies need not be mirror images of one another. In particular it is shown how it is possible for brain drain migration to reduce fertility rates and increase the rates of human capital accumulation and economic growth in both the sending and receiving economies.

This paper's second contribution to the literature is that it is the first paper to link the brain drain to fertility decisions. This is important because the shape of the world distribution of income is affected by the relative numbers of people in advanced and less advanced economies as well as by their relative income per head and it is a fact that sending countries tend to have higher rates of fertility and lower levels of human capital accumulation than the receiving economies. This paper uses a Becker (1981) quality versus quantity trade off argument for fertility decisions to show how these patterns may be reinforced by brain drain migration in equilibrium.

The growth in selective migration is almost surely related to another key empirical phenomenon which has been the subject of a great deal of recent economic analysis, namely, the expansion in human capital accumulation in developing and developed economies. In this paper we adopt the approach of Galor and Moav (2000) in modeling this rise in human capital accumulation in the world economy. Galor and Moav (2000) argue that education makes workers more adaptable and so makes them relatively more productive in conditions of technological change. Thus while the level of technology is skill-neutral, the *rate* of growth of technology is skill-biased. We extend this approach to the international environment by assuming that the *rate* of growth of frontier technology is skill-biased but that the rate of growth from internationally diffused or imitation technology is not skill biased. When brain drain migration is added to this environment there is a two way interaction between growth and the migration of skilled workers. Higher technological growth in an advanced economy increases the incentives for agents to migrate to the advanced economy and this spurs (gross) human capital accumulation in the sending economy. Skilled immigration also increases the growth rate of technology in the advanced economy and this further increases the incentives for skilled agents to migrate to the advanced economy as well as increases the incentives for human capital accumulation in the advanced economy itself.

The potential for Brain Drain migration to be beneficial to the sending economy is based on the assumption that the ability to migrate is uncertain and that prospects for migration effect agents' human capital accumulation decisions in the sending economies, see for example Mountford (1997) and Kanbur and Rapoport (2005). There is much empirical evidence supporting this assumption at both the micro and macro level. Micro-level evidence comes mainly from sectoral case-studies looking at specific professions (generally health professionals and engineers) in specific countries. For example, in their survey on medical doctors working in the UK, Kangasniemi, Winters and Commander (2004), the respondents estimate that migration prospects affect the effort of about 40 percent of current medical students in India. [3] Macro-level evidence is provided by Beine, Docquier and Rapoport (2003), who found in a cross-section of 50 developing countries a positive and highly significant effect of migration prospects on gross human capital formation .

The rest of this paper is organized as follows. Section 2 briefly reviews the recent evidence on the evolution of the world distribution of income and on the growth of brain drain migration and derives the implications of the latter for the former. The other sections describe the theoretical model. Section 3 describes an autarkic economy and analyzes its equilibrium when there is no migration, Section 4 analyzes the impact of brain drain migration on both the sending and receiving economies, and Section 5 analyzes the dynamic equilibrium in the world economy and derives the main results of the paper. Finally, Section 6 concludes.

2 Empirical background

This section briefly presents the recent evolution of the world distribution of income, on the one hand, and of brain drain migration, on the other hand, and discusses the implications of one for the other in the light of recent brain drain economic research.[4]

2.1 The growth of 'brain drain' migration, 1970-2000

Skilled emigration rates are rising for most developing countries, and tend to be highest in small and middle-income countries. These trends are shown in Table 1 derived from Docquier and Defoort (2005) which presents skilled emigration rates and selection biases by region and for selected developing countries from 1970-2000. It shows a general rise in brain drain emigration

[3] See also, Robert Lucas (2004), in particular pp. 22-23 on the emigration of Filippino graduates.

[4] See Commander, Kangasniemi and Winters (2004) and Docquier and Rapoport (2004) for detailed surveys of this literature..

with skilled emigration rates rising in all the main developing countries except Indonesia and Turkey.

[INSERT TABLE 1]

This rise in Brain Drain emigration has been caused by a combination of increasingly selective immigration policies on the demand side and a tendency for workers to positively self-select into migration on the supply side. On the demand side selective immigration policies (point-systems), first introduced in Australia and Canada in the early 1980s, have gradually spread to other OECD countries. The U.-S. Immigration Act of 1990, together with the creation of specific visas (H1-Bs) for highly skilled professionals, is among the most significant changes in the U.-S. immigration policy of the past twenty years. A growing number of EU countries have then adopted programs aiming at attracting a qualified workforce, be it temporarily or permanently (OECD, 2002) and in some cases, quality-selection has been proclaimed as the new official motto in immigration issues.[5]

On the supply side the level of education attainments in developing economies have also been rising throughout this period. However, as detailed in Table 1, the growth of brain drain migration has in most cases been greater than that of educational attainments in developing countries, resulting in increased skilled emigration rates.

Table 2 provides estimates of current emigration rates at three education levels for the year 2000 for selected developing countries and for countries grouped by demographic size, income level (using the World Bank classification), and region.

[INSERT TABLE 2]

Table 2 shows that there is a clear decreasing relationship between emigration rates and country size, which may be simply due to the fact that small countries tend to be more open. Indeed, from the last two columns of Table 2 it is clear that these differences cannot be attributed to the educational structure of the home country population or to a higher "selection bias" (ratio of skilled to total emigration rates) in small countries. We also observe from the lower panel of Table 2 that the largest developing countries exhibit relatively low rates of skilled emigration in

[5] Most recent examples are the introduction by the UK of a point-system in March 2006 which makes it easier for educated migrants and investors to obtain permanent residentship while restricting entry for other categories.

spite of their being among the main suppliers of highly-skilled emigrants.[6] This is notably the case for India (4.1 per cent), China (3.6 per cent), Indonesia (1.8 per cent) and Brazil (2.2 per cent). Secondly it is clear that the highest skilled emigration rates are observed in middle-income countries. The fact that skilled emigration rates tend to be lower in relatively affluent countries is easily explained by the low wage differentials between these countries and potential destinations. The reasons why they are also lower in poor countries are less obvious and could be due to a variety of causes, including the role of credit constraints on education and migration decisions or the imperfect transferability of human capital (or "brain waste").

2.2 The world distribution of income and population: recent trends

Estimation of the world distribution of income requires the integration of individual country's income distributions. Using different measures of inequality among world citizens, Sala-I-Martin (2006) finds that global inequality remained more or less constant during the 1970s and then declined during the 1980s and 1990s, with the size of the decline ranging between 4 to 30 percent depending on the exact inequality measure used. Although relatively modest, this decline is remarkable in that it comes after a secular trend of rising inequality at the world level (Bourguignon and Morrisson, 2002). This reversal is more than accounted for by the convergence in income per capita of countries such as India, China, and other Asian countries, while other regions of the world (especially Africa, which includes many small-sized countries) have kept diverging. Using a sub-set of inequality measures that allow for decomposing global inequality between within and across country inequality, Sala-I-Martin (2006) then shows that global inequality is due mostly to inequality across countries. However, within-country inequality has been rising since the 1970s and therefore accounts for an increasingly large share of global inequality – from about one quarter in 1970 to one third in 2000. Still, this increase in within-country inequality is more than offset by the decrease in (weigthed) across-country inequality, resulting in an overall decline of inequality at the world level.

2.3 Estimation of the effects of the Brain Drain on economic growth and the implications for the world distribution of income

The theoretical model will show that the Brain Drain can have a positive or negative effect on growth in the sending economy. Beine, Docquier and Rapoport (2003) have estimated the net

[6] In terms of total numbers, the main international suppliers of brains are the Philippines (1.126 million), India (1.037 million), Mexico (0.923 million) and China (0.816 million). Note that the UK (1.441 million) and Germany (0.848 million) complete the top of the list. See Docquier and Marfouk (2005).

growth effect (i.e., once emigration is netted out) of the brain drain using country specific effects. Their results show that countries that experience positive growth effects (the 'winners') generally combine low levels of human capital and low migration rates, whereas the 'losers' are typically characterized by high migration rates and/or high enrolment rates in higher education There seems to be more losers than winners, but the latter include the largest countries in terms of demographic size (China, India, Indonesia, Brazil) and represents more than 80 percent of the total population of the sample. Again, the implication for the WDI seems to be that brain drain migration will accelerate the rate of convergence of the main big "globalizers" and further marginalize small countries with high skilled emigration rates such as African and Carribean countries, which appear to be the main losers. If anything, the implied impact on the world distribution of income will strengthen the trends predicted by Sala-I-Martin (2006): a decrease in global inequality in the next few decades as India, China and other Asian countries catch up, and then a renewed increase in global inequality as the presence of diverging countries will be increasingly palpable.

3 The Theoretical Model

In this section we describe the dynamics of an economy when there is no migration. We model the rate of growth of frontier technology, g, as an important determinant of the relative productivity of skilled and unskilled workers, following Galor and Moav (2000). Agents live for two periods and are endowed with one unit of labor in their second period. Agents are identical in all respects except for their level of ability, a, which we will assume is distributed uniformly over the unit interval, $[0, 1]$ and independently of the ability level of their parent. To become skilled an agent must be educated at a cost to their parents. If the agent becomes skilled, then agent i can supply $g_t + a_i$ efficiency units of skilled labor. Otherwise the agent remains unskilled and supplies one efficiency unit of unskilled labor. This implies that an increase in the rate of technological progress will increase the number of efficiency units a skilled worker supplies and so will increase the relative wage of skilled workers.

In each period t output, Y_t, may be produced using two factors of production, skilled labor, H_t, and unskilled labor L_t, under perfect competition. The levels of H_t and L_t are determined endogenously by the optimal decisions of agents. The level of technology, A_t, in each period is given and technological progress from one period to the next is related to the level of human capital accumulation in the economy and so is also determined endogenously. Although, as described above, the rate of technological progress is skill-biased, the level of technology is skill neutral.

We first set out the production function and factor prices before analyzing agents' fertility and education decisions and the economy's dynamics.

3.1 Production and Factor Prices

In each period output is produced using two factors according to a constant returns to scale production function

$$Y_t = A_t H_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where H_t and L_t are the levels of skilled labor in the economy.

Defining $h_t \equiv H_t/L_t$, factor prices for each factor are given by their marginal products and hence

$$w_t^H = \alpha A_t h_t^{\alpha-1}; \qquad w_t^L = (1-\alpha) A_t h_t^{\alpha} \tag{2}$$

Thus we can write

$$\frac{w_t^L}{w_t^H} = \frac{(1-\alpha)}{\alpha} h_t \tag{3}$$

3.2 Individuals' Preferences and Budget Constraints

Individuals live for two periods and are identical in all respects except for their levels of ability, a, which we will assume is distributed uniformly over the unit interval, $[0, 1]$ and independently of the ability level of their parent. In their first period of life they are dependent on their parent and may or may not become skilled. Skilled individuals can supply $g_t + a_i$ efficiency units of skilled labor while those remaining unskilled can supply one efficiency unit of unskilled labor.

Individuals make optimal decisions over fertility, consumption and the training of their offspring (Becker (1981)). Following Galor and Mountford (2006) and Moav (2005) the preferences of a member of generation t (i.e. an individual who is born in period $t-1$) are defined over their consumption in period t, c_t, and the total income of their offspring, d_{t+1}, and are represented by the utility function.

$$u_t = c_t^{\theta} d_{t+1}^{1-\theta} \tag{4}$$

Individuals are assumed to be 'small' and so take the wage rate and growth rate in periods t and $t+1$ as given. Individuals optimally allocate their time between labor force participation and child rearing. Denoting the time required to bring up skilled offspring as, τ^s, and the time required to bring up unskilled offspring as, τ^u, where we assume that $0 < \tau^u < \tau^s < 1$, the budget constraint of a member i of generation t, is

$$c_t + w_t^i(\tau^s n_t^H + \tau^u n_t^L) \leq w_t^i \text{ for } \; i = \; s, \; u \tag{5}$$

where n_t^H and n_t^L are the measures of skilled and unskilled offspring respectively.

3.3 Optimization

An individual's fertility decision is a continuous one. Agents thus choose a measure of fertility, n, where n is almost surely *not* an integer and each offspring is of measure zero.[7] For each offspring the parent must make an education decision. Since each family is a price taker in the labor market this amounts to choosing a threshold ability level, $a^\star$, such that all offspring with ability level above $a^\star$ will be educated.

A member i of generation t's optimization problem can thus be written as the following

$$\{c_t, n_t, a^\star\} = \arg\max c_t^\theta (n_t[w_{t+1}^H \int_{a^\star}^1 (g_{t+1} + a_i)di + w_{t+1}^L a^\star])^{1-\theta} \tag{6}$$

such that, for $i = s, u$,

$$c_t + n_t[\tau^s(1 - a^\star) + \tau^u a^\star]w_t^i = w_t^i \tag{7}$$

The optimization gives the following optimal decision rules for consumption and fertility.

$$c_t = \theta w_t^i \tag{8}$$

$$n_t = \frac{1-\theta}{\tau^s(1-a^\star) + \tau^u a^\star} \tag{9}$$

3.3.1 The Education Decision

Optimization with respect to $a^\star$ implies that

$$\frac{(w_{t+1}^H(g_{t+1} + a^\star) - w_{t+1}^L)}{w_{t+1}^H \int_{a^\star}^1 (g_{t+1} + a_i)di + w_{t+1}^L a^\star} = \frac{\tau^s - \tau^u}{\tau^s(1-a^\star) + \tau^u a^\star} \tag{10}$$

Equation (10) provides an intuitive condition for the parental educational choice. If the cost of rearing skilled and unskilled offspring were the same, then it would be optimal to educate offspring up to the point where the earnings of the marginal worker, with ability level $a^\star$, would be the

[7] This is a sensible approach in the representative agent framework and is commonly used in the literature, see for example Becker (1981).

same whether s/he became skilled or not. However the extra cost of rearing skilled offspring implies that parents will need to get a greater return from education i.e. the opportunity costs of education is the possibility of increasing fertility by $(\tau^s - \tau^u)/(\tau^s(1-a^\star) + \tau^u a^\star)$. Hence in equilibrium it must be the case that $w^H_{t+1}(g_{t+1} + a^\star)$ is greater than w^L_{t+1}.

3.4 Technological Progress

We assume, following Galor and Moav (2000), that the rate of technological progress, $g_t \equiv (A_t - A_{t-1})/A_{t-1}$ is an increasing function of the skill intensity of the economy.[8] That is.

$$g_t = \phi(h_{t-1}), \quad \text{where} \quad \phi'(h_{t-1}) > 0. \tag{11}$$

3.5 Equilibrium In An Economy With No Migration

In this section we show that there exists a unique equilibrium level of $a^\star$. We further show that an exogenous increase in the rate of growth decreases the equilibrium level of $a^\star$ and so increases the proportion of offspring becoming educated and reduces the rate of fertility. These properties of the equilibrium are set out in the following propositions.

Proposition 1 *There a unique equilibrium level of* $a^\star$

Proof. Using Figure 3 and equations (3) and (10). Equation (10) can be rearranged and simplified to give

$$\frac{w^L_{t+1}}{w^H_{t+1}} = \frac{(g_{t+1} + a^\star)(\tau^s(1-a^\star) + \tau^u a^\star) - (\tau^s - \tau^u)\int_{a^\star}^1 (g_{t+1} + a_i)di}{\tau^s} \tag{12}$$

which is an increasing function of $a^\star$. This is the ratio of inverse factor supply functions and is labelled 'supply' in Figure 3.

Equation (3) can be written

$$\frac{w^L_{t+1}}{w^H_{t+1}} = \frac{(1-\alpha)}{\alpha}\frac{\int_{a^\star}^1 (g_{t+1} + a_i)di}{a^*} \tag{13}$$

which is a decreasing function of $a^\star$. This is the inverse ratio of inverse factor demand functions and is labelled 'demand' in Figure 3.

Figure 3 plots both these conditions and illustrates the equilibrium level of $a^\star$ □

[8] The assumption of a positive relationship between growth and human capital accumulation is a common one in the literature, see for example Nelson and Phelps (1966), Findlay (1978), Barro and Sala-I-Martin (1995) and also Galor Moav (2004).who provide an excellent survey of empirical support for this relationship.

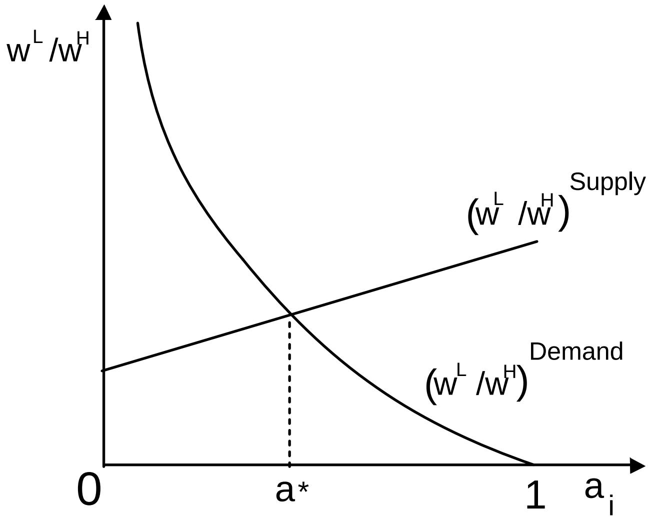

Figure 3 A unique equilibrium level of $a^\star$ under no migration

Proposition 2 *An exogenous increase in the rate of growth, g_t, increases the equilibrium level of h_t.*

Proof. In equilibrium both equations (13) and (12) hold and so we can write after a little manipulation

$$\frac{(1-\alpha)}{\alpha}\frac{\int_{a^\star}^{1}(g_{t+1}+a_i)di}{a^*}-\frac{(g_{t+1}+a^\star)(\tau^s(1-a^\star)+\tau^u a^\star)-(\tau^s-\tau^u)\int_{a^\star}^{1}(g+a_i)di}{\tau^s}=0$$

Totally differentiating this expression with respect to g_{t+1} for every given level of a^* and rearranging gives the following

$$\frac{da^\star}{dg_{t+1}}=\frac{(1-\alpha)(1-a^\star)/\alpha a^\star-\tau^u/\tau^s}{(1-\alpha)[a^\star(g_{t+1}+a^\star)+\int_{a^\star}^{1}(g+a_i)di)]/\alpha+(\tau^s(1-a^\star)+\tau^u a^\star)/\tau^s}$$

Hence $\frac{da^\star}{dg_{t+1}}<0$ iff $(1-\alpha)(1-a^\star)/\alpha a^\star<\tau^u/\tau^s$. But given that $g_{t+1}>0$ this will always be the case. Thus an increase in g_{t+1} reduces $a^\star$ and so increases h_{t+1}. □

Corollary 1 *An increase in the rate of growth, g_t, decreases the equilibrium level of n_t.*

Proof. This follows from equation (9) and proposition 2 □

3.6 Growth Dynamics In An Economy With No Migration

Proposition 2 shows that h_t is an increasing continuous function of g_t and from equation (11) g_{t+1} is an increasing function of h_t. Together these imply the following first order difference equation for the growth rate of technology,

$$g_{t+1} = \phi(h_t(g_t)) \tag{14}$$

where from above it follows that $dg_{t+1}/dg_t > 0$.

Since $dg_{t+1}/dg_t > 0 \forall g_t$ it follows that steady state levels of g_t will be either stable or unstable.

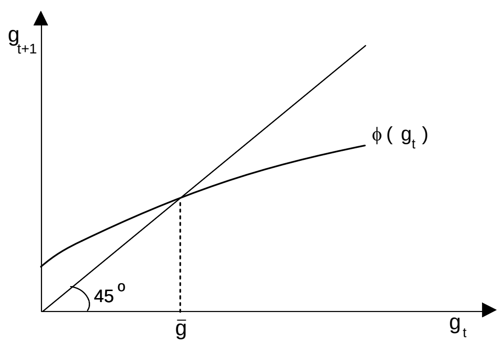

Figure 4a. Growth Dynamics for a Unique Steady state level of g

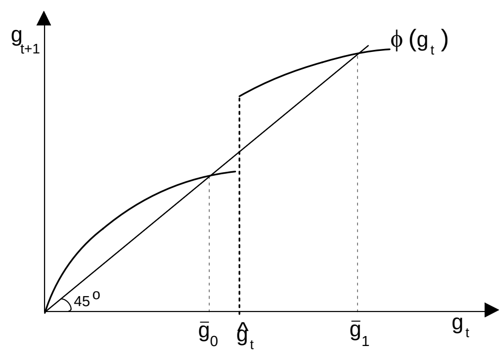

Figure 4b. The growth Dynamics for Multiple steady state levels of g

4 The Impact of Brain Drain Migration On Both The Sending and Receiving Economies

In this section we will describe the effects of a permanent Brain Drain on both the sending and receiving economies. We show that a brain drain can increase the growth rate in both the sending and receiving economies. We do this for each economy separately. In section 5 we put the two economies together and show how it is possible for a core-periphery equilibrium to exist. We assume that migration is limited to a proportion, $x\%$, of the receiving economy's population. This is an intuitive assumption and as shown in the appendix it is also one that can be supported as an equilibrium policy in a straightforward political economy model of immigration.

4.1 The Effects of Permanent Skilled Immigration on an Economy

The permanent immigration of skilled workers to an economy will have both static and dynamic effects on the receiving economy. The static effect reduces the proportion of indigenous agents who choose to become skilled workers and this *ceteris paribus* increases the fertility rate. The dynamic effect is for the receiving economy to converge to a new higher steady state growth rate. This has a positive effect on the proportion of agents who choose to become skilled workers and a negative effect on the fertility rate. Thus if the dynamic effect outweighs the static effect, the long run effect of the permanent immigration of skilled workers will be a raised level of human capital accumulation, a lower fertility rate and an increase in the growth rate in the receiving economy. We demonstrate these results in the following subsections

4.1.1 The Static Effects of Skilled Immigration

The immigration of skilled workers to an economy will, *ceteris paribus,* decrease the equilibrium wage skilled workers. This will, *ceteris paribus,* reduce the proportion of indigenous agents who choose to become skilled workers and so increase the fertility rate. Nevertheless the proportion of skilled labor in the economy, h, will increase as a result of the skilled immigration. This is shown in the following lemma and corollary where we denote the equilibrium ratio of skilled to unskilled labor after the immigration of $x\%$ skilled workers, as $h^A_{BD}(x)$.

Lemma 1 *The immigration of $x\%$ skilled workers in the advanced economy A, ceteris paribus increases the equilibrium ratio of skilled to unskilled labor, with $h^A_{BD}(x)$ an increasing function of x.*

Proof. Using Figure 5 and equations (13) and (12). An inflow of $x\%$ skilled workers will shift the factor price relationship (13) upward. i.e. the increased supply of skilled labor will increase the equilibrium level of w^L_t/w^H_t for every given level of $a^\star$. The relationship between w^L_t/w^H_t and the optimal threshold level of $a^\star$ is not affected by the inflow of skilled workers. Thus as Figure 5 shows, in equilibrium the optimal level of at $a^\star$ rises but so does w^L_t/w^H_t.. Since $w^L_t/w^H_t = ((1-\alpha)/\alpha)h_t$ this implies that h_t also rises in equilibrium. □

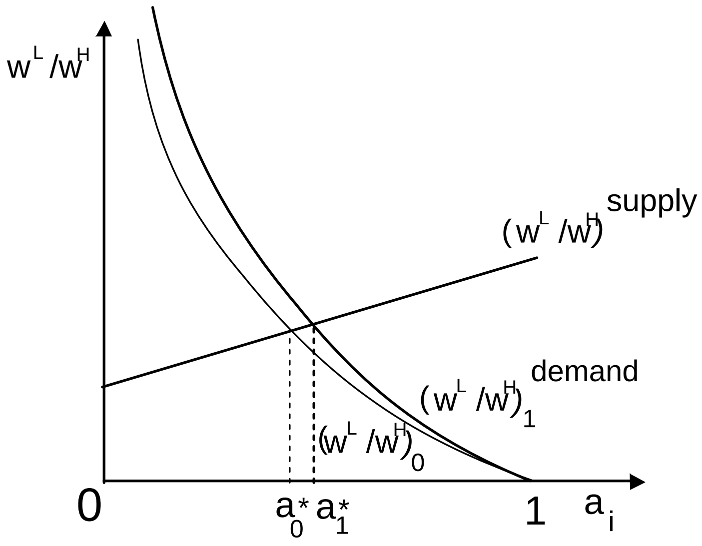

Figure 5 For a given growth rate, skilled immigration reduces the proportion of indigenous agents becoming skilled

Corollary 2 *The immigration of skilled workers in the advanced economy A, ceteris paribus increases the fertility rate, n_t, of economy A.*

Proof. From Lemma 1 we know that an inflow of skilled workers will increase the optimal level of $a^\star$ and hence from equation (9) the corollary follows. □

4.1.2 The Dynamic Effect of Skilled Immigration

For every given level of g_t, lemma 1. shows that the inflow of $x\%$ skilled workers will increase the equilibrium level of h_t. This will increase g_{t+1} and so may lead ultimately to a fall in fertility in the receiving economy as the following lemma and corollary demonstrate.

Lemma 2 *The permanent immigration of $x\%$ skilled workers in the advanced economy A, increases the equilibrium growth rate of economy A.*

Proof. The inflow of $x\%$ skilled workers increases the equilibrium level of h_t This implies that the dynamic equation now becomes $g_t = \phi(h_{t-1}(g_{t-1}, x))$ where h_{t-1} is an increasing function of both arguments. Thus as depicted in Figure 6. A permanent immigration of $x\%$ skilled workers each period shifts up the function $\phi(h_{t-1}(g_{t-1}, x))$ relative to $\phi(h_{t-1}(g_{t-1}, 0))$ and so increases the steady state rate of growth. □

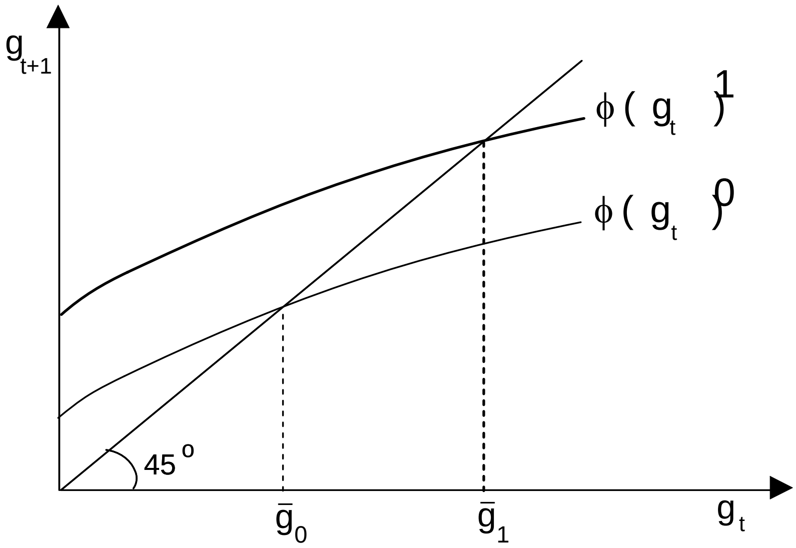

Figure 6. Dynamic effects of Brain Drain Immigration

This implies that if the growth effect is sufficiently strong, permanent skilled immigration can increase human capital levels and reduce the fertility levels in the receiving economy. This is shown in the following corollary

Corollary 3 *If the growth effect from permanent skilled immigration is sufficiently strong, then permanent skilled immigration can increase human capital levels and reduce the rate of population growth in the receiving economy*

Proof. By example. Consider the economy where $\alpha = 1/3, \tau^s = 0.95, \tau^u = \tau^s/2, \theta = 1/3$. Then if $g = 0.01$ then $a^\star = 0.819$ and $n = 1.188$. If there is a 1% inflow of skilled immigrants each period and g remains at 0.01 then $a^\star$ rises to 0.820 and n rises to 1.189. If however there is a 1% inflow of skilled immigrants each period and g rises to 0.5 then $a^\star$ falls to 0.817 and n falls to 1.186. . □

We will call the condition under which this happens as Condition A.

Condition A *A permanent skilled immigration increases human capital levels and reduces the rate of population growth in the receiving economy*

Note that if, in the spirit of Azardiadis and Drazen (1990), there is a threshold externality in the $g_t = \phi(h_{t-1})$ relationship then the increase g due to a Brain Drain immigration can be made arbitrariliy large so that condition A holds. Such a case is depicted in Figure 4b

4.2 The Effects of Skilled Emigration on an Economy

The emigration of skilled workers may increase or decrease the growth rate in the sending economy. This case has been analyzed in the literature before, see for example Mountford (1997) and Kanbur and Rapoport (2005), and the same intuition applies here. The loss of emigrating skilled agents will *ceteris paribus* reduce the level of h_t but the possibility of emigration will also increase the incentive to accumulate human capital. In this section we demonstrate that the latter effect dominates the former if emigration is limited and if the wage gain from emigration is sufficiently high.

We will assume that the sending economy takes the immigration policy of the receiving economy as given, so that each level of $x\%$ of the working population of the receiving economy translates into a maximum number, M, of emigrants from the sending economy. We will also assume that the ability to emigrate is randomly allocated in the event that there are an excess of qualified candidates and so the probability of successful emigration, p, is equal to $M_t/(1-a^\star)N_t^B$ where N_t^B is the population of the sending economy in period t.[9]

The factor market equilibrium condition under emigration now becomes

$$\frac{w_{t+1}^{L,B}}{w_{t+1}^{H,B}} = \frac{(1-\alpha)}{\alpha}\left[\frac{\int_{a^\star}^{1}(g_{t+1}+a_i)di - M(g+(1+a^\star)/2)}{a^*}\right] \tag{15}$$

where $(1+a^\star)/2$ is the average ability level of an emigrant and $w_{t+1}^{H,B}$ and $w_{t+1}^{L,B}$ are the skilled and unskilled wages in the sending economy B.

The individual agents' decision problem is also changed by the possibility of emigration. A member i of generation t now optimizes the following, taking factor prices and p as given.

$$c_t^{\theta}(n_t[(pw_{t+1}^{H,A}\int_{a^\star}^{1}(g_{t+1}^{A}+a_i)di + (1-p)w_{t+1}^{H,B}\int_{a^\star}^{1}(g_{t+1}^{B}+a_i)di) + w_{t+1}^{L,B}a^\star])^{1-\theta} \tag{16}$$

where $w_{t+1}^{H,A}$ is the skilled wage in the receiving economy, economy A. This expression is maximized subject to the same budget constraint, equation (7), and gives rise to the following optimality condition for $a^\star$,

$$\frac{w_{t+1}^{L,B}}{w_{t+1}^{H,B}} = \frac{(p(w_{t+1}^{H,A}/w_{t+1}^{H,B})(g_{t+1}^{A}+a^\star)+(1-p)(g_{t+1}^{B}+a^\star))(\tau^s(1-a^\star)+\tau^u a^\star)}{\tau^s} \tag{17}$$

$$-\frac{(\tau^s-\tau^u)(p(w_{t+1}^{H,A}/w_{t+1}^{H,B})\int_{a^\star}^{1}(g_{t+1}^{A}+a^\star)+(1-p)\int_{a^\star}^{1}(g_{t+1}^{B}+a_i)di)}{\tau^s} \tag{18}$$

[9] We are assuming that the receiving economy can only observe the level of education of an agent not his/her level of ability, a_i.

Note that since $w_{t+1}^{H,A} > w_{t+1}^{H,B}$ this relationship implies a higher level of $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ for every level of $a^\star$ than that in equation (12) for when there is no migration.

Lemma 3 *The ability of M skilled workers to emigrate from the less advanced economy, B, to the advanced economy A, increases the proportion of agents who choose to become skilled in economy, B.*

Proof. Using equations (15) and (17) and Figure 3. Noting that an increase in M shifts down the factor demand relationship for $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ in equation (15) and that the factor supply relationship for $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ in equation (17) is always above that for when there is no migration in equation (12) then using Figure 3 it follows that the equilibrium level of a^* will be lowered by Brain Drain emigration. . □

Corollary 4 *The ability of M skilled workers to emigrate from the less advanced economy, B, decreases the fertility rate of economy B*

Proof. From Lemma 3 we know that an outflow of M skilled workers will decrease the optimal level of $a^\star$ in economy B and hence from equation (9) the corollary follows. □

Whether the emigration of M skilled workers raises the equilibrium level of h in economy B depends on whether the positive effect of an increase in human skill accumulation is stronger than the negative effect of emigration. In the following proposition we show that if $w_{t+1}^{H,A}$ is sufficiently high for a given level of M then the level of h in economy B will increase.

Lemma 4 *The ability of M skilled workers to emigrate from the less advanced economy, B, to the advanced economy A, increases the equilibrium level of h_t in economy, B if the skilled wage in the advanced economy, $w_{t+1}^{H,A}$ is sufficiently large*

Proof. The factor demand relationship for $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ in equation (15) does not depend on $w_{t+1}^{H,A}$ and is downward sloping in $(w_{t+1}^{L,B}/w_{t+1}^{H,B}, a^*)$ space. Whereas the factor supply relationship for $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ in equation (17) does depend on $w_{t+1}^{H,A}$. Equation (17) can be rearranged to give,

$$\frac{w_{t+1}^{L,B}}{w_{t+1}^{H,B}} = \frac{(p(w_{t+1}^{H,A}/w_{t+1}^{H,B})[(g_{t+1}^{A}+a^\star)(\tau^s(1-a^\star)+\tau^u a^\star)-(\tau^s-\tau^u)\int_{a^\star}^{1}(g_{t+1}^{A}+a^\star)di]}{\tau^s} \quad (19)$$

$$+\frac{(1-p)[(g_{t+1}^{B}+a^\star)(\tau^s(1-a^\star)+\tau^u a^\star)-(\tau^s-\tau^u)\int_{a^\star}^{1}(g_{t+1}^{B}+a^\star)di)}{\tau^s} \quad (20)$$

which implies that an increase in $w_{t+1}^{H,A}$ increases this relationship and so increases the equilibrium $w_{t+1}^{L,B}/w_{t+1}^{H,B}$ for a given level of M □

5 The Dynamics of the World Economy Under Brain Drain Migration.

In this section we first derive analytical results showing how a 'core-periphery' equilibrium may be a stable equilibrium for the world economy. These results are derived under the assumption that the advanced economy is small relative to the less advanced sending economy.in the population dimension. It is shown in the core periphery equilibrium that Brain Drain migration patterns are permanent and that the Brain Drain increases growth in both the sending and receiving economies, although it also causes an increase in income inequality.between countries.

When the population of the advanced economy is not small relative to the less advanced economy the dynamics of the world economy are described by a four dimensional first order system of difference equations in the relative technology levels, the relative population levels, and the initial growth rates in both economies. A complete analytical description of this four dimensional system is beyond the scope of this paper. Instead we simulate the world economy and show the conditions under which the model can produce the same qualitative properties as the stylised facts presented in section 2. We begin by describing the dynamics of technological diffusion in the world economy.

5.1 Technological Diffusion in the World Economy

We assume that frontier art technology diffuses from the most advanced economy, A, to the less advanced economy, B with a lag.[10] In keeping with the discussion in section 3 we assume that this diffusion of technology raises the level of technology and increases the productivity of both skilled and unskilled labor in an unbiased manner. This contrasts with the growth of frontier knowledge which following Galor and Moav (2000) is assumed to be skill biased.[11] We follow Findlay (1978) and Nelson and Phelps (1966) in assuming that the rate of diffusion is positively related to the human capital intensity in economy B, h^B, and the size of the gap between the technological levels in the two economies, $A^A - A^B$, that is[12]

$$A_t^B = A_{t-1}^B(1 + g^B(h_{t-1}^B)) + \lambda(h_{t-1}^B)(A_{t-1}^A - A_{t-1}^B) \qquad (21)$$

[10] See Keller (2001) for evidence on the importance of technological diffusion for technology growth in developing economies.

[11] One can allow for diffused technological growth to be skill biased so long as the skill bias for an economy whose technological growth is significantly dependent on international technology diffusion is significantly less than that for an economy whose technological growth is completely due to increasing frontier technology.

[12] See Basu and Weil (1998) for a discussion of the issue of different types of advances in technology and on the importance of appropriate factor endowments for technology diffusion.

Note that if g^A, g^B and λ are constants satisfying $g^A > g^B - \lambda$ then repeated substitution gives the variation on Nelson and Phelps's (1966) result that the technological level of economy B tends to a constant fraction of that of economy A,

$$A_t^B = \frac{\lambda}{\lambda + g^A - g^B} A_t^A \tag{22}$$

where this fraction is decreasing in the rate of growth of the advanced economy, g^A.

Of course in general h_t^B will not be constant through time but we show in our simulation section that this ratio will approximately hold in the limit. However as we detail in the following section g^B and λ can be treated as constants under the assumption that economy B is large in terms of population relative to the advanced economy, A.

5.2 Existence of a Core Periphery Equilibrium in the World Economy

In this section we assume that economy B is large in terms of population relative to the advanced economy, A. It is shown that if condition A holds then a stable 'core-periphery' equilibrium of the world economy will exist. It is shown that in such a core-periphery equilibrium, Brain Drain migration will increase the rate of growth in both the sending and receiving economies, but will also increase income inequality between countries. This is described in the following propositions and corollaries.

Proposition 3 ***(Core-Periphery Equilibrium)***
If economies A and B are identical except for their levels of population and technology, where $A_t^A > A_t^B$ and A is small relative to economy B in terms of population and Condition A holds, then a 'Core-Periphery' equilibrium will be a stable equilibrium of the world economy. This equilibrium has the following two properties

(i) there is a permanent Brain Drain migration of agents from economy B to economy A,

(ii) the level of output per capita in economy B will be a constant fraction of that in economy A.

Proof. The assumption that economy B is large relative to economy A implies that the probability of emigration is close to zero. From equation (17) for a given ratio of $w_{t+1}^{H,A}/w_{t+1}^{H,B}$ as the probability of emigration goes to zero, economy B tends to its autarkic equilibrium. From lemma 2 this implies that $g^A - g^B$. If condition A is satisfied then economy A's rate of population growth will be below that of economy B. Thus the equilibrium is stable: economy A will maintain its lead in frontier technology while economy B will maintain its lead in population size. □

Corollary 5 *In the neighborhood of a Core-Periphery equilibrium income inequality between countries is increasing in the rate of Brain Drain migration*

Proof. This follows as economy B is close to its autarkic equilibrium then h_t^B can be treated as a constant through time and hence g^B and λ can be treated as constants. Once economy A is in the neighborhood of its new steady state then h_t^A and so g^A can also be treated as a constant. Hence equation (22) holds and it follows that the ratio of A_t^B/A_t^A declines when g^A increases. □

Corollary 6 *In the neighborhood of a Core-Periphery equilibrium world growth is increasing in the rate of Brain Drain migration*

Proof. Growth in economy A will increase from lemma 2 and growth in economy B will increase from the technology diffusion equation (21) . □

Finally one should emphasize that Condition A is a sufficient but not a necessary condition for the Core-Periphery equilibrium to be locally stable. If economies A and B differ for exogenous reasons, such as differences in growth institutions, so that under no migration $g^A > g^B$ it follows from corollary 1 that the rate of population growth in economy B is greater than that in economy A. Brain Drain migration will thus reinforce the pattern of relative technological growth rates but, if condition A does not hold, it will work against the pattern of relative population growth rates. However as long as the population growth rate in economy B is greater than that in economy A then a Core-Periphery equilibrium will be stable.

5.3 Simulations of the Evolution of the World Economy

In this section we display the results from simulations of the two country world economy described above We concentrate on the case where both economies are identical in every respect except for their population size, their technological level and their initial economy The case where economies differ for some fundamental reason e.g. growth promoting institution, follows routinely on from the cases discussed herey We first discuss the simulation results for the core periphery case described in section 5.2. We then describe the case of two similar economies where the sending economy's skill intensity falls after Brain Drain emigration. Our third case describes the case where Brain Drain emigration causes a large incentive to invest in human capital in the sending economy.

5.3.1 Core-Periphery Equilibrium

The simulations for a core periphery equilibrium are displayed in Figure 7. In the core periphery equilibrium we set the technological difference between the two economies to be initially large with $A^A = 10$ and $A^B = 1$ and the level of immigration into A to be low at 0.1% of A's working population. We also set $\alpha = 1/3, \theta = 1/3$, $\tau^s = 0.85, \tau^u = 0.6, N^A = 100$ and $N^B = 100$. Finally the dynamic equations are set such that economy A is above a dynamic growth threshold so that $g^A_{t+1} = (h^A_t)^{0.5}$ while economy B is below a growth threshold so that $g^B_{t+1} = (h^B_t)^{0.5}/1000$ i.e. frontier growth in economy B is practically zero. The coefficient on technological diffusion, $\lambda = 3h^B_t$

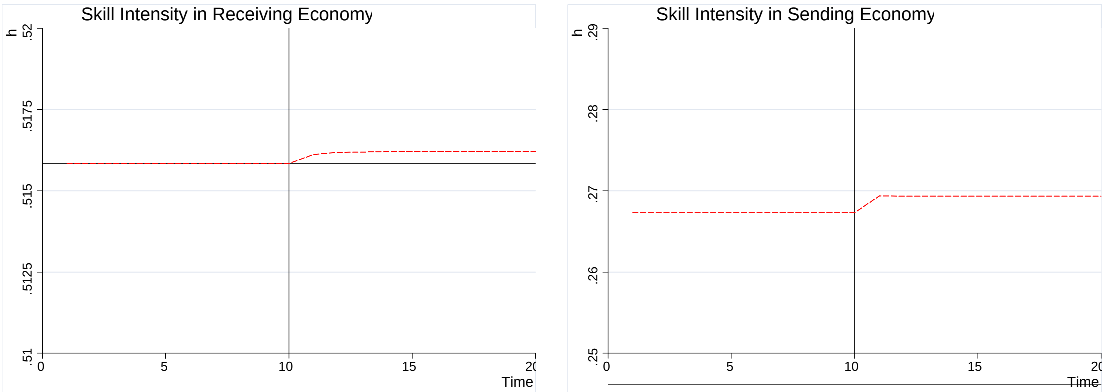

Figure 7 The effect on skill intensity of Brain Drain migration, starting in period 10 in both the sending and receiving economies

Brain Drain migration begins in period 10. The simulations show that this causes the skill intensity to rise in economy A which quickly converges to a new steady state. The skill intensity in economy B also rises as the incentive to invest in human capital is high since the technological difference between A and B is large while the actual numbers leaving economy B is small. This situation is stable as the population growth rate of economy B is higher than that of economy A and so gradually the incentive to invest in human capital in economy B falls as the probability of successfully emigrating falls.

5.3.2 Dynamics of Two Similar Economies

In contrast to the core periphery equilibrium, this section shows the results of two nearly identical economies but with a significant level of Brain drain migration.. Here we set $A^A = 10$ and $A^B = 9.99, g^A_{t+1} = (h^A_t)^{0.5}$, $g^B_{t+1} = (h^B_t)^{0.5}$ and $\lambda = 0.99$. Thus the technological level of the two economies is nealy identical. We set the level of immigration into A to be 5% of A's working population and the initial level of populations to be $N^A = 100$ and $N^B = 2500$. The other parameters are set to be the same as in the core-periphery simulations above.

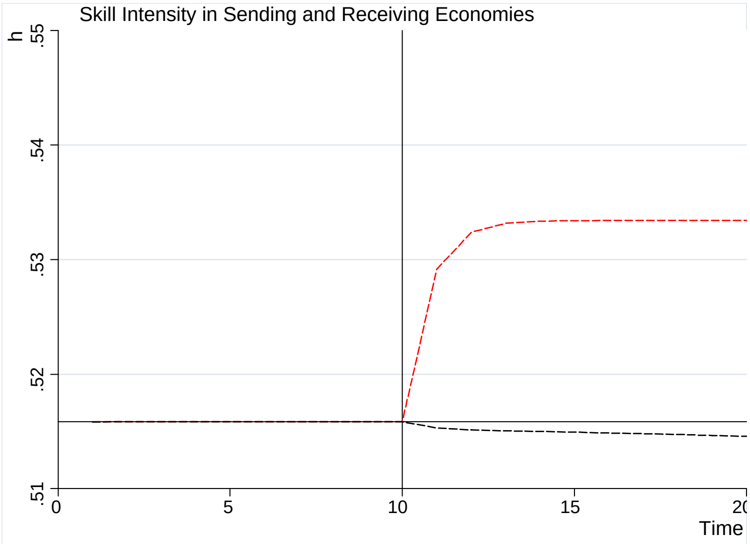

Figure 8

Brain Drain migration begins in period 10. The simulations show that as before this causes the skill intensity to rise in economy A which quickly converges to a new steady state. The skill intensity in economy B now declines as the incentive to invest in human capital is low since the technological difference between A and B is very small and the numbers leaving economy B are not insignficant. Under these parameters this situation is not stable as the population growth rate of economy B is lower than that of economy A and so gradually the incentive to invest in human capital in economy B rises as agents' probability of successful emigration rises. If economy B differed fundamentally from economy A so that it had a significantly large population growth then this situation would be stable.

5.3.3 Catching Up Dynamics

In this example we show the importance of the migration propensity for the determination of the equilibrium. We choose the parameters in this example to be precisely the same as in the core periphery equilibrium example above, except that now we have a much larger immigration propensity of say 4% of A's working population.

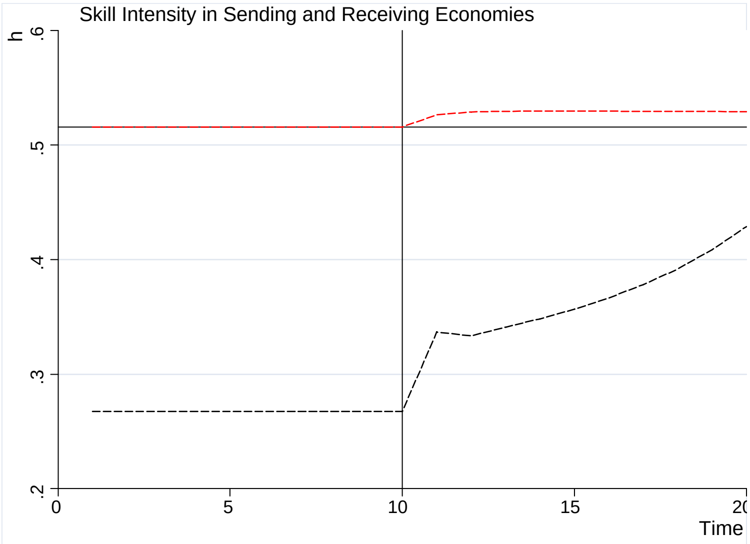

Figure 9 The effect on skill intensity of Brain Drain migration, starting in period 10 where the migration probability is significantly higher than in the core-periphery case

As before Brain Drain migration begins in period 10. Now in contrast to the core periphery case the larger incentive to invest in human capital accumulation due to the greater chance of successful emigration causes the level of h^B to rise markedly. This also reduces the fertility rate and so reduces B's population relative to A and so further increases the probability of successful emigration. This increases the incentive to invest in human capital and so on. Again if economy B differed fundamentally from economy A so that it had a sufficiently larger population growth then this equilibrium would not occur.

6 Conclusion

This paper has analyzed the implications of the current trend towards predominantly skilled, or Brain Drain, emigration from poor to rich countries on fertility and human capital formation and growth in both the sending and receiving countries It has shown that this pattern of migration may cause fertility to fall and human capital accumulation to rise in both the sending and receiving economies. It has also shown that this migration pattern may cause the world economy to converge to a special kind of core-periphery equilibrium where increasing inequality between countries is fueled by Brain Drain migration but where, nonetheless, world poverty is reduced, world growth is increased and the income of agents in both the core and the periphery is increased.

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Table 1. The brain drain to the six major immigration countries - a long run view

	Skilled emigration rates						Selection bias (skilled/total migration rate)					
By region	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**
AMERICA	2.0%	2.0%	2.5%	2.6%	2.7%	3.1%	1.40	1.35	1.35	1.28	1.09	1.04
USA and Canada	*0.9%*	*0.9%*	*1.1%*	*0.9%*	*0.8%*	*0.8%*	*1.15*	*1.13*	*1.36*	*1.30*	*1.24*	*1.25*
Caribbean	*54.2%*	*47.3%*	*45.3%*	*42.2%*	*39.7%*	*41.9%*	*5.61*	*4.67*	*3.83*	*3.41*	*3.11*	*2.87*
Central America	*13.8%*	*10.8%*	*12.9%*	*13.1%*	*16.3%*	*16.6%*	*3.08*	*2.32*	*2.01*	*1.78*	*1.60*	*1.45*
South America	*3.6%*	*3.4%*	*3.7%*	*3.7%*	*3.6%*	*4.2%*	*7.14*	*6.73*	*5.59*	*4.96*	*4.41*	*4.04*
EUROPE	6.1%	6.2%	5.8%	5.3%	4.5%	5.6%	2.14	2.15	2.11	2.03	1.83	2.02
Eastern Europe	*2.1%*	*2.7%*	*2.7%*	*2.7%*	*2.0%*	*3.4%*	*2.35*	*2.89*	*2.96*	*3.00*	*2.32*	*2.75*
Rest of Europe	*9.0%*	*8.4%*	*7.9%*	*7.0%*	*6.0%*	*7.0%*	*2.04*	*1.87*	*1.83*	*1.74*	*1.68*	*1.83*
incl. EU15	*8.6%*	*8.1%*	*7.7%*	*6.8%*	*6.0%*	*6.7%*	*2.01*	*1.84*	*1.81*	*1.72*	*1.74*	*1.83*
incl. EU25	*8.9%*	*8.6%*	*8.1%*	*7.3%*	*6.3%*	*7.2%*	*2.06*	*1.94*	*1.92*	*1.85*	*1.88*	*1.98*
AFRICA	7.3%	7.5%	9.2%	8.9%	9.0%	9.2%	8.30	8.10	9.72	9.33	8.68	8.63
Northern Africa	*9.9%*	*8.2%*	*9.1%*	*6.6%*	*6.6%*	*6.3%*	*3.93*	*3.19*	*3.86*	*3.02*	*3.11*	*3.13*
Sub-Saharan Africa	*6.2%*	*7.1%*	*9.3%*	*10.8%*	*10.8%*	*11.7%*	*17.89*	*18.55*	*19.69*	*20.32*	*16.43*	*15.80*
ASIA	3.8%	4.2%	4.8%	4.7%	4.8%	5.1%	10.81	11.10	10.50	9.21	8.26	7.82
Eastern Asia	*2.2%*	*2.4%*	*3.1%*	*3.1%*	*3.3%*	*3.5%*	*13.06*	*13.94*	*13.01*	*10.91*	*10.38*	*9.55*
South-central Asia	*3.3%*	*3.9%*	*3.8%*	*4.1%*	*4.1%*	*4.9%*	*13.43*	*15.57*	*12.62*	*12.13*	*10.63*	*10.69*
South-eastern Asia	*9.1%*	*9.4%*	*11.3%*	*10.1%*	*9.8%*	*9.3%*	*16.11*	*14.63*	*11.73*	*9.09*	*7.63*	*6.49*
Near and Middle East	*12.3%*	*9.2%*	*9.1%*	*7.0%*	*5.9%*	*6.0%*	*3.82*	*2.64*	*2.90*	*2.47*	*2.05*	*2.13*
OCEANIA	3.7%	3.8%	4.6%	4.5%	5.4%	6.1%	1.91	1.83	1.70	1.69	1.58	1.73
Australia and New Zealand	*3.2%*	*3.3%*	*3.8%*	*3.6%*	*4.2%*	*4.9%*	*1.78*	*1.60*	*1.46*	*1.44*	*1.36*	*1.53*
Other Pacific countries	*45.5%*	*47.7%*	*50.2%*	*50.3%*	*49.3%*	*44.4%*	*16.43*	*20.52*	*14.33*	*14.62*	*10.23*	*8.48*
Selected countries	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**
Argentina	*2.6%*	*3.2%*	*3.2%*	*2.6%*	*2.1%*	*2.1%*	*6.33*	*6.90*	*5.63*	*4.31*	*3.45*	*3.00*
Brazil	*0.7%*	*0.8%*	*0.8%*	*1.0%*	*1.2%*	*1.6%*	*8.25*	*8.51*	*7.40*	*7.37*	*6.95*	*6.74*
China	*2.5%*	*3.1%*	*3.8%*	*2.6%*	*3.1%*	*3.3%*	*32.04*	*38.84*	*36.12*	*21.31*	*21.94*	*19.06*
India	*2.9%*	*3.2%*	*2.7%*	*2.8%*	*3.2%*	*4.1%*	*13.75*	*15.40*	*11.82*	*11.34*	*12.02*	*12.55*
Indonesia	*3.3%*	*5.6%*	*8.3%*	*2.6%*	*1.9%*	*1.4%*	*43.89*	*70.23*	*96.32*	*28.50*	*18.23*	*14.00*
Korea	*4.4%*	*4.3%*	*4.8%*	*5.3%*	*4.0%*	*4.4%*	*6.02*	*5.51*	*4.28*	*3.83*	*2.68*	*2.44*
Mexico	*11.4%*	*8.8%*	*9.9%*	*10.5%*	*13.9%*	*15.0%*	*2.28*	*1.69*	*1.46*	*1.39*	*1.31*	*1.24*
Russia	-	-	-	-	*0.1%*	*1.2%*	-	-	-	-	*0.79*	*2.88*
Saudi Arabia	*3.5%*	*3.9%*	*3.0%*	*0.8%*	*0.9%*	*0.9%*	*13.71*	*17.35*	*16.35*	*5.87*	*5.66*	*5.83*
South Africa	*6.0%*	*12.0%*	*11.6%*	*11.1%*	*6.7%*	*6.7%*	*8.97*	*18.01*	*14.88*	*14.21*	*6.37*	*6.01*
Turkey	*11.5%*	*7.5%*	*7.2%*	*6.5%*	*6.2%*	*5.3%*	*2.54*	*1.45*	*1.61*	*1.56*	*1.30*	*1.18*

Source: Docquier and Defoort (2005)

Table 2. International migration data for selected countries and country groups in 2000

	Share in the world population	Share in the OECD immigration stock		Rate of emigration			Share of skilled workers	
By country size	**in %**	**Total**	**Skilled**	**Total**	**Skilled**	**Selection bias**	**Among residents**	**Among migrants**
Large countries (Pop>25 million)	84.2%	60.6%	63.9%	1.3%	4.1%	3.144	11.3%	36.4%
Upper-Middle (25>Pop>10)	10.0%	15.8%	15.2%	3.1%	8.8%	2.839	11.0%	33.2%
Lower-Middle (10>Pop>2.5)	5.2%	16.4%	15.7%	5.8%	13.5%	2.338	13.0%	33.1%
Small countries (Pop<2.5)	0.6%	3.7%	3.7%	10.3%	27.5%	2.666	10.5%	34.7%
By income group	**in %**	**Total**	**Skilled**	**Total**	**Skilled**	**Selection bias**	**Among residents**	**Among migrants**
High Income countries	16.0%	30.4%	33.7%	2.8%	3.5%	1.238	30.7%	38.3%
Upper-Middle Income countries	10.3%	24.3%	17.7%	4.2%	7.9%	1.867	13.0%	25.2%
Lower-Middle Income countries	15.6%	26.6%	27.2%	3.2%	7.6%	2.383	14.2%	35.4%
Low Income countries	58.1%	15.1%	19.8%	0.5%	6.1%	12.120	3.5%	45.1%
By region	**in %**	**Total**	**Skilled**	**Total**	**Skilled**	**Selection bias**	**Among residents**	**Among migrants**
AMERICA	13.6%	27.2%	22.9%	3.3%	3.3%	1.002	29.6%	29.7%
USA and Canada	*5.2%*	*2.9%*	*4.7%*	*0.8%*	*0.9%*	*1.127*	*51.3%*	*57.9%*
Caribbean	*0.5%*	*5.3%*	*5.8%*	*15.3%*	*42.8%*	*2.807*	*9.3%*	*38.6%*
Central America	*2.2%*	*14.2%*	*6.7%*	*11.9%*	*16.9%*	*1.418*	*11.1%*	*16.6%*
South America	*5.7%*	*4.9%*	*5.7%*	*1.6%*	*5.1%*	*3.219*	*12.3%*	*41.2%*
EUROPE	11.9%	37.0%	33.3%	4.1%	7.0%	1.717	17.9%	31.7%
Eastern Europe	*5.0%*	*8.1%*	*7.9%*	*2.2%*	*4.3%*	*1.930*	*17.4%*	*34.2%*
Rest of Europe	*6.9%*	*28.9%*	*25.4%*	*5.2%*	*8.6%*	*1.637*	*18.3%*	*31.0%*
incl. EU15	*6.2%*	*23.8%*	*21.9%*	*4.8%*	*8.1%*	*1.685*	*18.6%*	*32.5%*
incl. EU25	*7.4%*	*28.5%*	*26.5%*	*4.9%*	*8.7%*	*1.789*	*17.6%*	*32.8%*
AFRICA	13.1%	7.9%	6.9%	1.5%	10.4%	7.031	4.0%	30.9%
Northern Africa	*2.8%*	*4.0%*	*2.2%*	*2.9%*	*7.3%*	*2.489*	*7.5%*	*19.6%*
Sub-Saharan Africa	*10.3%*	*3.9%*	*4.7%*	*1.0%*	*13.1%*	*13.287*	*2.8%*	*42.5%*
ASIA	60.8%	26.4%	35.1%	0.8%	5.5%	7.123	6.3%	46.8%
Eastern Asia	*24.7%*	*7.3%*	*11.5%*	*0.5%*	*3.9%*	*8.544*	*6.3%*	*55.5%*
South-central Asia	*24.4%*	*6.3%*	*9.3%*	*0.5%*	*5.3%*	*10.030*	*5.0%*	*52.5%*
South-eastern Asia	*8.5%*	*7.3%*	*10.6%*	*1.6%*	*9.8%*	*5.980*	*7.9%*	*51.4%*
Near and Middle East	*3.2%*	*5.5%*	*3.6%*	*3.5%*	*6.9%*	*1.937*	*11.4%*	*22.9%*
OCEANIA	0.5%	1.4%	1.8%	4.3%	6.8%	1.578	27.8%	45.0%
Australia and New Zealand	*0.4%*	*1.0%*	*1.4%*	*3.7%*	*5.4%*	*1.479*	*32.7%*	*49.2%*
Other Pacific countries	*0.1%*	*0.4%*	*0.4%*	*7.6%*	*48.7%*	*6.391*	*3.1%*	*35.2%*
Selected developing countries	**in %**	**Total**	**Skilled**	**Total**	**Skilled**	**Selection bias**	**Among residents**	**Among migrants**
Argentina	*0.6%*	*0.4%*	*0.5%*	*1.0%*	*2.5%*	*2.410*	*19.7%*	*48.2%*
Brazil	*2.8%*	*0.7%*	*0.8%*	*0.4%*	*2.2%*	*5.076*	*8.4%*	*43.4%*
China	*20.9%*	*3.0%*	*4.1%*	*0.2%*	*3.8%*	*17.121*	*2.7%*	*48.0%*
India	*16.7%*	*3.0%*	*5.2%*	*0.4%*	*4.3%*	*12.104*	*4.8%*	*60.5%*
Indonesia	*3.5%*	*0.4%*	*0.5%*	*0.2%*	*2.1%*	*9.097*	*5.0%*	*46.3%*
Korea	*1.1%*	*2.1%*	*3.3%*	*2.8%*	*5.6%*	*2.034*	*25.8%*	*54.1%*
Mexico	*1.6%*	*11.3%*	*4.6%*	*12.4%*	*15.3%*	*1.229*	*11.3%*	*14.4%*
Russia	*2.4%*	*1.0%*	*1.4%*	*0.6%*	*1.5%*	*2.521*	*20.1%*	*51.1%*
Saudi Arabia	*0.4%*	*0.0%*	*0.1%*	*0.2%*	*0.9%*	*5.129*	*12.5%*	*64.6%*
South Africa	*0.7%*	*0.5%*	*0.8%*	*1.3%*	*7.5%*	*5.639*	*10.4%*	*62.6%*
Turkey	*1.1%*	*3.5%*	*0.9%*	*5.6%*	*5.8%*	*1.038*	*8.5%*	*8.8%*

Source: Own calculations based on Docquier and Marfouk (2005)