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Can A Brain Drain Be Good For Growth ?

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Abstract

This paper shows how a brain drain - the emigration of agents with a relatively high level of human capital in an economy - can paradoxically increase the productivity of an economy where productivity is a function of the average level of human capital. The model uses Galor and Tsiddon's model of income distribution, endogenous human capital formation and growth, to analyze the interaction between income distribution and migration. The paradoxical positive effect of a brain drain on productivity occurs when successful emigration is not a certainty and when the increase in human capital accumulation by people wishing to become eligible to emigrate, causes a change in the long run income distribution which outweighs the decrease in human capital caused by the brain drain itself.

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1 Introduction

The recent emphasis on the importance for economic growth of the average level of human capital in an economy, has led many to presume that a 'brain drain' may leave a developing country in a poverty trap. The intuition being that the average level of human capital in a developing country will not grow because the developed world will 'siphon off' its highly educated workers, thus increasing the productivity of the developed world at the expense of the developing economy. This paper shows that when human capital accumulation is endogenous and if successful emigration is not a certainty, that paradoxically a brain drain may increase the growth of a developing country. The intuition behind this paradox is that the chance of emigration increases the returns to education and may increase human capital accumulation enough to offset the negative effect of the brain drain itself ! The increase in human capital accumulation can occur for both short run and long run reasons. The short run reason is simply the individual's optimization decision: a higher expected real wage per efficiency unit implies a greater optimal level of investment in obtaining these efficiency units. The long run reason is that the brain drain may also effect the long run income distribution in the economy and may cause there to be a greater proportion of 'highly educated' people in the economy. It is shown that it is this long run channel that is potentially the most powerful and most long lasting.

The assumption that attempted migration is not always successful, can be justified both as a positive economic theory and on grounds of realism. As a piece of positive economics this paper shows how, for example, a 'leaky border' or an exit visa emigration policy in which an individual is uncertain whether s/he will obtain this visa, may increase the productivity of an economy. Thus for a government that wishes to maximize next period's per capita income, there will exist an optimal probability of emigration, or an optimal number of exit visas. This assumption is also not too far away from a realistic description of the emigration policy of the old Soviet Union [1].

The assumption that the level of productivity in an economy is related to the average level

[1] Another analogy is the attempt to emigrate to America via an American graduate school. First the potential emigrants must obtain a degree in their own land and then apply for acceptance to an American school, which is by no means a non-stochastic process.

of human capital accumulation in an economy is a common one, see for example Barro's [2] and Mankiw, Romer and Weil's [8] empirical work and Lucas' [7] and Azariadis and Drazen's [1] theoretical work. This assumption is robust in this paper, in the sense that the 'brain drain' paradox may also exist if the productivity externality is associated with the number of highly skilled people in the economy, as in Miyagiwa [9].

The most related articles to this paper are Miyagiwa's and Galor and Tsiddon's [6] papers on income distribution, human capital accumulation and growth and Galor and Stark's [4], [5] papers on capital accumulation and return migration. Miyagiwa's paper concentrates on the effect of scale economies on migration, when the productivity externality is dependent upon the number of educated people in an economy. It shows how a large economy will attract a small economy's educated workers and thus that this brain drain will necessarily reduce the productivity of the small economy. Galor and Tsiddon examine the two directional relationship between income distribution and growth, in a model with endogenous human capital accumulation. This paper uses a simplified version of the Galor and Tsiddon model to examine the effects of migration on income distribution and human capital accumulation. Galor and Stark show that the possibility of enforced return migration to a lower wage economy, will increase an immigrant's saving. Galor and Stark do not address the issue of income distribution. The contribution of this paper is to show the importance of the interaction between income distribution, accumulation and migration and to show that even if the best 'accumulators' in an economy emigrate, that due to changes in the dynamics of income distribution, an economy may still become more productive. The dynamic nature of the model also allows us to contrast the effects of a temporary and a permanent migration, which is also an important topic in the literature, see for example Karayalcin [3]. This paper shows that both a temporary and a permanent brain drain can have permanently beneficial effects on per capita income if they alter the long run income distribution in the economy.

This paper is organized as follows. In the second section we describe the behaviour in terms of growth and income distribution of a small open economy without migration. In the third section we look at the effect of first, a general migration and then a ‘brain drain’, on the growth and income distribution of this economy. This section also examines the different implications of a temporary and permanent emigration.

2 Description of an Economy without Migration

The model in this section is a simplified version of Galor and Tsiddon’s model. The economy is a small open overlapping generations economy, existing in a world where there is one good and perfect capital mobility. The world’s one good is produced under constant returns to scale by two factors, capital and efficiency units of labor. The supply of both factors is determined by agents’ optimal decisions taken in the previous period. The amount of agents in each generation - L_t - is assumed to grow at rate n.

2.1 Production of Goods and Factor Prices

The amount of capital and efficiency units of labor in time period t, are denoted by K_t and E_t respectively. The productivity of labor, or the state of the technology, in period t is given by λ_t.

Production is generated by a constant returns to scale production function. The output produced at time t, Y_t, is

$$Y_t = F(K_t, \lambda_t E_t) = f(k_t)\lambda_t E_t \text{ where } k_t = \frac{K_t}{\lambda_t E_t}$$

We make the standard assumptions about this function, namely

$$f(k) > 0 \quad f'(k) > 0 \quad f''(k) < 0 \quad \forall k > 0$$

and the ‘Inada Conditions’

$$\lim_{k\to 0} f(k) = 0 \quad \lim_{k\to 0} f'(k) = \infty \quad \lim_{k\to\infty} f'(k) = 0$$

Factor prices are determined in the standard way by the factor's marginal product. Due to perfect capital mobility and the smallness of the economy, $k_t = \bar{k} \ \ \forall t$, where $\bar{k}$ is the k in the rest of the world. Thus the return to capital, r_t, is

$$r_t \ = \ f'(\bar{k}_t) = \bar{r}$$

and the return to efficiency labor, w_t, is

$$w_t \ = \ \lambda_t[f(\bar{k}_t) - \bar{k}_t f'(\bar{k}_t)] = \lambda_t \bar{w}$$

2.2 Technological Progress and Human Capital Production

In this sector the nature of the human capital externality is explained. It is assumed that the economy wide productivity at time t, λ_t, is dependent on the average level of human capital of the eldest generation in a society. However it is also assumed that there is a 'family level' externality, which makes an individual's accumulation of human capital easier, the greater the human capital accumulation of his/her parent. These two externalities are modeled as follows.

The level of technology in period t, λ_t, is thus modeled as a function of the average level of 'parental' human capital, that is

$$\lambda_{t+1} = \lambda(\bar{e}_t) \quad \text{where } \bar{e}_t \equiv \frac{E_t}{L_t}$$

where L_t is the measure of people in generation t and where $\lambda'(\bar{e}_t) > 0$.

An individual i's accumulation of human capital, or efficiency units of labor, is an increasing function of the individual's parent's level of human capital e_t^i and the resources invested in human capital accumulation, or education, x_t^i by the individual. For simplicity we also assume a threshold externality in the effect of parental human capital so that parents with more human capital than $\hat{e}$ give their offspring much greater returns than parents with less human capital[2].

[2]This threshold externality is purely a simplifying assumption and is *not* needed for the results in this paper. The model could use the more realistic and more complicated function of Galor and Tsiddon [6], where ϕ is a continuous increasing and concave function of both e_t^i and x_t^i, and obtain the same results.

Thus the human capital production technology is given by the following production function

$$e^i_{t+1} = \begin{cases} \psi(e^i_t)\phi(x^i_t) & \text{if } 0 \leq e^i_t \leq \hat{e} \\ \alpha\psi(e^i_t)\phi(x^i_t) & \text{if } e^i_t > \hat{e} \end{cases}$$

It is assumed that $\alpha > 1$ and that $\psi(e^i_t)$ and $\phi(x^i_t)$ are concave functions - $\psi'(e^i_t), \ \ \phi'(x^i_t) > 0; \ \ \psi''(e^i_t), \ \ \phi''(x^i_t) < 0$ - with positive intercepts $\psi(0), \ \ \phi(0) > 0$.

2.3 Individuals' Optimization Decisions

Agents exist in an overlapping generations world and live for three periods. In their first period of life agents want to consume and invest resources in human capital accumulation. They have no resources and so they must borrow from the capital market at the world's rate of interest, $\bar{r}$. The second period of existence is the only time when an agent can work. Thus in this period the agent must repay the debt of the first period, consume and save in order to consume in the last period of life. In the third period agents are retired and use their savings to consume. All agents have the same preferences and access to the same technology, although of course they do not have the same levels of 'parental' human capital. It is this difference which allows there to be a long run dispersal of household income levels in the economy.

In this paper we assume log-linear preferences, though again this is for simplicity and a general monotonic strictly quasi-concave utility function would give the same results. Thus the utility of individual i born at time t, $u^{t,i}$, is given by

$$u^{t,i} = \log(c^{t,i}_t) + \delta \log(c^{t,i}_{t+1}) + \delta^2 \log(c^{t,i}_{t+2}) \tag{1}$$

This function is maximized subject to the individual's budget constraint. This is best considered by realizing that an individual only gets income in the second period of life and thus the lifetime income of individual i born at time t, I^i_{t+1}, is

$$I^i_{t+1} = \bar{w}\lambda_{t+1}\alpha^J\psi(e^i_t)\phi(x^i_t); \quad \alpha > 1$$

Where J is an indicator function which equals 1 if parental human capital is greater than $\hat{e}$ and 0 otherwise. The budget constraint for individual i born in period t, is thus

$$(x_t^i + c_t^{t,i})(1+\bar{r}) + c_{t+1}^{t,i} + \frac{c_{t+2}^{t,i}}{(1+\bar{r})} \leq I_{t+1}^i \tag{2}$$

An individual maximizes equation (1) subject to equation (2) and the human capital production function.

The first order conditions for this problem are straightforward. They imply that,

$$\frac{c_t^{t,i}}{c_{t+1}^{t,i}} = \frac{c_{t+1}^{t,i}}{c_{t+2}^{t,i}} = \frac{1}{\delta(1+\bar{r})}$$

and that

$$\phi'(x_t^i) = \frac{(1+\bar{r})}{\alpha^J \psi(e_t^i)\bar{w}\lambda_{t+1}}; \quad \alpha > 1 \tag{3}$$

From the concavity of ϕ it is clear from equation (3) that an individual's investment in human capital will be positively related to his/her parent's level of human capital. It can be shown that there exists a function mapping the level of parental human capital to that of their offspring, $e_{t+1}^i = \theta(e_t^i)$. Figure 1. draws this function. Although in general this function can have many steady state values above and below the threshold level $\hat{e}$, we will assume $\theta'(e_t^i)$ to be always less than one, so that there are at most two steady states, one above and one below $\hat{e}$. Again this is purely a simplifying assumption and is not vital to the results.

2.4 Long Run Income and Income Distribution

If we hold the level of λ constant, we can use Figure 1. to depict the dynamics of the income distribution of the economy. If it is so that there are two steady state values of human capital accumulation then Figure 1. shows that all families with an initial level parental capital above the threshold $\hat{e}$ will converge to the higher steady state level of human capital, e^h and all other families will converge to the lower steady state level of human capital e^l.

However λ is not constant. It is dependent on the average level of human capital accumulated in the previous period in the economy. Thus if the average level of human capital rises, this increases λ which, from equation (3), increases the investment in human capital by all members of the economy - an upward shift of both lines in Figure 1 - and thus will cause another rise in λ. This is thus a potentially perpetual growth process. For the time being however we will assume that the growth process is stable and the long run income and income distribution settle down to a steady state, though this is again not vital to the main result of this paper.

3 The Effects of Migration

Given the model described in the previous section we can now discuss the implications of a 'brain drain' in an economy with endogenous human capital accumulation. We will first look at the effect of a general chance for anyone in the economy to emigrate to an economy with a better level of technology, $\bar{\lambda}$, and hence a better wage rate per efficiency unit of labor, $\bar{\lambda}\bar{w}$. Then we will look at the effect of an emigration in which only the most highly educated have a chance to emigrate. We shall see that it is possible that such a 'brain drain' may increase the per-capita income of an economy. The implications of the duration of the emigration are also analyzed and it is shown how temporary chances to emigrate can have permanent effects.

3.1 The Effect of a General Chance to Emigrate

If it is known that workers in the following period will have a chance, π to emigrate to a country with a higher level of technology, $\bar{\lambda}$ then this will increase the investment in human capital by all members of the 'young' generation. Not only will this increase the productivity of the non-emigrating workers next period but also in all the following periods as the economy converges to a new steady state with a higher λ.

To see this is so, we must redefine the maximization problem in terms of expected utility. Substituting the budget constraint into the utility function allows us to write agent i's maximization problem as the following:

$$\max_{\{c_t^i, x_t^i, s_{t+1}^i\}} \log(c_t^i) + \pi \log(\bar{w}\bar{\lambda}\alpha^J \psi(e_t^i)\phi(x_t^i) - (x_t^i + c_t^i)(1+\bar{r}) - s_t^i)$$

$$+(1-\pi)\log(\bar{w}\lambda_{t+1}\alpha^J \psi(e_t^i)\phi(x_t^i) - (x_t^i + c_t^i)(1+\bar{r}) - s_{t+1}^i) + \log(s_{t+1}^i(1+\bar{r}))$$

The first order condition with respect to the human capital accumulation gives the following equation

$$\frac{\pi}{c_{t+1}^E}[\bar{w}\bar{\lambda}\alpha^J\psi(e_t^i)\phi'(x_t^i) - (1+\bar{r})] + \frac{(1-\pi)}{c_{t+1}^{NE}}[\bar{w}\lambda_{t+1}\alpha^J\psi(e_t^i)\phi'(x_t^i) - (1+\bar{r})] = 0$$

Where c_{t+1}^E and c_{t+1}^{NE} are the consumption in the second period when emigrating and not emigrating respectively. Using the implicit function theorem, it follows that the amount invested by individual i, is an increasing function of the probability of the emigration, that is

$$\frac{dx_t^i}{d\pi} = -\frac{\frac{1}{c_{t+1}^E}[\bar{w}\bar{\lambda}\alpha^J\psi(e_t^i)\phi'(x_t^i) - (1+\bar{r})] - \frac{1}{c_{t+1}^{NE}}[\bar{w}\lambda_{t+1}\alpha^J\psi(e_t^i)\phi'(x_t^i) - (1+\bar{r})]}{\frac{\pi}{c_{t+1}^E}[\bar{w}\bar{\lambda}\alpha^J\psi(e_t^i)\phi''(x_t^i)] + \frac{1-\pi}{c_{t+1}^{NE}}[\bar{w}\lambda_{t+1}\alpha^J\psi(e_t^i)\phi''(x_t^i)]} > 0$$

Thus the human capital accumulation schedule shifts upwards as depicted in Figure 2. Again assuming that the global externality λ is weak, the economy will settle down to a new steady state. It is clear from Figure 2. and from the above analysis that the average level of human capital in the new steady state will be higher than in the previous non-emigration steady state.

It is noteworthy that this general migration can also effect the long run income distribution and thus a temporary emigration opportunity can have lasting beneficial effects. If the opportunity to migrate shifts the lower branch of the $\theta(e_t^i)$ function up, so that it no longer crosses the 45° line then all agents will tend towards the high education steady state, e^h. In this case a temporary emigration opportunity that lasts long enough for many agents to jump to the upper branch of the $\theta(e_t^i)$ function, will have a permanent effect on average level of human capital accumulation in the economy.

It is also noteworthy that a permanent chance to emigrate will still increase the productivity in an economy, even if it leads to an eventual depletion of that economy. If the chance to emigrate is permanent and if the probability of successful emigration is greater than the population growth rate then in the limit the economy will be totally depleted, but while workers remain in this economy their per capita productivity will be above that that would have occurred had no emigration been possible.

3.2 The Effect of a Brain Drain

This section looks at the consequences of a selective immigration policy by the more productive economy. Suppose now there is only a chance of emigration, π, if the agent has a certain level of human capital accumulation, $e^\star$. This too can have beneficial effects for the small economy for two reasons. Firstly, as in the previous section, those people who would previously have obtained a level of $e^\star$ or greater, will now invest more in human capital accumulation and thus the average level of human capital accumulation in the next period may increase. Secondly, there is also a potentially very large dynamic effect, whereby some agents who would previously have chosen a level of human capital accumulation of less than $e^\star$, will now choose to accumulate a level of $e^\star$, in order to have the chance to emigrate. This may change the dynamics of income distribution in the economy and may result in many more people reaching the high education level steady state.

The first subsection shows how the first effect may by itself be sufficient to cause an increase in per capita income in the small economy, although this would require either a very large increase in the human capital accumulation of the potential emigres or a very small number of lowly educated people. The second subsection describes the second dynamic effect, which is the interaction of the chance to emigrate and the long run income distribution. This is potentially very powerful and is a more reasonable and intuitive channel through which a brain drain can increase the productivity of an economy.

3.2.1 The Simple Brain Drain Effect

For simplicity let us assume that the small open economy is at a long run steady state and that $e^\star = \hat{e}$ and is such that none of the people at the low income steady state will choose to increase their human capital accumulation in order to attain the level required to have a chance of emigrating, either initially or in the long run. If we denote the number of people and their level of education at the low education steady state as L^l and e^l, respectively and the corresponding variables at the high education steady state as L^h and e^h, then the average level of human capital, $\bar{e}_t$, before a brain drain is:

$$\bar{e}_t = \frac{L^l e^l + L^h e^h}{L^h + L^l}$$

If however there was a chance, π, which enabled M randomly selected people, with human capital above $e^\star$, to emigrate and if this probability was known in the previous period, then the average level of human capital, $\bar{e}_m$, would be :

$$\bar{e}_m = \frac{L^l e^l + (L^h - M)e^m}{L^h - M + L^l}$$

where e^m is the level of human capital accumulation chosen by potential emigrants and from the analysis in the previous section, $e^m > e^h$. If e^m is sufficiently greater than e^h, or if L^l is sufficiently small, then clearly, $\bar{e}_m$ will be greater than $\bar{e}_t$. The following period will therefore have a higher λ_{t+1} and thus everyone in the next period will increase their human capital accumulation relative to their pre-emigration levels.

In this section we are assuming that the dynamic process does not raise the lower branch of the $\theta(e_t^i)$ function wholly above the $45°$, which is the case analyzed in the next section. Without such a change in the long run income distribution this will be a very weak effect, for three reasons. Firstly the values of the variables required for a beneficial brain drain are not intuitive. One would expect for example, that the number of low educated individuals is not small relative to the number of high skilled individuals. Secondly, this effect is not robust to the specification of the technological externality, λ. If like Miyagiwa [9], the externality is related to the number of individuals in an economy that possess a certain level of human capital – most intuitively $\hat{e}$ – then clearly a brain drain would reduce productivity. Thirdly, this specification is not robust to the duration of the brain drain. Since no-one in the economy changes ‘education’ classes and since population growth is the same for all members of society, then eventually because of the loss of a fraction π of the highly educated people every period, the proportion of highly educated people in the economy will fall over time, which can cause the average level of human capital accumulation to fall, potentially below the original pre-emigration level.

The following section looks at the more powerful dynamic channel through which a brain drain can increase productivity, which does not suffer from these three deficiencies.

3.2.2 The Dynamic Brain Drain Effect

This section assumes that the level of education, $e^{\star}$ required to be eligible to emigrate is not too high to tempt some less educated people to increase their level of human capital accumulation. An agent that would invest less than $e^{\star}$ if there was no chance to emigrate, will only invest $e^{\star}$ or more if the benefits of participating in the ‘emigration lottery’ outweigh the costs of a greater investment in education. Since the benefits are increasing in the level of parental capital then there will be a critical level of parental capital, e^{c}, such that an individual with this level of parental capital will invest $e^{\star}$ and those with parental capital below e^{c} will invest the same as they would without the opportunity to emigrate.

To illustrate the potentially large effect of the change in income distribution on economic growth, we consider the case where e^{c} is below the low education steady state, e^{l} and where $e^{\star} > \hat{e}$. In this case the low education steady state disappears and so eventually everyone remaining in the economy converges to the high education steady state, e^{h}. Thus the average level of human capital accumulation in the economy increases substantially. This situation is depicted in Figure 3.

Note that this mechanism is robust to the deficiencies of the previous section. As long as π is not too high then this could increase the *number* of people in the economy with a level of education above $\hat{e}$, though of course if the probability of emigration is greater than the rate of population growth this benefit will eventually disappear. When the productivity externality is related to the average level of human capital, the problem of the duration of the brain drain is also irrelevant. Everyone ends up at the same steady state level of human capital accumulation thus in the long run there is no problem of the number of lowly educated people dominating the number of highly educated people.

In a more general model with more than two 'education classes' - i.e. more than one threshold in the human capital production function, or an unrestricted $\theta(e_t^i)$ function - there can still be a long run increase in the average level of human capital even if almost all the highly educated agents have emigrated. If the temporary increase in the number of highly skilled people raised λ so that the $\theta(e_t^i)$ function shifts up enough to enable lowly educated people to shift to another more educated 'class', then this positive effect on the average level of human capital could outweigh the negative effect of the gradual dwindling of the percentage of highly educated people in the economy due to emigration. Finally note that a temporary brain drain can have permanent beneficial effects in precisely the same way as a temporary general migration, which was described in section 3.1.

4 Conclusion

This paper has shown that when human capital accumulation is endogenous and when successful emigration is not a certainty, that the interaction between human capital accumulation decisions, growth and income distribution can paradoxically lead to the result that a brain drain, either temporary or permanent, may increase the growth rate of per capita income in a developing country.

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