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Brain Gain: Claims about Its Size and Impact on Welfare and Growth Are Greatly Exaggerated

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ABSTRACT

Brain Gain: Claims about Its Size and Impact on Welfare and Growth Are Greatly Exaggerated*

Based on static partial equilibrium analysis, the "new brain drain" literature argues that, by raising the return to education, a brain drain generates a brain gain that is, under certain conditions, larger than the brain drain itself, and that such a net brain gain results in an increase in welfare and growth due to education's positive externalities. This paper, on the other hand, argues that these claims are exaggerated. In the static case, and based on both partial and general equilibrium considerations, the paper shows that i) the size of the brain gain is smaller than suggested in that literature; ii) the impact on welfare and growth is smaller as well (for any brain gain size); iii) a positive brain gain is likely to result in a smaller human capital gain and may even have a negative impact on the stock of human capital; iv) an increase in the stock of human capital may have a negative impact on welfare and growth; and v) in a dynamic framework, the paper shows that the brain drain is unambiguously larger than the brain gain, i.e., that the steady state is characterized by a net brain loss.

JEL Classification: D61, D62, F22, H20, H41, I12, J61

Keywords: brain gain size, welfare, growth, exaggerated claims

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1. Introduction

The traditional brain drain literature has viewed the exodus of human capital as something of a curse for developing countries,[1] and has considered policies to counter it or reduce its negative impact on the emigration countries, including the taxation of migrants' income abroad (Bhagwati 1976, Bhagwati and Hamada 1976, Bhagwati and Wilson 1989).[2] That literature has viewed the benefits of the brain drain as including increased trade, remittances, knowledge, capital flows--including FDI (partly attributed to a "Diaspora" effect (Lucas 2005)), and the skills acquired by return migrants in the destination country.[3]

A benefit not considered in the traditional brain drain literature is the brain-drain-induced 'brain gain,' a central feature of the 'new brain drain' literature. Since a brain drain implies that a share of skilled individuals will migrate and earn a higher wage abroad, the new brain drain literature posits that:

i) the brain drain raises the expected return on education;

ii) this induces additional investment in education (a brain gain);

iii) conditions exist under which the brain gain dominates the brain drain (a net brain gain); and

iv) a net brain gain raises welfare and growth.

[1] This remains the view of the majority of analysts working on this issue (e.g., see Solimano 2001).
[2] On a nationalist view of the brain drain in this literature, see Patinkin (1968). On an internationalist view, see Johnson (1968) and Bhagwati and Wilson (1989).
[3] A recent contribution is Javorcik, Ozden and Spatareanu (2004). They show that a larger stock of immigrants from a given source country to the US results in greater US outward FDI to that country, with the effect essentially due to skilled immigrants.

These results are said to hold independently of other potential effects of the brain drain on the level of education, whether through remittances or through the skills return migrants might have acquired in the destination countries.

Seminal papers in the new brain drain literature include Mountford (1997)**,** Stark et al. (1997, 1998), Stark and Wang (2002), Stark (2004), Stark et al. (2004), Beine et al. (2001, 2003), Docquier and Rapoport (2004), and Vidal (1998).[4] Their work has led to a reconsideration of the impact of the brain drain on the number of skilled individuals and on economic welfare and growth in the source country.

Most studies in that literature are theoretical, though empirical results are slowly emerging thanks to the work of Carrington and Detragiache (1998, 1999) and Docquier and Marfouk (2004).[5] [6] These studies have estimated the stock of skilled migrants from developing countries who are living in OECD countries. [7]

The number of skilled migrants--and their share in total migration--has risen dramatically in recent decades. Docquier and Hillel (2004) report that the number of migrants residing in OECD countries increased by 50% between 1990 and 2000, with the increase of skilled migrants 2.5 times that of unskilled ones (70% versus 28%).

A case in point is the flight of human capital in the health sector, with the more extreme cases of emigration taking place in Sub-Saharan Africa and the Caribbean. For instance, Grenada (Jamaica) has had to train twenty two (five) doctors in order to retain

[4] Commander, Kangasniemi and Winters (2004) provide a survey of the brain drain literature.
[5] Regional differences in the brain drain are examined in Docquier et al. (2005).
[6] Adams (2003) used the same assumptions as Carrington and Detragiache and provides brain drain estimates for 24 countries in 2000.
[7] Carrington and Detragiache used the 1990 US census data to estimate the brain drain for a number of developing countries in 1990. Docquier and Marfouk (2004) improved the measurement of the brain drain by expanding data sources to all OECD countries, estimating the brain drain for a larger number of developing countries, and doing so for the year 2000 as well as for 1990.

one (Stalker, 1994). This implies a brain drain of 95.5% for Grenada and 80% for Jamaica. The large exodus of other healthcare providers is similarly worrisome.

The necessity to assess the validity of the claims of the new brain drain literature has increased with the growing flight of skilled workers from developing countries, and with the related skilled immigration programs recently put in place by a number of destination countries. This paper provides such an assessment, based on a more detailed analysis of the relationship between the brain drain and brain gain.

The remainder of the paper is organized as follows. Based on partial equilibrium analysis, Section 2 shows why the brain gain is likely to be smaller than appears from the new brain drain literature. Section 3 does so from a general equilibrium viewpoint. The latter has so far not been incorporated in the new brain drain literature, despite the fact that it is central to the analysis of the size of the brain gain and of the impact on welfare and growth. Section 4 considers destination country policies that may result in a negative brain gain, Section 5 examines the impact of the brain gain on welfare and growth, and Section 6 concludes.

Section 2 also provides a dynamic analysis of the new brain drain literature's claim regarding the net brain gain. Specifically, Section 2.1.3 examines whether the claim holds in the steady state.

1.1. Main Findings

This paper examines some of the assumptions underlying the theoretical and empirical findings in the new brain drain literature. It finds that the impact of the brain drain on welfare and growth is likely to be significantly smaller, and the likelihood of a negative impact on welfare and growth significantly greater, than reported in that literature. These findings are due to the fact that the brain gain is smaller than has been obtained in the literature and because various negative effects of the brain gain on human capital, welfare and growth have not been taken into account. These results are based on both partial and general equilibrium analysis.

Last but certainly not least, an analysis of the dynamics of the brain drain and brain gain shows that the steady state is characterized by a brain gain that is smaller than the brain drain, i.e., by a net brain loss, irrespective of whether the transition path is characterized by a net brain gain or net brain loss. This result holds despite the fact that the analysis is based on the same assumptions about the brain gain as those prevailing in the new brain drain literature. These assumptions are very optimistic because they do not include the impact of a variety of partial and general equilibrium effects, all of which result in a smaller brain gain.

Contributors to the early brain drain literature viewed the brain drain as entailing a loss for the developing source countries. An implication of the arguments presented in this paper is that their views were probably close to the mark.

2. Smaller Brain Gain: Partial Equilibrium

Sections 2 and 3 argue that the brain gain is smaller than is claimed by the new brain drain literature. This section presents arguments based on static and dynamic partial equilibrium analysis. General equilibrium considerations are examined in Section 3.

Before turning to these arguments, it seems useful to provide a simple graphical representation of the central issue examined in this paper. It reflects a static partial equilibrium view of the issue. Figure 1 shows the brain drain (*BD*), the brain gain (*BG*) and the net brain gain ($NBG = BG – BD$), as functions of the skilled migration probability p (i.e., the share of the brain drain in the skilled labor force). The brain drain *BD* is drawn as a 45-degree line rising from zero at $p = 0$ to the entire skilled labor force at $p = 1$. The brain gain $BG = 0$ for $p = 0$ and $p = 1$, and positive for $0 < p < 1$.

Figure 1 presents two alternative brain gain curves, $BG = BG_1$ and $BG = BG_2$. In the case of BG_1--the type of brain gain assumed in the new brain drain literature, the net brain gain NBG_1 is positive for $p < p_1$ and negative for $p > p_1$. Thus, a brain drain would result in a net increase in education for low migration probabilities (for a small brain drain relative to the skilled labor force).

This paper argues that the actual brain gain is closer to BG_2 than to BG_1 (or is actually equal to BG_2) with a negative net brain gain ($NBG_2 < 0$) or a net brain loss for any $p > 0$. Note also that *NBG* is negative for large values of p, irrespective of whether *BG* is equal to BG_1 or BG_2. This is one result on which the new brain drain literature and this paper agree.

2.1. Dynamic Implications of Endogenous Migration Probability

Two assumptions prevalent in the new brain drain literature seem questionable, namely that the source country determines the migration probability (i.e., the share of migrants in the skilled population) and that this probability is exogenous. The second one has fundamental effects on the dynamics of the brain drain and brain gain. Section 2.1.3 shows that a net brain loss must hold in the steady state, i.e., it must be the case that the brain drain is greater than the brain drain.

2.1.1. Who Determines the Brain Drain?

The first assumption relates to the source country's ability to determine the probability or rate of migration. This assumption is found in most studies in the new brain drain literature. For instance, Stark and Wang (2002) examine the role of a migration policy implemented by source country governments.

In fact, though trade and capital flows have been greatly liberalized, destination countries continue to impose strict barriers on immigration. Exceptions include a few repressive regimes—e.g., Cuba, Myanmar and North Korea--that deny their citizens the right to migrate. The number of such regimes has greatly diminished in recent years, mainly due to the collapse of the Soviet bloc.

Thus, except for a few countries, migration controls are firmly in the hands of destination countries' authorities. This is particularly true for the more skilled migrants who have less to gain by migrating illegally.

2.1.2. Migration Probability and Evolution of the Brain Drain and Brain Gain

The second assumption in the new brain drain literature is that the probability of migration is exogenously given and is unaffected by individuals' education decisions. However, I am not aware of *any* destination country immigration policy that stipulates that a specific *percentage* of a source country's skilled individuals is allowed entry. Rather, destination countries tend to use numerical quotas in order to restrict entry. In that case, the migration probability is endogenous, and its value depends on the size S of the skilled population. These quotas are (almost) always filled. Denote the quota by BD (the brain drain).

The models in this literature typically start from a situation of zero migration and compare it with that of positive migration. The starting migration probability $p_0 = BD/S_0$, where *BD* is the destination-country-determined brain drain (i.e., the quota of skilled immigrants) and S_0 is the skilled population in period $t = 0$, before migration takes place. The new destination-country migration policy is announced at $t = 0$.

The new brain drain literature's models take the migration probability p as a constant that is determined exogenously. If so, those who are considering at $t = 0$ whether to acquire additional education take the migration probability at $t = 1$ (when they graduate) as being the one they observe at the time $t = 0$ when they must make the decision. That probability is p_0. In other words, $p_1^e = p_0$, where p_1^e is the probability assumed to prevail at $t = 1$.[8] The fact that $p_1^e = p_0 = BD/S_0$ is now positive raises the expected return on education and results in a brain gain BG_1 (where *BD* is the brain drain (a flow), *BG* is the brain gain (a flow), and S_0 is the skilled population at $t = 0$ (a stock). Thus, BG_1 is a function of $p_1^e = p_0$, i.e., $BG_1 = BG(p_0)$. More generally:

$$BG_t = BG(p_{t-1}),\ BG' > 0, BG'' < 0\,. \tag{1}$$

[8] The model where such expectations are used is known as the cobweb model. The assumption of such expectations is certainly more plausible for the brain gain than for crop prices, the case for which the cobweb model was originally developed. One reason is that the assessment about the probability of migration is made by *different* individuals every period and they do so only once, while the *same* farmers and traders operate over many periods and therefore have a better understanding of the markets in which they operate. A second reason is the availability of information. Information on commodity prices (spot and futures) is available on a continuous basis through various electronic media outlets, which is certainly not the case for the future migration probability. Consequently, learning about the latter is much *harder* than for agricultural prices and is thus *less* likely, making the assumed expectations formation rule quite plausible. Note that the same expectations rule obtains in the case of uncertainty (e.g., if there is a random disturbance term in equation (1)) in various rational expectations equilibrium models, resulting in what is known as a 'random walk', where $p_{t+1} = p_t + e_t$, and e_t is a 'white noise' error term, so that $E_t(p_{t+1}) = p_t$. Note that in this case, the expectations solution is the result of individuals exploiting all the available information rather than due to ignorance of the market.

Note that a number of individuals were acquiring education before migration became an option, i.e., when the expected return to education was lower than under migration. Denote the number of these individuals by *E*. With migration, the benefit of education increases, and *new* individuals decide to acquire education (the brain gain), and those individuals who acquired education in the absence of migration continue to do so under migration. In other words, *E* is constant. Then, $S_1 = S_0 + \Delta S_1 = S_0 + (E + BG_1 - BD)$. More generally:

$$S_t = S_{t-1} + \Delta S_t = S_{t-1} + (E + BG_t - BD) = S_0 + \sum_{i=1}^{t} (E + BG_i - BD)\,. \qquad (2)$$

The only variable that might vary over time is the brain gain *BG*. Note that if $E > BD$, the skilled population rises over time (irrespective of the size--or existence--of the brain gain), a situation that is not considered to be a brain drain *problem*. In order for a brain drain problem to prevail, *E* must be smaller than *BD* (Lowell, 2003, provides conditions for a brain drain, one of which is $E < BD$). This is assumed in the analysis below.

2.1.3. An Unambiguous Net Brain Loss in the Steady State

The initial stock of educated people is S_0. The increase in the stock between periods 0 and 1 is $\Delta S_1 = E + BG_1 - BD$, which is either positive or negative. Assume that in the first transition path, $E + BG_1 - BD > 0$ (with an ambiguous sign for the net brain gain $NBG = BG - BD$). In that case, the number of skilled people increases to $S_1 > S_0$ and the migration probability decreases to $p_1 = BD/S_1 < p_0 = BD/S_0$. From equation (1), $BG_2 < BG_1$ and $\Delta S_2 < \Delta S_1$. Over time, the stock S_t increases at a decreasing rate until period *j* where $\Delta S_j = 0$, with a steady-state stock $S_t = S^P$ for all $t \geq j$.

In the second transition path, $\Delta S_1 = E + BG_1 - BD < 0$ (with the net brain gain $NBG = BG_1 - BD < -E < 0$). Then, $S_1 < S_0$, $BG_2 > BG_1$, $|\Delta S_2| < |\Delta S_1|$, and S_t falls at a decreasing rate. This process continues until period k where $\Delta S_k = 0$. The steady-state stock is $S_t = S^N$ for all $t \geq k$.

The first (second) transition path results in a steady-state stock S^P (S^N) that is larger (smaller) than the initial stock, i.e., $S^P > S_0 > S^N$. Though the steady-state stock depends on the transition path, the change in stocks in the steady state does not, and neither does the relationship between the brain drain and the brain gain. In the steady state, we have:

$$\Delta S_j = \Delta S_k = E + BG - BD = 0, \qquad (3)$$

where BG is the value of BG_t that solves equation (3).

Consequently, the net brain gain $NBG \equiv BG - BD = -E < 0$ in the steady state, irrespective of the transition path. Thus, the brain gain can *never* compensate for the brain drain in the steady state. The result also implies that a country that starts with a higher initial level of education E (before migration takes place) will experience a larger *net brain loss NBL* = E in steady state.

The result holds under other expectation formation rules as well, including perfect foresight and rational expectations (see latter part of footnote 8), and adaptive expectations.[9] The new brain drain literature claims that a brain drain results in a net brain gain under certain conditions. The steady-state result provides a powerful challenge to this claim because no specific conditions are imposed for the result to hold.

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[9] Convergence to the steady state is faster under perfect foresight and rational expectations, and is slower under adaptive expectations.

Note that the steady state may never be reached. For instance, assuming that those who obtain an education in the absence of migration have a greater ability than those who obtain an education after migration is allowed (i.e., after the incentives to do so have increased), and that the destination country possesses a perfect screening process and only gives access to those with the higher ability level, it follows that there is no more benefit in acquiring an education for the lower-ability group than in the absence of migration. Thus, there is no brain gain and the change in the skilled population is $E - BD$, which—as discussed earlier—is negative, implying that the skilled population falls continuously.

The results obtained in this section are based on an optimistic assumption about the size of the brain gain, an assumption shared by the new brain drain literature. As examined below, there are additional reasons why the brain gain is smaller that suggested in the new brain drain literature. Consequences for transitional dynamics and for the steady state are also analyzed.

2.2. Heterogeneity

2.2.1. Individual Heterogeneity

Assume, for simplicity, that abilities are distributed uniformly and that an individual's ability affects the benefit of education but not its cost which is a constant *C*. This is shown in Figure 2, which draws on Commander et al. (2004). Figure 2 also shows three parallel lines declining from right to left, with the lower (higher) (middle) line depicting the benefit of education obtained in the absence of migration (obtained in the destination country) (expected, given the migration probability). The ability level also declines from right to left. The education cost C is invariant with respect to ability.

In the absence of migration, the equilibrium is at A^*. Under migration, equilibrium is at A^{**}, with a brain gain equal to ($A^{**} - A^*$). However, one cannot simply compare ($A^{**} - A^*$) and ($A^* - A_{MAX}$) because of the different ability levels between the two groups. Recalling that the distribution of abilities is uniform, individuals who acquired education under no migration have an average ability level $A_{NM} = (A^* + A_{MAX})/2$, which is greater than the average ability level $A_M = (A^{**} + A^*)/2$ of those who acquired education once migration became possible.

Thus, it would be incorrect to conclude that a net brain gain takes place when the share of the brain gain (relative to the total number of educated individuals) $S = (A^{**} - A^*)/(A^{**} - A_{MAX})$ is larger than the migration probability p since $A_M < A_{NM}$. This can be seen with the help of Figure 2.

In the absence of migration, the source country benefits from the presence of its most able individuals (those with abilities between A_{MAX} and A^*). Recall that the new brain drain literature assumes that skilled migrants are selected randomly among all skilled individuals. Thus, in the case of migration, a share p of migrants originates *both* in the more able group (between A_{MAX} and A^*) *and* in the less able group (from A^* to A^{**}).

Consequently, the skilled individuals remaining in the source country consists of a share ($1 - p$) of non-migrants from *both* the more able *and* the less able groups, with an average ability of $A_{MIG} = (A_{MAX} + A^{**})/2$, compared to the higher average ability $A_{NM} = (A^* + A_{MAX})/2$ of those who got educated in the absence of migration.

Thus, when $S = p$, i.e., when the *number* of skilled individuals in the source country is the same irrespective of whether migration takes place or not, migration results in a lower ability level in the source country by an amount equal to $A_{NM} - A_{MIG} = (A^* - A^{**})/2$ and thus in a lower *effective* human capital stock.

Thus, a brain drain results in a *negative* net effective brain gain or in a net effective brain *loss* when the number of skilled individuals remains unchanged once migration takes place, i.e., when $S = p$, and in a greater loss when $S < p$. A necessary but not sufficient condition for a net effective brain gain is $S > p$.[10]

2.2.1.1. Transition Dynamics and Steady State

With heterogeneous abilities, the net effective brain gain (a flow) is smaller relative to *E*—defined earlier as the number of individuals who acquired education in the absence of migration and do so under migration (a flow)--compared to the uniform ability case. Thus, if $\Delta S_1 = E + BG_1 - BD > 0$ (< 0), convergence to the steady state will be slower (faster). Moreover, in steady state, the condition $E + BG - BD = 0$ implies an even greater net brain loss $BD - BG$. Accounting for screening would further reduce the likelihood of a net effective brain gain. Its dynamic implications are examined at the end of Section 2.1.3.[11]

[10] In an interesting paper, Fan and Stark (2005) present a model where decision-making takes place in three stages or less, and which generates equilibrium unemployment of skilled workers. The model assumes heterogeneity with respect to educational ability. Given that ability in the job market tends to be positively related to educational ability, incorporating this feature changes a number of results.

[11] As Winters (2005) states: “Screening is a critical dimension of the brain drain … because its existence tends to undermine the ‘beneficial brain drain’ argument of Mountford (1997) or Stark et al. (1997).” The extent to which the brain-drain-induced brain gain would be reduced would depend on the quality of the screening and its enforcement.

2.2.3. Group Heterogeneity

Heterogeneity may occur across groups rather than across individuals. This situation is depicted in Figure 2 which shows three groups with different ability levels. In the absence of migration, two groups acquire education and the lowest-ability group does not. Once migration takes place, the expected return to education rises, though not sufficiently for the low-ability group which does do not acquire education in this case either. Thus, the brain drain does not result in a brain gain ($A^{**} = A^{*}$), and the source country loses some of its most able individuals.[12] Alternatively, if the low-ability group acquires education, we obtain the same result as for individual heterogeneity (Section 2.2.1).

2.3. Unskilled Migration

Most analyses in the new brain drain literature examine the incentives to acquire education in the absence of migration and compare them to the incentives prevailing in the case of skilled worker migration. However, the reality is that out-migration of unskilled workers is substantial in most source countries, and their expected wage is higher under migration, just as is true for skilled workers.

Denote the migration probability of skilled (unskilled) labor by p (q), skilled (unskilled) variables by subscript S (U), and destination country variables by *. In the absence of migration ($p = q = 0$), the education benefit or skill premium is

[12] Stark (…) includes two groups in his model where, as assumed here, low-ability individuals do not acquire education when migration takes place, though high-ability individuals invest more in education when incentives improve. The model presented here assumes, as in most papers dealing with the brain gain, that individuals can only acquire a fixed amount of education.

$$B_1 = W_S - W_U \,. \tag{4}$$

With a brain drain ($p > 0$, $q = 0$), the expected benefit of education is

$$B_2 = (\,pW_S^* + (1-p)W_S\,) - W_U \; = (W_S - W_U\,) + p(W_S^* - W_S\,)\,, \tag{5}$$

i.e., B_2 is equal to the domestic skill premium (as in equation (4)) plus the skilled labor migration premium multiplied by the skilled labor migration probability p.

With migration by both skilled and unskilled labor (p, $q > 0$), the expected benefit of education is

$$B_3 = (\,pW_S^* + (1-p)W_S\,) - (qW_U^* + (1-q)W_U\,) = (W_S - W_U\,) + p(W_S^* - W_S\,) - q(W_U^* - W_U\,)\,. \tag{6}$$

Thus, B_3 is equal to the domestic skill premium plus the skilled labor migration premium multiplied by the skilled labor migration probability p, minus the unskilled labor migration premium multiplied by the unskilled labor migration probability q. Equations (4) and (5) show that a brain drain *raises* the expected return to education by the expected migration benefit

$$\Delta B_S \equiv B_2 - B_1 = p(W_S^* - W_S\,) \; > 0. \tag{7}$$

This implies a brain gain, a basic finding of the new brain drain literature.

Equations (5) and (6) show that when both skilled and unskilled labor can migrate, the expected return to education *falls* compared to the case where only the skilled can migrate, with the change equal to

$$\Delta B_U \equiv B_3 - B_2 = -q(W_U^* - W_U\,) < 0 \,. \tag{8}$$

Thus, the impact of a brain drain on the return to education is smaller under the assumption that unskilled workers can migrate as well. This implies a smaller brain gain.

The steady-state outcome is unchanged. However, convergence to the steady state is slower (faster) for $\Delta S_1 = E + BG_1 - BD > 0$ (< 0).

2.4. Brain Waste

Foreign workers are often hired to do jobs for which they are overqualified. Examples of Caribbean doctors or Eastern European scientists working as taxi drivers in some large US city are well known. Similarly, Moroccan doctors in France are typically working in less skilled positions (e.g., as interns) with significantly lower salaries.

Mattoo, Neagu and Ozden (2005) refer to this phenomenon as a "brain waste" in their recent study of US immigration. They find that the *extent* of the brain waste—i.e., the difference in the skill content of a migrant's job versus that of a native of the destination country with similar education and experience—varies according to origin country characteristics and US immigration policies.

Using the same notation as in Section 2.3 above, the expected benefit of education B_4 under skilled migration and brain waste (*BW*) conditions is:

i) $B_4 = W_S - W_U$ for $W^*_{BW} < W_S$, (9a)

and

ii) $B_4 = (pW^*_{BW} + (1-p)W_S) - W_U = (W_S - W_U) + p(W^*_{BW} - W_S)$ for $W^*_{BW} > W_S$. (9b)

In case (i), there is no brain drain or brain gain. In case (ii) where $W^*_{BW} > W_S$ and a brain drain takes place, the difference in benefits without brain waste (B_2 in equation (5)) and with brain waste (B_4 in equation (9b)) is

$$\Delta B_{BW} \equiv B_4 - B_2 = p(W^*_{BW} - W^*_S) < 0, \partial W^*_{BW} \big/ \partial BW < 0. \quad (10)$$

That income loss reduces the impact of the brain drain on the benefit of education, implying a *smaller* brain gain. As can be seen from equation (10), the income loss depends on the extent of the brain waste and on the wage gap between skilled and 'brain waste' jobs in the destination countries.

The steady-state outcome is unchanged. However, convergence to the steady state is slower (faster) for $\Delta S_1 = E + BG_1 - BD > 0$ (< 0).

2.5. Uncertainty

Risk aversion is likely to greatly reduce the brain-gain response to a brain drain. The sources of uncertainty include the probability of success in school, the level of host countries' skilled wages, the level of the exchange rate and of skilled wages at home at the time the studies are completed, host countries' immigration policies, the probability of obtaining a job abroad at that time, the allowed length of stay in the host country, the value of the student's time for the family during the entire period of studies. That value rises when the family crop fails, its price falls, or a family member becomes ill, and it may force some students to abandon their studies and lose their investment.

Assuming that the cost of education is C and risk aversion is represented by an expected utility function EU. Then, due to the concavity of the utility function, we have:

$$U[p(W_S^* - C) + (1-p)(W_S - C)] > EU = pU(W_S^* - C) + (1-p)U(W_S - C). \quad (11)$$

In other words, and unsurprisingly, the expected utility of education's benefit is smaller than the utility of the expected benefit, implying a smaller brain gain.

Given that $p(W_S^* - C) + (1-p)(W_S - C) > W_S - C$, we have under risk neutrality:

$$U[p(W_S^* - C) + (1-p)(W_S - C)] > U(W_S - C). \quad (12)$$

Equations (11) and (12) imply that under risk aversion:

$$EU = pU(W_S^* - C) + (1-p)(W_S - C) \ > \text{or} < U(W_S - C)\,, \qquad (13)$$

i.e., whether the expected utility from education with migration probability *p* is larger or smaller than that from education and not migrating is ambiguous. If $EU = pU(W_S^* - C) + (1-p)(W_S - C) \ < U(W_S - C)$, there will be no brain drain, no brain gain, and no brain drain problem.

Consequently, once skilled migration is allowed by the destination country, risk aversion results either in a smaller brain-drain induced brain gain, or in zero migration and no brain gain.

In the former case, the steady-state outcome is unchanged and convergence to the steady state is slower (faster) for $\Delta S_1 = E + BG_1 - BD > 0$ (< 0). In the latter case, the steady state is never reached and the number of skilled individuals falls continuously.

3. Smaller Brain Gain: General Equilibrium Effects

Additional resources for education means fewer resources for other activities. The former is likely to include teachers, administrative personnel, books and other educational tools, schools, student housing, and the students' time. Education is typically provided publicly and is heavily subsidized, though--as the costs listed above indicate--an important part of the costs are borne by the students or their families, the main one being the opportunity cost of the students' time.

In the case of tertiary education, a report by the World Bank (2000) states that "with developing country systems heavily dominated by public universities that tend to have low tuition fees, the costs fall predominantly on the state." The report estimates these costs relative to GNP for 1995, and finds that the worldwide average amounts to 77% of GNP per capital.

Lucas (2004) updated the figures for the year 2000 and, based on both sources, finds that 24 out of 90 countries had higher costs than the world average (Table 4.7). For Sub-Saharan countries, the cost relative to GNP was over 500% of the world average. Implications for the brain gain and human capital are examined below.

3.1. Public Expenditures and Tax Revenues

Assuming that education is provided publicly,[13] an increase in education will require additional funds. Moreover, time spent acquiring additional education means less work and lower tax revenues. Fiscally responsible authorities can respond to this situation by i) a tax increase, ii) a reduction in educational subsidies, or iii) a reduction in other public expenditures. [14]

A reduction in disposable income associated with the tax increase will reduce the demand for education and result in a smaller brain gain.[15] Similarly, a reduction in educational subsidies will raise the cost of education and will also result in a smaller brain gain.

Implications for transition dynamics and for the steady state, these are the same as in Section 2.3 and 2.4.

The third option entails a reduction in non-educational public expenditures. To check the likelihood of substitution between the two categories of public expenditures, I

[13] The results hold under privately provided education as well.
[14] Note that if fiscal considerations were unimportant, it would very likely imply a weak education response to a brain drain and a net brain loss.
[15] Of course, a smaller brain gain implies a smaller tax increase, which simply means that the equilibrium tax rate and brain gain must be solved simultaneously.

estimated a relationship between public education expenditures (log *E*) and other capital expenditures (log *K*), both measured as a share of GDP. The sample covered over 70 developing countries, with an average of 7 observations per country and a total of over 600.

A negative and significant relationship between log *K* and log *E* was obtained with a coefficient of -.47, significant at the 1% level. The coefficient indicates that a one percent increase in the share of GDP devoted to education results in close to a half percent reduction in the share of other capital expenditures.[16]

This is unlikely to affect the extent of the brain gain, though it might affect welfare and growth (see Section 5.2) as well as the extent of the human capital gain. The latter is examined below.

3.2. <u>A Brain Gain that Results in a Smaller Human Capital Gain</u>

As shown in the previous section, an increase in public education expenditures is associated with a reduction in other public expenditures. Among those that might be curtailed are investments in the country healthcare infrastructure, maintenance, and the provision of healthcare services. This would have an adverse impact on the population's health status, and more so for poorer families that have little or no access to private healthcare.

Moreover, because individuals who are studying do not contribute to family income, expenditures will have to be reduced, especially in poorer families. If

[16] Interestingly, Beine et al. (2003)'s model includes a variable representing physical capital, R&D expenditures and infrastructures. Its impact on growth in their regressions is significantly greater than that of the brain drain. Thus, it would seem plausible that a reduction in that variable, associated with an increase in the investment in education, would have a large impact on welfare and growth.

expenditures on healthcare are reduced, household health is likely to be adversely affected. And if food expenditures are reduced, the nutrition and health status of the family is likely to suffer as well.

Furthermore, purchases of household appliances may have to be postponed, and may cause additional harmful effects. For instance, postponing the purchase of a refrigerator might not necessarily affect nutrient intake but it would most likely have adverse effects on nutritional status and health (Schiff and Valdés 1990a, 1990b).[17] In his AEA Presidential address entitled "Investment in Human Capital," Schultz (1961, p. 5) notes that, when adults have such a meager diet that they cannot work more than a few hours a day, food should be treated partly as a productive input that raises the level of human capital.

Since human capital depends on education as well as on health (Schultz, 1961, p.3), the impact of the brain drain on human capital is likely to be smaller than its impact on the brain gain. An educated workforce that is unable to work on a regular basis because of illness is unlikely to be very productive. In fact, reduced spending on health by individual families and the public sector might have devastating effects on the populations' health status and might lower the stock of human capital. Thus, a negative human capital gain might obtain, even though the brain gain would probably be positive.

Dynamic implications are the same as in Sections 2.3 and 2.4.

[17] In the face of high food income elasticity estimates at low incomes and the implication that the poor suffered from malnutrition, the nutrition literature argued that what mattered is not food but nutrient intake and showed a low income elasticity for a variety of nutrients (calories, proteins, etc.) because, starting at low incomes, food expenditures shift from nutrient to non-nutrient attributes as income increases (due to greater demand for variety, ease of preparation and taste), with the implication that the poor do not suffer from malnutrition. Schiff and Valdés (1990a, 1990b) contributed to that literature by arguing that what matters is not nutrient intake but nutritional status, which depends on various household and community variables as well as on nutrients. Since investments in the former clearly depend on income (e.g., refrigerators and clean water), nutritional status is likely to be quite elastic with respect to income (and thus be worse for poor people), even if nutrient intake is not.

4. Negative Brain Gain

Assume that below a critical level of education E_0, some destination countries only hire unskilled workers, irrespective of their qualifications, and attracts both unskilled and skilled migrants (with $E < E_0$) because $W_U^* > W_S > W_U$. This should reduce the incentive to acquire education in source countries, and result in a negative brain gain.

The expected wage rate for unskilled labor is $E_U(W) = pW_U^* + (1-p)W_U$ and that for skilled labor is $E_S(W) = pW_U^* + (1-p)W_S$. The return to education in that case is $(1-p)(W_S - W_U) < W_S - W_U$, the return to education in the absence of migration. In other words, the migration option lowers the return to education, resulting in a negative net brain drain *NBG* or net brain loss. In other words, some who might have obtained additional education in the absence of migration but who have decided to migrate might choose to work before migrating (possibly to save for the expensive trip).

McKenzie and Rapoport (2005) found evidence of such an effect in the case of rural Mexico. They found that migration led to a decrease in education inequality, and that this decrease was due to a reduction in the educational level of those at the upper end of the distribution rather than an increase at the bottom of the distribution.[18] [19]

This type of outcome might also prevail under less extreme forms of "brain waste." For instance, with the high demand for Filipino nurses, some medical doctors

[18] They also find that migration raises income inequality in the short term as only the better-off individuals are able to pay for migration costs, and reduces it over time as networks and information expand, resulting in lower migration costs and enabling poorer individuals to migrate. Taylor (1991) examined the impact of remittances on asset and income inequality and obtained similar results.

[19] Note that for rural Mexico, a high level of education may not be much more than six years of schooling, while a low level of education is probably two years or less.

have gone back to school in order to become nurses, and some students have changed their plans of becoming medical doctors and have chosen to become nurses.

5. Brain Gain , Welfare and Growth

5.1. Brain Gain Size

The previous section provided a number of static and dynamic arguments based on both partial and general equilibrium analytical frameworks supporting the assertion of a significantly smaller brain gain and, by implication, a significantly smaller (and possibly negative) *net* brain gain than would appear from the literature. The obvious implication is that the impact on welfare and growth would also be significantly smaller.

5.2. General Equilibrium Effects

Romer's (1986) seminal paper on endogenous growth posited that, due to positive externalities, returns to physical capital were increasing, and that policies affecting the stock of physical capital could permanently change the economy's growth rate. Lucas (1988) also provided a model of endogenous growth but emphasized the role human capital. I assume in this section that both human and physical capital affect the economy's growth rate through contemporaneous externalities, intergenerational externalities (a la Beine et al., 2003), or both.

Section 3.1 listed three ways to deal with the higher public expenditures and lower tax revenues associated with a brain gain, namely higher taxes, lower education subsidies, or a reduction in other public expenditures. The first two lower the demand for education. The third one either lowers the level of human capital if, say, healthcare expenditures are reduced, or lowers other public expenditures that most likely generate positive externalities.

The new brain drain literature assumes that education is the only sector that generates positive externalities. In fact, positive externalities are also generated by a number of other public (and private) sector activities as well. These activities include healthcare provision, investment in R&D, and the provision of many other public goods where benefits for from the presence of very large externalities and the temptation to free ride explains why these are provided publicly rather than privately.

In such a case, a government would maximize welfare through a tax and expenditure policy that results in the equalization of the per-currency-unit social marginal present value across all activities, whether private or public, consumption or investment, and pecuniary or not. Internalizing all the externalities associated with education, without taking into account the reduction in other expenditures and the consequent loss of other positive externalities, reduces the welfare gains and growth increase of the brain gain and may result in a welfare loss, and similarly for the growth rate.

The full effect of an increase in the brain drain would have to include the loss due to the brain drain itself. In other words, there are now two negative effects (the brain drain and the reduction in other expenditures) and a positive one (the brain gain). Thus, the likelihood of a beneficial brain drain seems much diminished.

5.3. Empirical Results

This paper has argued that the net brain gain *NBG* is closer to NBG_2 (see Figure 1) than to NBG_1. In fact, NBG_1 is quite similar to the function shown in Figure 6 in

Docquier and Rapoport (2004). It is reproduced here as Figure 4, with the vertical axis measuring the effect on the annual growth rate rather than the effect on *NBG*. Despite the fact that Figure 4 depicts an estimated relationship while Figure 3 does not, they tell a similar story, namely that a beneficial brain drain is more likely at low migration rates. As Beine et al. (2003, p.35) state: " … most countries combining low levels of human capital and low emigration rates of their highly-educated are positively affected by the brain drain."

On the other hand, and as shown in Figures 1 and 4, high migration rates (larger than p_2) inevitably result in a lower rate of growth. Consequently, countries in Sub-Saharan Africa and the Caribbean (and possibly others) that are suffering form massive outflows of medical personnel and other skilled workers cannot hope for much help from the brain gain effect, irrespective of whether $NBG = NBG_1$ or $NBG = NBG_2$. [20]

Three studies have examined the impact of the brain drain on education levels or growth. As mentioned above, Beine et al. (2003) obtain a beneficial brain drain for countries with low levels of human capital and skilled migration rates. On the other hand, Faini (2005) finds little indication of a positive impact of the brain drain on growth in source countries, while Lucas (2005)—using two alternative definitions for the education variable—obtains a negative impact of the brain drain on education (see Table 1).

Thus, we have three empirical studies with three different sets of results with respect to the impact of the brain drain: a positive impact on the level of education (Beine et al.), a negative impact on the level of education (Lucas) and no impact on growth (Faini). However, the results obtained from these analyses should be considered as being

[20] Recall that Grenada (Jamaica) experienced a 95.5% (80%) brain drain in the case of doctors, with similar problems in sub-Saharan Africa and Central America.

preliminary, and additional conceptual and empirical work is needed before firm conclusions can be reached.

6. Concluding Comments

Based on static analysis, this paper has shown that the size of the brain gain and its impact on welfare and growth are significantly smaller that found in the new brain drain literature and may even be negative. The main reasons for the smaller brain gain size are:

i) heterogeneity ;

ii) unskilled migration;

iii) uncertainty;

iv) brain waste; and

v) general equilibrium effects.

The main reasons for the smaller—and possibly negative—impact of the brain gain on welfare and growth are:

i) the smaller (or negative) brain gain size, and

ii) general equilibrium considerations, namely the fact that an increase in public education expenditures results in welfare and growth costs associated with increased taxes, lower education subsidies or a reduction in other expenditures, with a decrease in their positive externalities.

Dynamic aspects of the brain-drain-induced brain gain are also examined in this paper. It is shown that the brain drain *BD* dominates the brain gain *BG* in steady state. In other words, the steady state is characterized by a *negative* net brain gain or a net brain *loss*, irrespective of whether the net brain gain is positive or negative in the transition.

The steady-state result provides a powerful challenge to the claim by the new brain drain literature that a brain drain results in a net brain gain under certain conditions, the reason being that no conditions are imposed for the steady-state result to hold. The reason for this result is that:

i) in steady state, all variable are invariant over time, including the number of educated individuals. This implies that the number of individuals E who obtained education in the absence of migration plus the net brain gain NBG associated with migration must be equal to zero. Thus, the net brain gain $NBG = - E < 0$. In other words, the source country unambiguously suffers a net brain loss.

Contributors to the early brain drain literature viewed the brain drain as entailing a loss for the developing source countries. An implication of the arguments presented in this paper is that these contributors were close to the mark.

The new brain drain literature and this paper are in agreement on one point, namely that the net brain gain is negative for larger migration probabilities and certainly in the most severe brain drain cases. In other words, the new brain drain literature offers no solution to the most severe brain drain problems. This includes the exodus of healthcare providers from Sub-Sahara Africa--the world's poorest region--and the Caribbean.[21]

[21] These regions have been hit by two simultaneous shocks: increased mortality from highly contagious and often deadly diseases, and the flight of healthcare providers to rich destination countries.

Consequently, policies to slow down or stop the exodus of skilled labor are urgently needed. This issue is beyond the scope of this paper, though it might be worth examining the possibility of i) host countries supporting (financially and with expertise) education in source countries in the areas where they expect to need skilled labor in the future, together with ii) instituting programs of temporary migration (possibly with migrant circulation). This should enable both source and host countries to benefit.

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Table 1: Impact of the Brain Drain on Education

	Ln increment of tertiary education at home 95-2000 (Change in Stocks)		Ln tert enrolment
	ALL	Low Income	
Ln brain drain	-0.366 (3.53)	-0.331 (2.21)	-0.256 (2.32)
Ln income	0.567 (9.11)	1.400 (9.48)	0.691 (9.31)
Ln population	0.887 (14.95)	0.797 (8.74)	-0.112 (2.18)
No. obs. R sq	91 .90	39 .91	55 .69

OLS; SE Robust; t-stats in parentheses; intercepts included, not shown.
Brain Drain: OECD (2000)
Tertiary Enrollment: UNESCO (….)

Figure 1: Brain Grain (BG), Brain Drain (BD) and Net Brain Gain (NBG = BG-BD)

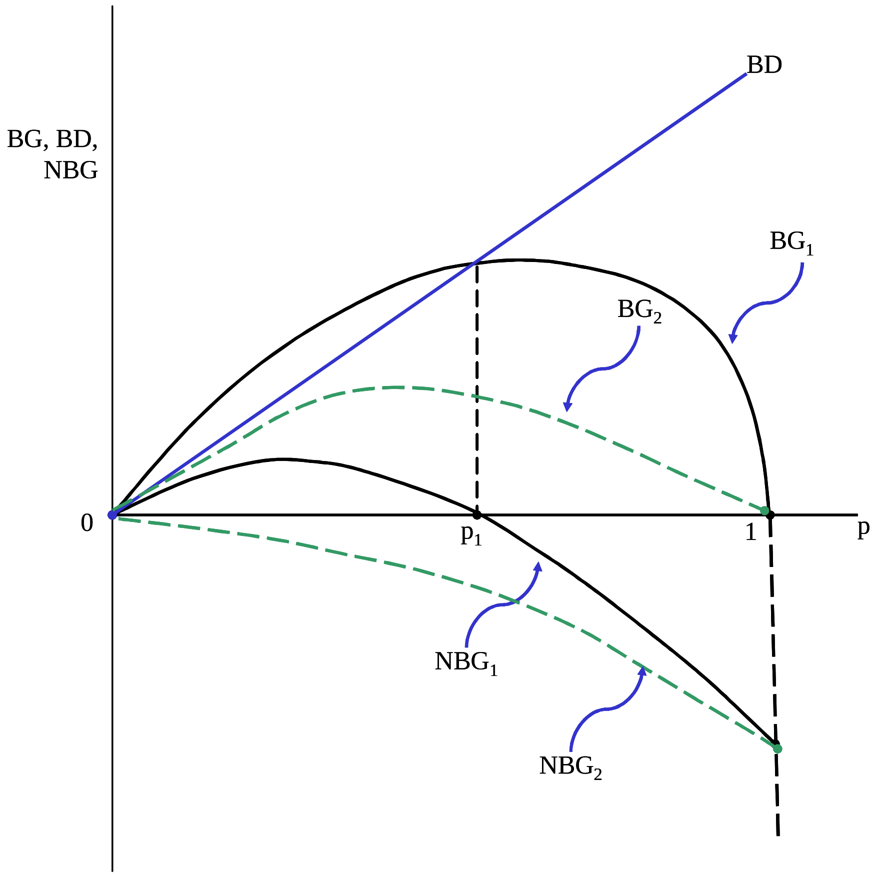

Figure 2: Endogenous Migration Probability

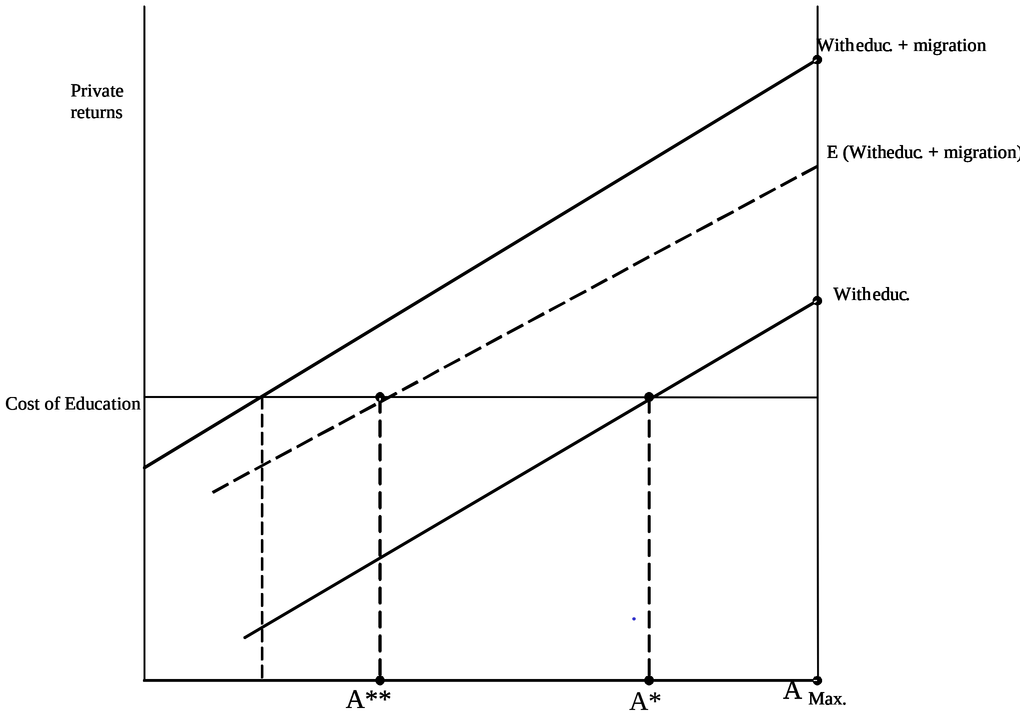

Figure 3: Group Heterogeneity

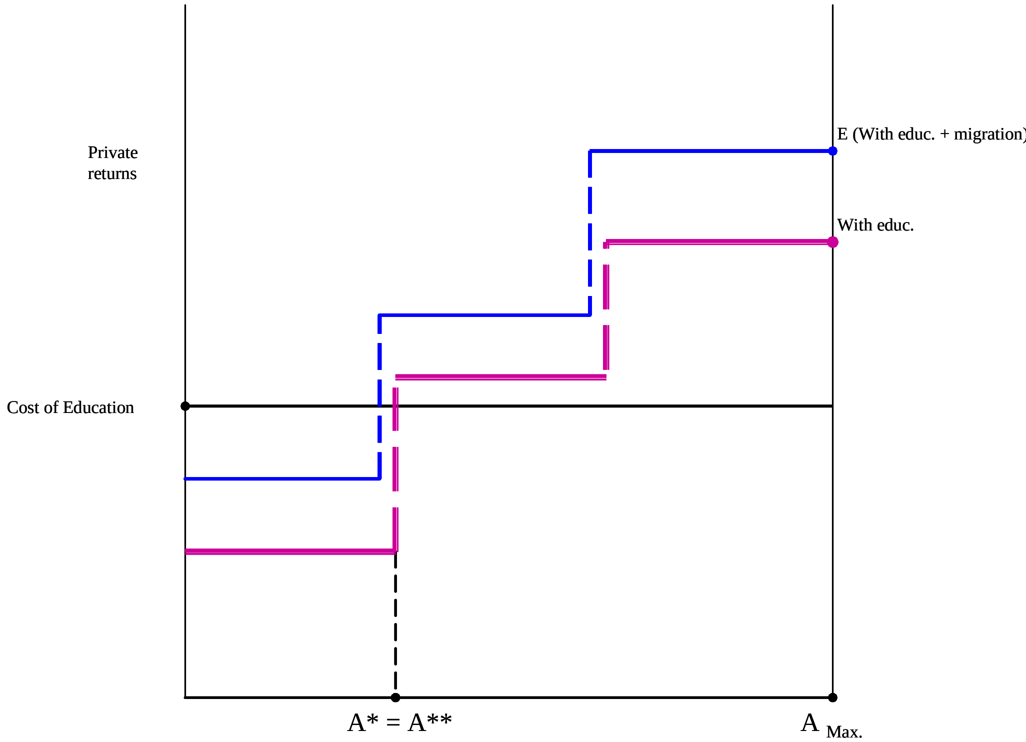

Figure 4. Brain drain and LDC's growth (with 2nd order polynominal trend)