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How Big Is the Brain Drain?

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Abstract

The brain drain from developing countries has been lamented for many years, but knowledge of the empirical magnitude of the phenomenon is scant owing to the lack of systematic data sources. This paper presents estimates of emigration rates from 61 developing countries to OECD countries for three educational categories constructed using 1990 U.S. Census data, Barro and Lee's data set on educational attainment, and OECD migration data. Although still tentative in many respects, these estimates reveal a substantial brain drain from the Caribbean, Central America, and some African and Asian countries.

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Summary

The brain drain from developing countries has been the object of much policy discussion for many years, but knowledge of the empirical magnitude of the phenomenon is limited because of the lack of systematic data sources.

Using newly available data on educational attainment by country from Barro and Lee (1993), as well as U.S. Census data and OECD migration information, this paper constructs estimates of the stock of migrants to OECD countries by educational level and by country of origin for 61 developing countries. Migration figures are reported both in absolute terms and as a percentage of the population in each educational category that remains in the country. Because of data limitations, these estimates are quite rough and leave much to be desired. Nonetheless, they should be sufficiently accurate to provide a sense of the empirical magnitude of the phenomenon.

The paper finds that individuals with little or no education generally have limited access to international migration, and migrants tend to be much better educated than the rest of the population of their country of origin. For almost all countries, the highest migration rates are for individuals with a tertiary education. The "brain drain" is particularly high in the Caribbean, Central America, and some African countries.

I. INTRODUCTION

Perhaps the oldest question in economics is why countries have different levels of prosperity. The latest wave of research on this question (the “new growth literature”), pioneered by the work of Romer (1986, 1987) and Lucas (1988), has put new emphasis on the role of human capital as a factor of production, and on increasing returns to knowledge (often identified as accumulated human capital) as a source of long-run differences in income levels across countries. It follows from this work that low levels of education are a chief contributing factor to poverty, and that efforts to increase schooling opportunities in developing countries should lead to faster rates of growth and higher income levels. This view has received some empirical support from the influential work of Barro and Lee (1993, 1994), as well as from other researchers.

Yet, while there is little doubt that highly skilled workers in many developing countries are scarce, it is also true that many scientists, engineers, physicians, and other highly trained professionals from LDCs work in the United States, Canada, or other OECD countries. This phenomenon, often referred to as the “brain drain”, was noticed as early as the 1960s, and it has been a contentious issue in the North-South debate ever since.² In addition to the brain drain of highly-skilled workers, there are also clear instances where large numbers of medium-skilled workers, such as merchants and low-level entrepreneurs, have left LDCs for OECD countries. These phenomena suggest that the lack of skilled workers in LDCs may not follow exclusively from a shortage of educational opportunities, and that, at least in a number of LDCs, some skills are perhaps not so scarce. On the other hand, the migration of the highly skilled may also simply reflect the fact that well-educated individuals from LDCs prefer to work in rich countries, and that rich countries give them the opportunity to do so.

In either case, the “new growth theory” has typically ignored international labor mobility and, more specifically, human capital migration. A recent exception is Haque and Kim (1995), who develop an endogenous growth model in which highly educated workers in poor countries tend to emigrate to richer countries, and this exodus reduces income levels and long-run growth rates in poor countries. In this set up, educational subsidies in poor countries have stronger growth-enhancing effects if they are targeted to basic education as opposed to higher education. These authors also suggests that the design of policies such as tax reform, labor market reform, or wage restraints for public employees, which are often part of Fund- supported economic stabilization programs, should take into account the potential effect on the migration of skilled workers.

But precisely how pervasive is the brain drain? Which countries or regions are especially affected? Do highly skilled professionals from LDCs living abroad represent a

²See, for instance, Adams (1968) and Bhagwati and Partington (1976).

sizeable fraction of the pool of skilled workers in their countries of origin, or are their numbers too small to worry about? Unfortunately, attempts to answer these important questions quickly clash against a formidable barrier: there is no uniform system of statistics on the number and characteristics of international migrants. Also, source countries typically do not keep track of emigrants' characteristics, and, while some receiving countries do, they often use different definitions of immigration. Thus, it is difficult to precisely measure the flow of immigrants. In addition, it is only recently become possible to measure the stock of educated workers in each source country, the pool from which the brain drain must draw. In sum, data limitations have heretofore severely limited any precise quantification of the brain drain phenomenon.

By using newly available data, this paper surmounts some of the above data problems and constructs estimates of the stock of migrants by educational level in OECD countries, both in absolute terms and as a percentage of the population in each educational category by country of origin. As we will illustrate below, these estimates are quite rough and leave a lot to be desired in many respects; nonetheless, we believe that they are good enough to give a sense of the empirical magnitude of the phenomenon, so that they may be useful to researchers who intend to study the characteristics of the brain drain, as well as to those who may be interested in formulating a policy response. They are also broadly consistent with anecdotal evidence about international migration.

Our study covers migration from 61 countries, accounting for about 70 percent of the total LDC population. Because of lack of data, we do not investigate the brain drain from the former Soviet Union and from Eastern Europe, even though casual evidence suggests that it is a sizeable phenomenon. Also excluded from our study are migratory flows among developing countries. The estimates of total migratory flows are based on migration data from the 1990 U.S. Census and the OECD Continuous Reporting System on Migration. These sources, together with population information from the United Nations, allow us to compute estimates of migration rates both to the United States and to the OECD as a whole by sending country for individuals over 25 years of age.³ Then, using U.S. Census information on years of schooling of migrants, we construct the educational profile of the migrant population in the United States. We group educational attainment into three categories: up to primary education (0 to 8 years of schooling), secondary (9-12), and tertiary (13 and above). The third step is to combine these estimates with data on educational attainment by country constructed by Barro and Lee (1993) to arrive at a measure of the fraction of the population in each educational category that has migrated to the United States. Finally, we obtain estimates of the brain drain from developing countries to the OECD as a whole by assuming that migrants to the United States have, on average, the same educational attainment as migrants to the rest of the OECD; thus, the estimates are particularly tentative for countries who do not send many migrants to the United States.

³Korea and Mexico were not part of the OECD in 1990, thus they are covered as sender countries.

Our estimates indicate that the majority of LDC migrants have a secondary education, and that flows of migrants with primary education or less are quite small both in absolute number and relative to the size of the LDC population in this educational category. Thus, individuals with little or no education have little access to international migration, and migrants tend to be much better educated than the rest of the population of their country of origin.⁴ The very well educated tend to be the most internationally mobile group, and for the large majority of the countries in our sample migration rates are the highest for this educational category. This may be due to the immigration policies of OECD countries, which in some cases favor highly skilled individuals, or to the fact that only better educated individuals in LDCs can afford to pay migration costs; also, studies of labor mobility within countries show that highly educated workers tend to be more mobile even where there are no legal barriers to labor mobility, suggesting that the brain drain may be, at least in part, a more general phenomenon (Greenwood (1975); Borjas, Bronars, and Trejo (1992)).⁵

In absolute terms, the largest flows of highly educated migrants are from Asia, but relative to the number of highly educated individuals the "brain drain" is small for most Asian countries (although Iran and Taiwan are notable exceptions). In contrast, the outflow of highly educated individuals reaches above 30 percent in a number of countries in the Caribbean, Central America, and Africa. These countries have very high overall migration rates, but the outflow of educated people is exceptionally strong. The exodus of workers with secondary education is also substantial in most Central American countries, reaching more than 60 percent in El Salvador.

The paper is organized as follows: the next section explains our methodology and data sources. Section III presents estimates of overall migration rates and of the educational composition of migrants to the United States. Estimates for the OECD as a whole are presented in Section IV, and Section V concludes.

⁴Migrants, however, may be less educated than the average population of the receiving countries. For instance, Borjas (1995) reports that in 1991 working male migrants in the United States (including migrants from developing countries) had on average 11.6 years of education, relative to 13.2 years for the native population.

⁵For a more sophisticated theoretical model of the brain drain, see for instance Kwok and Leland (1982). For reviews of immigration policies see Zimmermann (1994), (Europe) and Bhagwati (1996), (United States).

II. METHODOLOGY AND DATA SOURCES

This section discusses the methodology followed to construct data on immigration rates by level of education. The first step in our analysis was to develop estimates of the number of immigrants in the United States from the largest possible set of source countries. This was done by assembling information from the 1990 Census of the United States.⁶ In particular, from the 5 percent sample of the 1990 Census data we extracted information on all persons of over 25 years of age who were born in a foreign country. Let the total number of people meeting these criteria for source country i be X_i . Because we use the 5 percent sample, we then estimate the total number of immigrants from country i to the United States to be $I_i = 20 * X_i$.

The restriction on age being greater than 25 years is made in order to maximize the comparability of the immigrant population with the Barro and Lee data set, which measures the educational attainment of the population over the age of 25 in each source country. As will be explained below, the Barro and Lee data are used to compute migration rates by country for specific educational categories. In addition to the total number of immigrants in the United States, we estimated the number of immigrants for three educational categories, identified by the years of schooling: primary or less (0-8 years of schooling), secondary (9-12 years of schooling), and tertiary (13 or more years of schooling). Let X_{is} denote the number of migrants from country i and with schooling level s . Then, the total number of immigrants from country i with educational level s is computed as $I_{is} = 20 * X_{is}$.

While the U.S. Census records information on educational attainment, it does not directly record where that education took place. Thus, it is possible that the education of a U.S. immigrant could have taken place entirely in the country of origin, entirely in the United States, or in some mixture of the two. The Census records the five-year band within which each person immigrated, and it is possible to use this information to make educated guesses about where the person was educated. For example, if a person was recorded as being born in 1960 and having immigrated in 1965, we could safely assume that the person was educated solely in the United States. For the majority of immigrants, however, it is difficult to precisely allocate the fraction of education that took place in the United States, and we have not adjusted our numbers in any way to account for education undertaken after immigration. Thus, in interpreting our numbers on the brain drain, it is important to recognize that the some or all of the education of some migrants may have taken place in the

⁶Census data were obtained from IPUMS, the historical census data website operated by the University of Minnesota History Department.

United States.⁷ The possibility of discontinuous education is an additional impediment to the assessment of where the education took place based on age and year of immigration quite difficult. Furthermore, the size of the immigrant population that was educated in the United States may not be so large because we only consider individuals over 25 years of age, so that children who arrived in the late 1980s are not counted, and migration from developing countries to the United States began in earnest only after the immigration reform of 1965.

A related problem is that the foreign-born individuals counted in the Census may not be true migrants, but rather foreign students who are in the United States to complete their education rather than to work. Because of the age restriction, foreign students at the undergraduate level or below are (except for perhaps a few exceptions) not included in our figures. However, some (and perhaps most) graduate students are probably included, and may account for a substantial proportion of individuals with tertiary education from some LDCs included in our sample. To eliminate this distortion, we have constructed estimates of the number of graduate students in the United States for the countries in our sample using data from the Institute of International Education. This institute conducts a yearly census of foreign students in United States colleges and universities. For the academic year 1990/91, the institute reports the total number of foreign students in the United States by country of origin, but the total is not disaggregated between graduate and undergraduate students (Zichopoulos (1991)). In the latest version of the report, however, a disaggregation is provided (Davies (1996)), so we have used the share of graduate students in the total for 1995/96 to compute an estimate of the number of graduate students in 1990/91. Our measure of migrants in the United States with a tertiary education is then constructed by subtracting the graduate students from the estimates of foreign-born individuals with 13 years of schooling or more from the Census.

A final problem with census data is that illegal immigrants or, more generally, the less educated among the migrants may not be counted, especially if they do not speak

⁷Whether our inability to measure the location of an immigrant's education is a big problem, of course, depends on the use that one wants to make of the brain drain estimates. If the purpose is to make an assessment of the pool of highly skilled workers of a given nationality who choose to work in a foreign country, then there is no need to worry about where the education took place. Also, if the purpose is to estimate the loss of human capital through migration for an LDCs, and if the LDC has only a fixed supply of individuals capable of obtaining a higher education, then again the issue of where the education actually takes place is moot. Conversely, to the extent that an immigrant with a given natural ability obtains more schooling in the United States than in the home country, then our estimates would overstate the loss of human capital in the LDC. Also, if the measures of the brain drain are intended to capture the loss of direct monetary investment in human capital in the LDC, then our measures would be biased upwards, since source countries do not generally pay for United States education (although in some cases they do).

English.⁸ Thus, the United States Census figures may underestimate the total number of migrants, and they may overestimate the average level of education of the immigrant population. This source of bias, however, should not excessively distort our estimates of the migration rate of individuals with tertiary education, since the latter are unlikely to be in the United States illegally.

The United States is easily the largest destination for international migrants, as Borjas (1990) has estimated that the United States accounted for roughly 45 percent of the immigrants to OECD countries over the 1959-81 period, and more recent figures suggest a similar pattern. Obviously, however, there is substantial migration from LDCs to other OECD countries and to some non-OECD countries as well, such as the Gulf states, and a comprehensive picture of the brain drain needs to take these flows into account. Unfortunately, systematic data sources on migration to non-OECD countries are virtually nonexistent. For OECD countries, on the other hand, data on migration flows by country of origin are assembled by the OECD. The most recent data are presented in **Trends in International Migration: Annual Report 1994** (OECD, 1995). However, these figures are not as comprehensive as the U.S. Census data, and, further, the data from the two sources are simply different in some important ways.

First, the data for non-U.S. OECD countries do not report the educational attainment of migrants. Thus, for example, we do not know the educational distribution of Turkish immigrants to Germany. For lack of any implementable alternatives, our strategy here is to assume that the distribution of immigrants across attainment groups from each source country is the same for the United States as for other OECD countries. Thus, we will assume, for instance, that immigrants from South Africa to Great Britain are distributed across educational categories in the same way as immigrants from South Africa to the United States. As it will be shown in the next sections, while this is the only feasible approach and it often produces numbers that are consistent with anecdotal evidence, there are some instances in which it yields implausible results. Mistakes seem particularly likely in countries with low immigration rates to the United States, but with high immigration rates to some other OECD country. Immigration to the United States for such countries is likely to be highly selective, whereas immigration to the rest of the OECD may be more representative of the base population. As an example, there are many immigrants from Algeria to France and very few immigrants from Algeria to the United States. Our method imputes to the French Algerians the same high level of education as is found in their U.S. counterparts, many of whom are likely to be graduate

⁸In 1992 the stock of illegal immigrants in the United States was estimated at 3.4 million, or about 16 percent of the stock of foreign-born population, of which 1.76 million are Mexican (Borjas (1995)).

students. In this case, our method leads to gross overestimates of the brain drain. In discussing the results, we will point out the instances where we think our methods are particularly misleading.

A second problem with the data from non-U.S. OECD countries lies in their different ways of classifying immigrants. Since U.S.-born children of immigrants, or even of travelers, have U.S. citizenship, the United States defines an immigrant as a person who was born abroad to non-U.S. citizens. This criterion is followed also by Canada and Australia, two of the largest recipients of international immigrants. Most European countries, on the other hand, follow an ethnicity-based definition of immigrant status (OECD, 1995). This method defines immigrant status based on the ethnicity or immigration status of the parent, rather than on the place of birth. Thus, a child of Turkish parents born in Germany will typically be classified as an immigrant in the German recording system. The same would be true of the children of North African parents born in France. In contrast, foreign-born individuals with some claim to domestic ethnic status, such as an ethnic German who came from Romania for example, are usually not characterized as immigrants in European countries. If we take the United States definition of immigrant as a baseline, then it is not clear whether the European-style definition of immigrant is an overcount or an undercount. It is clearly different, however, and we will try to remind the reader of this fact where appropriate.

A third difficulty with the OECD data is that we were unable to place any age restriction on the immigration figures. This means that, relative to the United States, immigration figures for non-U.S. OECD countries are somewhat inflated in that they include immigrants under the age of 25. It is possible that a more thorough study would be able to exclude from the count immigrants under 25 years of age, for example by examining source files contained in the Luxembourg Income Study. We have not attempted to do this here, however.

The final difference between the OECD data and the U.S. Census data has to do with the number of source countries recorded. The U.S. Census data can be used to count the number of immigrants to the United States from virtually every country in the world, regardless of how few immigrants there are. In contrast, the OECD only records immigrants for the top five or ten immigrant-sending countries to each OECD country. Thus, for example the OECD figures for Canada would include specific information on the number of immigrants from Mexico and China, but not for Jamaica and El Salvador. This is not a terrible problem for large source countries, such as Turkey, since they will be one of the top five or ten sources in any country receiving significant shares of their emigrants. It is a problem, however, for smaller source countries where the immigration flows are significant for the source country but small for the receiving country. To take two examples that have caught our attention, Guyana and Belize are two very small countries whose immigration to Canada or Great Britain, which may be significant, eludes detection in our data source. Thus, particularly for small countries, our estimates of immigration to OECD countries other than the United States may be seriously understated.

Thus far, we have described the steps followed to compute the number of migrants by country of origin and educational category. What remains to be done to construct migration rates by educational category is to match these figures to analogous figures on the populations from which they were drawn. We start this by taking 1990 population figures for each country from the Penn-World Tables (Summers and Heston (1997)). To be conformable with our estimates of the number of migrants, we must adjust these figures so as to exclude the fraction of the population under the age of 25. To this end, we resort to the United Nations Demographic Yearbook (United Nations, 1995), which records the fraction of the population that is within various age bands for most countries in the world. Some countries in our sample, however, were missing, and in these cases we imputed missing values with continent-wide averages. Thus, as an example, we assumed the fraction of the population over 25 in Bolivia, which was missing, to be equal to the average of the rest of South America.⁹ The share of the population over 25 years of age was then multiplied by the population figure in the Penn-World Table for 1990 to obtain an estimate of the population over the age of 25 in 1990 in each country. Let this number be denoted by N_i .

The next step is to allocate the population over the age of 25 for each country into the three educational categories used to classify migrants. To obtain information on the educational level of the population in the source countries, we use Barro-Lee's educational attainment data set (Barro and Lee (1993)). This database reports for each country the fraction of the population over 25 years of age that falls within various educational categories. Barro and Lee base their estimates on the most recent census data, or on historical schooling enrollment figures when census data is not available. In cases where enrollment figures are relied upon, estimates of the current stock of education are constructed using a perpetual inventory method. Of course, various factors (including migration) may distort estimates based on historical enrollment patterns. Nevertheless, the Barro and Lee database appears to be the best currently available set of estimates of educational attainment for a broad cross-section of countries.

Unfortunately, there are some difficulties associated with matching the Barro-Lee data to the immigration figures described above. In particular, while the U.S. Census measures education by years of schooling, the Barro-Lee educational attainment measures are based on the highest level of schooling attained, e.g. "no schooling," or "some secondary schooling". If there were a consistent method available for matching the Barro-Lee and Census systems to one another on a country-by-country basis, then the different approaches would not be a

⁹Note that this may not be a completely unbiased procedure, as it tends to be the poorer countries that have missing data. To the extent that poorer countries also have higher rates of population growth and, thus, a younger population, our procedure would overstate the fraction of the population over 25 years of age. We do not believe that this source of bias can substantially distort our results.

problem. However, there appears to be no systematic way to match the data. Thus, we have simply adopted the following mapping between the two databases:

Barro-Lee Class	Census Schooling
No Schooling or Primary Schooling	0-8 years of schooling
Secondary Schooling	9-12 years of schooling
Higher School Graduates and Beyond	13 or more years of schooling

Of course, this mapping may be incorrect for some countries. For example, if in a country "Higher School" corresponds to something less than 13 years of schooling, then we will tend to *understate* the fraction of this group that is abroad, and vice versa. Our sense is that for most countries our mapping tends to understate the number of individuals with a given educational attainment who have migrated.

The Barro-Lee data set, along with the estimates of the population over 25 years of age allow us to compute the number of individuals in each of the three educational categories (primary or less, secondary, and tertiary) for each source country in the sample. Let N_{is} denote these numbers. Before computing migration rates by educational category and by country, one more data problem needs to be addressed: the Census data provide us with an estimate of I_{is} , the number of immigrants from country i and schooling level s , and Barro-Lee provide an estimate of N_{is} , the number of people still in country i with schooling level s . However, there remains a question of how to use this information to formulate an estimate of the rate of outmigration by educational group. There are two polar choices. Simply taking the ratio of I_{is} to N_{is} implicitly assumes that immigrants to the United States are still counted in the home-country censuses on which our estimates of N_{is} are based. If this is not true, then N_{is} will understate the pool of potential migrants, and the ratio I_{is}/N_{is} will overstate the actual migration rate. As a practical matter, there is nothing to constrain the ratio I_{is}/N_{is} to be less than one, and in fact it is not less than one for some groups with high rates of migration to the United States. College graduates from Jamaica are one such example. Thus, we view the ratio I_{is}/N_{is} as an upper bound on the rate of migration.

A second way of estimating immigration rates is to take the ratio $I_{is}/(I_{is}+N_{is})$ as our estimate of the immigration rate for country i and schooling group s . This implicitly assumes that *none* of the U.S. immigrants are counted in the home country censuses. This is also obviously not strictly true, as it is surely the case that some U.S. immigrants are counted as still being residents in their home country. This is particularly true for countries such as Mexico, where U.S. immigrants often travel back and forth between their new and old countries, and thus still maintain contact and presence in their old community. However,

whereas the I_{is}/N_{is} method is likely to overstate immigration rates, the $I_{is}/(I_{is}+N_{is})$ method is likely to understate them. Our approach is to view these as upper and lower bounds respectively, and to report both figures.¹⁰

Despite the many caveats discussed above, we believe that the above procedures are a reasonable method for deriving crude estimates of the number of immigrants to OECD countries by country of origin and educational attainment. The description of the methodology shows that the estimates for non-U.S. OECD countries are much more tentative than the U.S. figures, and some readers may be interested in considering only the more precise but less comprehensive estimates of the brain drain to the United States. Hence, in the next sections we will report U.S. migration rates and total OECD migration rates separately.

III. THE BRAIN DRAIN TO THE UNITED STATES

This section presents estimates of immigrants in the United States by educational attainment and by country of origin, both in absolute number and as a fraction of the individuals in the country of origin with the same educational attainment. As explained in the previous section, in accordance with U.S. statistical conventions, these figures consider as immigrants all foreign-born individuals residing in the country, except for graduate students, which are netted out. Thus, they may include categories of individuals who are not usually associated with the brain drain, such as individuals who migrated to the United States when they were children, received their education in the United States, and have little ties with their country of origin.

A first summary view of the educational distribution of LDC migrants in the United States can be obtained from the shaded rows of Figure 1, which report the number of immigrants for broad regions. The first striking phenomenon is that immigration flows of individuals with no more than primary education are quite small, both in absolute terms and relative to other educational groupings (about 0.5 million individuals, out of a total of 7 million). As mentioned in the previous section, however, foreign-born individuals with little or no education are likely to be undercounted by the Census, so the true figure may be higher. The largest group of immigrants (about 2.7 million) is that of individuals with secondary education from other North American countries (primarily Mexico). Perhaps surprisingly, the second largest group (almost 1.5 million individuals) consists of highly educated migrants from Asia and the Pacific. Immigration flows of Asians with secondary education and North Americans with tertiary education are also substantial (0.8 and 0.6 million individuals), while

¹⁰Of course, given the other compromises made in constructing this data set, using the term "bound" is perhaps a bit self-indulgent. Nevertheless, we apologize and continue to use the term for lack of any superior alternative.

immigration from South America and, especially, Africa is quite small. It is noteworthy, however, that the latter consists primarily of individuals with tertiary education (about 95,000 individuals out of a total of 128,000 African migrants).

Table 1 also presents country-by-country information about the educational attainment of the foreign-born population in the United States. In the Asia and Pacific region, the biggest source country is the Philippines, with 0.73 million migrants. Of these, the great majority has tertiary education, and only slightly more than 10,000 people have 8 years of schooling or less. The second largest stock of migrants is from China (0.40 million individuals), whose immigrants are almost equally split between the secondary and tertiary educational group. Both Korea and India sent over 0.3 million people to the United States. It is striking that over 75 percent of Indian immigrants have tertiary education, compared with only 53 percent of Koreans. Also Iran and Taiwan Prov. of China have substantial flows of highly educated migrants to the United States.

With regard to Africa, the biggest migratory flows to the United States are from Egypt, Ghana, and South Africa. For these three countries, over 60 percent of the migrants have a tertiary education.¹¹ Migration of low-educated Africans is almost nil. The picture is quite different for the migratory flows from North America: here Mexico is by far the largest sending country (2.7 million); the large majority of the Mexican migrants (2 million) has a secondary education, while less than 13 percent have a tertiary education. This pattern is shared by the smaller countries in Central American, but not by the two Caribbean countries for which we have information, Jamaica and Trinidad and Tobago. In the Caribbean, migrants with tertiary education are a more substantial fraction of the total (42 percent for Jamaica and 46 percent for Trinidad and Tobago). Finally, migration from South America is relatively small in absolute numbers, and it is split almost equally between the secondary and the tertiary educational group. Colombia has by far the largest number of migrants, followed by Peru, Argentina, and Guyana.

The next question is how big are the migratory flows relative to the size of the population with a given educational attainment in each country. Table 2 contains migration rates by educational category for each country. Rather than a single figure, each cell contains a range because, as explained in the preceding section, we do not know to what extent the population figures used as a denominator in the Barro-Lee measures of educational attainment include migrants. If the figures do not include migrants, then the correct measure of the brain drain is the lower bound, and vice versa. For countries with small migration rates, of course, there is virtually no difference between the two measures, while for others the difference can be substantial. In fact, in a handful of cases (for instance, the Gambia and Guyana) the upper bound exceeds 100 percent for the tertiary education category, meaning that the number of

¹¹Unfortunately, the most populous African country, Nigeria, is missing from our sample because of lack of data.

Table 1. Number of Immigrants to the United States by Educational Attainment for Selected Developing Countries, 1990

Country of Origin	Schooling Level			
	Total	Primary or Less	Secondary	Tertiary
Asia and Pacific:	2,376,277	95,320	818,860	1,462,177
Bangladesh	12,385	180	3,860	8,345
China	404,579	48,420	190,560	165,599
Fiji	11,420	740	7,120	3,560
India	304,030	6,960	68,800	228,270
Indonesia	32,172	220	8,800	23,152
Iran	150,906	3,740	41,640	105,526
Korea	377,940	13,060	163,420	201,460
Malaysia	15,261	260	4,820	10,181
Pakistan	52,717	1,680	14,940	36,097
Papua New Guinea	480	0	160	320
Philippines	728,454	10,680	224,700	493,074
Sri Lanka	8,751	20	2,280	6,451
Syria	27,504	1,580	12,780	13,144
Taiwan prov. of China	152,957	2,880	32,060	118,017
Thailand	53,118	2,120	21,300	29,698
Turkey	43,605	2,780	21,540	19,285
Africa:	127,853	2,060	30,640	95,153
Algeria	43,904	60	1,280	2,564
Benin	180	20	80	80
Cameroon	1,694	60	200	1,434
Central African Republic	160	0	60	100
Congo	200	0	20	180
Egypt	53,261	980	13,020	39,261
Gambia	747	100	120	527
Ghana	12,544	40	3,400	9,104
Kenya	8,372	40	1,420	6,912
Lesotho	160	0	20	140
Malawi	460	0	120	261
Mali	220	0	100	120
Mauritius	1,100	0	260	840
Mozambique	920	80	280	560
Rwanda	200	0	20	180
Senegal	1,370	180	420	770

Table 1 (Concluded). Number of Immigrants to the United States by Educational Attainment for Selected Developing Countries, 1990

Country of Origin	Schooling Level			
	Total	Primary or less	Secondary	Tertiary
Sierra Leone	4,155	80	1,060	3,015
South Africa	22,678	200	4,980	17,498
Sudan	2,496	0	760	1,736
Togo	460	20	140	300
Tunisia	2,816	60	1,120	1,636
Uganda	5,060	120	1,000	3,940
Zambia	1,613	0	340	1,273
Zimbabwe	3,161	20	420	2,721
North America:	3,761,084	436,420	2,677,420	647,244
Costa Rica	28,784	660	15,340	12,784
Dominican Republic	187,871	13,000	132,420	42,451
El Salvador	263,625	30,320	188,840	44,465
Guatemala	127,346	12,820	88,840	25,686
Honduras	54,346	3,440	35,840	15,066
Jamaica	159,913	3,060	90,220	66,633
Mexico	2,743,638	368,540	2,027,880	347,218
Nicaragua	61,168	3,100	34,920	23,148
Panama	68,583	340	28,780	39,463
Trinidad and Tobago	65,810	1,140	34,340	30,330
South America:	616,004	16,320	314,780	284,904
Argentina	64,080	900	27,980	35,200
Bolivia	18,772	380	7,080	11,312
Brazil	53,904	1,080	23,560	29,264
Chile	36,252	480	15,800	19,972
Colombia	162,739	5,940	93,000	63,799
Ecuador	89,336	2,720	55,020	31,596
Guyana	61,936	2,260	34,440	25,236
Paraguay	4,313	60	2,020	2,233
Peru	86,323	1,920	40,820	43,583
Uruguay	15,716	360	8,960	6,396
Venezuela	22,634	220	6,100	16,314

Source: Authors' calculations using data from the 1990 U.S. Census and the United Nations Population Yearbook. Migrants are defined as foreign-born residents over 25 years of age minus graduate students. Primary education or less corresponds to years of schooling between 0 and 8, secondary education to years of schooling between 9 and 12, and tertiary to years of schooling above 12.

migrants with this educational level exceeds the number of domestic residents. In these cases, of course, the upper bound must overstate the true size of the brain drain. The first column in Table 2 contains the average migration rate for each country.^{12 13}

If there is a single theme to the results of Table 2, it is that, at least according to Census figures, low-skilled emigration to the United States is not generally an important phenomenon for most countries. There are very few countries for which we estimate the emigration rate for low-skill individuals to be greater than one percent. The highest figure is that of Mexico, ranging from 1.6 to 1.7 percent, compared to an average migration rate of 7.7 percent. In contrast, if we focus on the most educated fraction of the population, migration rates are remarkably high for a significant number of countries. In fact, for most countries the tertiary educational category has the highest rate of outflow, the exceptions being the Central American countries, Ecuador, and Thailand (in the latter country, the secondary and tertiary educational categories have approximately the same migration rates).

Thus, migrants to the United States tend to be better educated than the average population in the sending country, and the fraction of the very highly educated that migrates is particularly high; also, migration from Central America seems to follow a somewhat different pattern than migration from other LDCs, in that the largest migration rate is for the secondary education category, rather than the tertiary education one.

Table 2 also shows that high-skill migration to the United States appears to be of paramount importance for many Latin American and Caribbean countries. Virtually all of the high-skill immigration rates for the Central American and Caribbean countries in our sample are above 10 percent, and some appear to be as high as 50 percent, or even more. In South America, the country with the largest brain drain by far is Guyana, where over 70 percent of individuals with tertiary education have moved to the United States; for the rest of the region, the figures are much lower, with a peak of around 5.5 percent in Colombia. Among Asian countries, Iran has a substantial drain of highly educated individuals (over 15 percent) and

¹²Note that the highest average rates of migration are found in small countries. This is largely an artifact of U.S. immigration policy, which sets limits on the annual numbers of immigrants that may be accepted from each country. With some exceptions, the limits are set uniformly across countries regardless of the size of the native population. Obviously, a limit of 20,000 legal immigrants per year per country is much more of a binding constraint for Mexico than it is for El Salvador, and this provides one explanation of why estimated migration rates are so high for El Salvador (11.4 percent, versus 7.7 percent for Mexico).

¹³Although we ultimately excluded it from our sample because of the lack of comparable data from Barro and Lee, Belize had the highest estimated migration rate of all the countries that we collected data for. Certain other small countries in the Caribbean, St. Kitts for example, were also estimated to have very high immigration rates.

Table 2. Migration Rates to the United States by Educational Attainment, 1990

Country of Origin	Schooling Level			
	Total	Primary or Less	Secondary	Tertiary
Asia and Pacific:				
Bangladesh	...	...	...	0.6-0.6
China	...	...	0.1-0.1	1.4-1.4
Fiji	3.6	0.4	6.6-7.1	21.3-27.1
India	...	...	0.1-0.1	1.1-1.1
Indonesia	...	...	0.1-0.1	1.4-1.4
Iran	0.8	...	1.0-1.1	14.7-17.4
Korea	1.6	0.2-0.2	1.2-1.2	5.7-6.1
Malaysia	0.2	...	0.2-0.2	4.4-5.6
Pakistan	...	...	0.2-0.2	2.4-2.5
Papua New Guinea	...	...	0.1-0.1	2.2-2.3
Philippines	2.2	...-0.1	4.4-4.6	6.6-7.1
Sri Lanka	0.1	...	0.1-0.1	3.7-3.9
Syria	0.7	...	2.2-2.3	3.1-3.2
Taiwan prov. of China	1.4	0.1-0.1	0.8-0.8	8.3-9.2
Thailand	0.2	...	1.5-1.6	1.2-1.3
Turkey	0.2	...	0.7-0.7	1.4-1.5
Africa:				
Algeria	...	...	0.2-0.2	0.7-0.7
Benin	...	...	0.1-0.1	0.4-0.4
Cameroon	...	...	0.1-0.1	3.2-3.4
Central African Republic	...	...	0.1-0.1	1.7-1.8
Congo	...	...	...	0.5-0.6
Egypt	0.3	...	0.4-0.4	2.5-2.6
Gambia	0.2	...	0.6-0.6	59.1-159.0
Ghana	0.2	...	0.3-0.4	15.1-18.0
Kenya	0.1	...	0.2-0.3	9.9-11.1
Lesotho	...	...	...	2.9-3.0
Malawi	...	...	0.1-0.1	2.0-2.0
Mali	...	...	0.1-0.1	0.9-0.9
Mauritius	0.2	...	0.1-0.1	7.2-7.7
Mozambique	...	...	0.5-0.5	8.6-9.4
Rwanda	...	...	...	2.2-2.3
Senegal	...	...	0.3-0.3	1.6-1.7
Sierra Leone	0.3	...	1.2-1.3	24.1-32.1

Table 2 (Concluded). Migration Rates to the United States by Educational Attainment, 1990

Country of Origin	Schooling Level			
	Total	Primary or Less	Secondary	Tertiary
South Africa	0.1	...	0.1-0.1	2.6-2.7
Sudan	...	...	0.1-0.1	1.7-1.8
Togo	...	...	0.1-0.1	1.3-1.4
Tunisia	0.1	...	0.3-0.3	1.6-1.6
Uganda	0.1	...	0.6-0.6	15.4-18.4
Zambia	...	...	0.1-0.1	5.0-5.3
Zimbabwe	0.1	...	0.3-0.3	4.6-4.9
North America:				
Costa Rica	2.4	0.1	10.1-11.2	7.0-7.6
Dominican Republic	6.3	0.6-0.6	29.7-42.3	14.2-16.6
El Salvador	11.4	1.6-1.6	66.6-199.3	26.1-35.3
Guatemala	3.4	0.4	29.1-41.1	13.5-15.6
Honduras	3.0	0.2	15.7-18.7	15.7-18.6
Jamaica	13.4	0.4-0.4	23.4-30.5	67.3-208.0
Mexico	7.7	1.6-1.7	20.9-26.4	10.3-11.5
Nicaragua	4.7	0.3-0.3	33.3-50.0	18.7-23.2
Panama	6.7	0.1-0.1	9.4-10.4	19.5-24.4
Trinidad and Tobago	9.4	0.3-0.3	15.9-18.9	57.2-136.9
South America:				
Argentina	0.4	...	0.7-0.7	1.9-1.9
Bolivia	0.7	...	2.1-2.2	4.2-4.4
Brazil	0.1	...	0.7-0.7	0.6-0.6
Chile	0.6	...	1.0-1.0	3.3-3.4
Colombia	1.1	...-0.1	3.6-3.8	5.6-5.9
Ecuador	1.9	0.1-0.1	11.4-12.9	3.8-3.9
Guyana	14.5	0.9-0.9	23.7-31.1	77.3-345.3
Paraguay	0.2	...	0.7-0.8	1.9-2.0
Peru	0.9	...	2.3-2.4	3.0-3.1
Uruguay	1.1	...	2.3-2.4	3.7-3.9
Venezuela	0.3	...	0.6-0.6	1.6-1.7

Source: Authors' calculations using data from the 1990 U.S. Census, the United Nations Population Yearbook, and the Barro-Lee data set on educational attainment. Migrants are defined as foreign-born residents over 25 years of age minus graduate students. Primary education or less corresponds to reported years of schooling between 0 and 8, secondary education to years of schooling between 9 and 12, and tertiary to years of schooling above 12. The upper bound of the range is calculated assuming that the Barro-Lee figures include migrants in the population, while the lower bound is calculated assuming that they do not. (...) indicates less than 0.1 percent.

so does Taiwan Prov. of China (around 8-9 percent). Two countries with relatively high overall emigration rates, Korea and the Philippines, are not especially affected by a severe brain drain, as the percentage of individuals with tertiary education which migrated in the United States is around 6-7 percent.

IV. THE BRAIN DRAIN TO THE OECD

Table 3 contains estimates of the brain drain from developing countries to the OECD as a whole obtained under the assumption that migrants to the OECD have the same educational attainment as migrants to the United States. To gauge the accuracy of the estimates, the last column of the table reports the share of the United States in total OECD migration. For the LDCs in our group, the United States accounts for 54.3 percent of the total OECD migration (7 million out of 12.9 million), but the numbers are quite different across regions.

If, as a rule of thumb, we consider the estimates not reliable when migrants to the United States account for less than one third of the total, then all estimates for the Asian countries are reliable with the exception of Malaysia, Sri Lanka, and Turkey. Among the remaining countries, the size of the brain drain is substantial—and it increases significantly compared to the U.S. data—for Iran, Korea, and, to a smaller extent, the Philippines. In Iran, the fraction of the population with tertiary education living in the OECD is estimated between 25 and 34 percent, while for Korea is between 15 and 17 percent; in the Philippines, the figure is between 9 and 10 percent. In Pakistan, the migration rate of individuals with tertiary education reaches over 7 percent, while in India it is around 2.7 percent; these figures, however, fail to take into account the sizable flow of professionals from the Indian subcontinent to the Gulf states, and, therefore, neglect an important source of brain drain for these countries. The migration rate of highly educated individuals from China is around 3 percent.

In Africa, the estimates are unreliable for Algeria, Tunisia, and Senegal, whose migratory flows are mainly directed towards France. For most other countries, however, migration to non-US OECD countries is quite small, so the results derived for the United States essentially go through.¹⁴ There are, however, some exceptions: in Ghana the migration rate of highly educated individuals is a dramatic 26-35 percent; in South Africa it reaches over 8 percent; in Egypt, the brain drain goes from 2.5-2.6 percent for the United States to 5.0-5.3 percent for the OECD as a whole. For countries in Oceania, and Central and Latin America, the United States accounts for the bulk of migratory flows, and inclusion of flows

¹⁴For a number of small countries, migratory flows to non-U.S. OECD countries may be underestimated, because the reporting system of some receiving countries provides country-of-origin information only for migrants from major sending countries.

Table 3. Migration Rates to OECD Countries by Educational Attainment for Selected Developing Countries, 1990

Country of Origin	Total	Schooling Level			U.S. as a Percentage of Total OECD
		Primary or Less	Secondary	Tertiary	
Asia and Pacific:					
Bangladesh	0.1	...	0.2-0.2	2.5-2.6	25.9
China	0.1	...	0.2-0.2	3.0-3.1	51.5
Fiji	3.6	0.4	6.6-7.1	21.3-27.1	100.0
India	0.2	...	0.3-0.3	2.6-2.7	44.1
Indonesia	...	...	0.1-0.1	1.5-1.6	90.5
Iran	1.5	...	2.0-2.1	25.6-34.4	51.3
Korea	4.2	0.5	3.3-3.4	14.9-17.6	36.0
Malaysia	1.2	...	1.2-1.2	22.7-29.4	18.2
Pakistan	0.3	...	0.5-0.5	6.9-7.4	35.2
Papua New Guinea	...	...	0.1-0.1	2.2-2.3	100.0
Philippines	3.1	0.1	6.0-6.4	9.0-9.9	71.6
Sri Lanka	0.8	...	0.5-0.5	23.6-31.0	14.1
Syria	0.7	0.1	2.3-2.3	3.0-3.1	100.0
Taiwan prov. of China	1.6	0.1	0.8-0.8	8.4-9.2	100.0
Thailand	0.2	...	1.7-1.8	1.5-1.6	87.6
Turkey	8.5	0.7	26.9-36.9	46.2-86.0	1.9
Africa:					
Algeria	6.3	0.1	19.7-24.6	55.0-122.1	0.6
Benin	...	...	0.1-0.1	0.4-0.4	100.0
Cameroon	...	...	0.1-0.1	3.2-3.4	100.0
Central African Republic	...	...	0.1-0.1	1.7-1.8	100.0
Congo	...	...	...	0.5-0.6	100.0
Egypt	0.5	...	0.8-0.8	5.0-5.3	50.6
Gambia	0.2	...	0.6-0.6	61.4-159.3	100.0
Ghana	0.4	...	0.7-0.7	25.7-34.6	53.3
Kenya	0.1	...	0.3-0.3	10.0-11.1	100.0
Lesotho	...	...	...	2.9-3.0	100.0
Malawi	...	...	0.1-0.1	2.0-2.0	100.0

Table 3 (Continued). Migration Rates to OECD Countries by Educational Attainment for Selected Developing Countries, 1990

Country of Origin	Schooling Level				U.S. as a Percentage of Total OECD
	Total	Primary or Less	Secondary	Tertiary	
Mali	...	...	0.1-0.1	0.9-0.9	100.0
Mauritius	0.2	...	0.1-0.1	7.2-7.7	100.0
Mozambique	...	...	0.5-0.5	8.6-9.4	100.0
Rwanda	...	...	...	2.2-2.3	100.0
Senegal	2.4	...	14.5-17.0	47.7-91.3	2.0
Sierra Leone	0.3	...	1.2-1.3	24.3-32.1	100.0
South Africa	0.4	...	0.4-0.4	7.9-8.5	32.4
Sudan	...	...	0.1-0.1	1.8-1.8	100.0
Togo	...	...	...-0.1	1.3-1.4	100.0
Tunisia	8.6	0.2	20.2-25.3	63.3-172.2	1.1
Uganda	0.1	...	0.6-0.6	15.5-18.4	100.0
Zambia	0.1	...	0.1-0.1	5.0-5.3	100.0
Zimbabwe	0.1	...	0.3-0.3	4.7-4.9	100.0
North America:					
Costa Rica	2.4	0.1-0.1	10.1-11.2	7.1-7.7	100.0
Dominican Republic	6.5	0.6-0.6	30.5-43.8	14.7-17.2	96.7
El Salvador	11.3	1.6-1.6	66.6-199.3	26.1-35.4	100.0
Guatemala	3.4	0.4-0.4	29.1-41.1	13.5-15.6	100.0
Honduras	3.0	0.2-0.2	15.7-18.7	15.7-18.6	100.0
Jamaica	20.3	0.7-0.7	33.3-50.0	77.4-341.8	61.0
Mexico	7.7	1.6-1.7	20.9-26.4	10.3-11.5	100.0
Nicaragua	4.7	0.3-0.3	33.3-50.0	18.8-23.2	100.0
Panama	6.7	0.1-0.1	9.4-10.4	19.6-24.4	100.0
Trinidad and Tobago	9.5	0.3-0.3	16.0-18.9	57.8-136.9	100.0

Table 3 (Concluded). Migration Rates to OECD Countries by Educational Attainment for Selected Developing Countries, 1990

Country of Origin	Total	Schooling Level			U.S. as a Percentage of Total OECD
		Primary or Less	Secondary	Tertiary	
South America:					
Argentina	0.6	...	1.0-1.0	2.7-2.8	72.3
Bolivia	0.7	...	2.2-2.2	4.2-4.4	100.0
Brazil	0.2	...	1.6-1.6	1.4-1.4	44.0
Chile	1.1	...	1.9-1.9	6.0-6.4	54.3
Colombia	1.1	...-0.1	3.8-3.9	5.8-6.1	96.9
Ecuador	1.9	0.1-0.1	11.4-12.9	3.8-4.0	100.0
Guyana	14.5	0.9-0.9	23.7-31.1	77.5-345.3	100.0
Paraguay	0.2	...	0.7-0.8	2.0-2.0	100.0
Peru	1.0	...	2.7-2.7	3.4-3.6	87.1
Uruguay	1.1	...	2.3-2.4	3.8-3.9	100.0
Venezuela	0.4	...	0.8-0.8	2.1-2.2	77.4

Source: Authors' calculations using data from the 1990 U.S. Census, OECD's Continuous Reporting System on Migration, the United Nations Population Yearbook, and the Barro-Lee data set on educational attainment. The upper bound of the range is calculated assuming that the Barro-Lee figures include migrants in the population, while the lower bound is calculated assuming that they do not. Primary education or less corresponds to reported years of schooling between 0 and 8, secondary education to years of schooling between 9 and 12, and tertiary to years of schooling above 12. Estimates assume that migrants to non-U.S. OECD countries have the same average educational attainment as migrants to the United States. Migrants are defined as the stock of foreign born population in Australia, Canada, and the United States. For all other OECD countries, migrants are the stock of foreign population residing in the country. (...) indicates less than 0.1 percent.

to the rest of the OECD makes little difference. The only exception is Jamaica, which has a considerable stock of migrants in the United Kingdom. For this country, the lower bound of the drain from the population with secondary education reaches 33 percent, while that from the population with tertiary education is over 77 percent.

V. CONCLUDING REMARKS

This paper has presented estimates of the flows of migrants from LDCs to OECD countries by educational attainment. To our knowledge, this is the first attempt to provide a comprehensive quantitative assessment of the much-debated phenomenon of the brain drain. Because data limitations are severe, we emphasize that the estimates are quite tentative especially for countries with little migration to the United States. Therefore, they should be interpreted with caution and, whenever possible, complemented with country-by-country information.

The estimates in this paper show that there is an overall tendency for migration rates to be higher for higher skill levels, suggesting that migrants are generally better educated than the average population. With the important exception of Central American countries, in the countries in our sample the highest migration rates are for individuals with tertiary education. In a number of countries, especially small countries in the Caribbean, Central America, and Africa, this skill group experiences losses to migration that reach above 30 percent. We find a substantial brain drain also in some larger Asian countries, such as Iran, Korea, Taiwan Prov. of China, and the Philippines. These numbers suggest that in several countries the outflow of highly skilled individuals from LDCs is a phenomenon that cannot be ignored by policy-makers. At a minimum, the design of policies to improve educational opportunities within these countries should involve an analysis of the factors that induce so many highly educated individuals to leave.

Our research also indicates several avenues in which estimates of the brain drain could be improved upon using existing data. The first would be to use census information for other large receiving countries, such as Australia, Canada, Germany, and France. Together with the United States, these four countries account for about 93 percent of total migratory flows to the OECD, so the resulting figures would be a very good approximation to the total.¹⁵ Of course, this exercise is feasible only if census data in non-U.S. receiving countries include information about years of schooling, or some other measure of the educational attainment of migrants. A second problem with our estimates is that U.S. data include foreign-born individuals who migrated at a young age, acquired their education in the United States and,

¹⁵Migratory flows of skilled workers to Gulf states, which are substantial for countries such as India, Pakistan, and Jordan, would still be missing, however.

presumably, have little ties with their country of origin. This source of bias could be reduced by excluding from the number of migrants foreign-born individuals who entered the United States before a certain age (for instance, 16 years of age). Unfortunately, the census does not ask individuals to report the age at which they entered the country; however, it asks them to report their current age and how many years they have been in the United States (whether 0 to 5, etc.); thus, with some effort, an approximate calculation of the age of entry would be possible.

Another promising direction for future research is to try to obtain from census data or other sources more detailed information about the occupational category of highly skilled migrants, to assess whether the brain drain from a given country is especially large for particular professional groups (for instance, physicians, accountants, financial analysts). This type of analysis could be useful for evaluating the potential problems that policy programs such as health sector reform programs, financial liberalization, or reform of the civil service may encounter in developing countries.

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