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Globalizing talent and human capital: implications for developing countries

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Contents

Tables

Figures

Box

Summary

Human capital flows can take several forms and include the international circulation of scientists, information technology experts, intellectuals, artists and entrepreneurs. The evidence shows that traditional "brain drain", say a permanent and irreversible outflow of human capital, co-exists also with cycles of emigration and return of national talent ("brain circulation"). Thus, for developing countries, the emigration of domestic talent need not be always a permanent loss. However, although return rates vary from country to country, poor economies suffer particularly hard from the emigration of domestic talent.

The empirical evidence point-out to a very unequal distribution of world resources in science and technology that mimics also large disparities in per capita income across nations. Rich countries spend more (as a share of GDP) in science in technology than middle income and poor countries. However, there are some significant outliers such as China and India whose ratios of spending in science and technology (S &T) to GDP are significantly higher than the international average corresponding to their income per capita levels. These international differentials in resources devoted to S&T is correlated with the observed outflows of scientists and technology experts from developing countries/transition economies to the U.S. and other OECD countries where they find more resources (included better pay) to carry out their scientific research and technology work.

Policies to stem the outflow of human capital and entrepreneurship require action at several fronts: national governments of developing countries need to give a greater priority and devote more resources to science, technology and knowledge generation at home recognizing its pay-off in enhanced productivity, competitiveness and long-run development. Less bureaucracy and more friendly policies to business creation helps also to stem the outflow of entrepreneurial talent. Developed countries in turn can increase the transfer of knowledge to LDCs and redefine foreign aid priorities towards science and technology in developing countries.

These national and international public sector effort in S&T can be complemented by grants from international foundations to support science and technology in developing countries supporting for example the creation, of centers of excellence among other initiatives. All this would be a powerful signal to stem the outflow of talent away from the developing world.

I. Introduction[1]

The last decade has seen an increase in the international mobility of highly skilled, talented individuals (i.e. human capital) in response to the expansion of the knowledge economy accompanying globalization.

The topic of human capital mobility and brain drain has remained somewhat dormant in the academic and policy literature in the last two to three decades after being actively debated in the 1960s. Two views dominated the positions of that time: one was the "internationalist view" championed by Harry Johnson. The alternative view was the "nationalist view" exposed by Don Patinkin and others. The "internationalists" favored unrestricted international migration of highly skilled individuals as a vehicle to enhance "global efficiency," while the "nationalists" were concerned with the adverse impact on national development of human capital outflows to advanced economies. In the world of the early 21 century the debate is better framed in terms of the contribution of international mobility of human capital to global knowledge creation and dissemination, global inequality, national development and successful post-socialist transition.

The international movement of human capital (HC) can be identified, in practice, as the movement of scientists, engineers (e.g. in the information sector), executives, and other professionals across

1 Paper presented at the 4th Annual World Bank Conference on Development Economics (ABCDE) for Europe held in Oslo, Norway on June 24-26, 2002. Efficient assistance by Claudio Aravena in the preparation of this paper is appreciated.

frontiers. These are people with special talents, high skills and specialized knowledge in the scientific, technological and cultural areas. Another dimension of the international mobility of talent is entrepreneurial migration, say people with talent for business creation and resource mobilization rather than necessarily individuals with a high stock of formal education.

From the viewpoint of developing countries (and transition economies) the international mobility of HC has been seen with a mix of concern and possibility. On the one hand developing countries encourage national students to earn graduate degrees abroad (typically in the U.S. and Europe) in science, technology and other disciplines as a way to upgrade their knowledge and human resource base. On the other hand, when outstanding scientists and professionals stay abroad, the concern arises of a “brain drain” due to the flight of scarce human capital and talent whose contribution is needed for economic development at home.

Albeit this work was initially undertaken from a Latin American perspective, the issues analyzed are global by their very nature, and are of interest to all developing countries.

This paper deals with several topics related to the international flows of human capital mainly from a developing countries perspective. It discusses main facts and trends in the international mobility of human capital, assessing the world distribution of science and technology resources, the economic peculiarities of human capital migration, the issue of brain drain and brain circulation, the existence of scientific diasporas and entrepreneurial migration. The paper also discusses the impact of human capital migration on global inequality and national development and highlights policies to induce human capital repatriation and greater sharing by developing countries (and transition economies) in the benefits of global knowledge creation.

II. Facts and trends in the international mobility of human capital

The demand for skilled individuals has been on the rise in the last decade or so. The main pole of attraction for foreign skilled people is the United States. Some 40 percent of its foreign –born population have tertiary education levels. Since the early 1990s some 900,000 skilled professionals mainly Informational Technology (IT) specialists have emigrated to the United States coming from India, China, Russia and some OECD countries (U.K., Germany, Canada). These immigrants often come under the H1-B visa program for highly skilled professionals.

The U.S. is also a main recruiter of foreign students in higher education (it accounts for 32 % of all foreign students in the OECD countries)[1]. Higher education is an important channel for recruiting high skill personnel and 25 percent of H1-B visa holders in 1999 were students previously enrolled in U.S. universities.

The U.S. is not the only net importer of foreign talent. Germany, in 2000, launched a sort of "green card" scheme to recruit some 20,000 foreign IT specialists. The main recruiters come from Russia, Poland and other Eastern European nations that have an important pool of scientific and technical specialist trained during the socialist period and afterwards. Similar initiatives have been launched,

1 See OECD Observer (2002).

recently, in the U.K., Australia, New Zealand (see Box 1). In the developing world, Singapore has been meeting shortages of IT specialists with immigrants from Malaysia, China and other neighboring countries.

The magnitude and impact on developing countries of the outflow of human capital varies from region to region. In Africa, the International Organization for Migration (IOM), estimates that around 300,000 professionals live and work in Europe and North America. Sending countries include Nigeria, Ethiopia, South Africa, Ghana and others. Casual evidence shows that as a consequence of the large scale emigration of medical doctors in Africa, the poor are forced to seek medical treatment from traditional healers while the rich elite fly to London for their routine medical checkups[2]. A recent study[3] shows that Africa is losing as much as US$ 4 billions a year due to the emigration of top professionals seeking better jobs abroad. The study argues that about 20,000 professionals leave Africa each year. This emigration of professionals in Africa has several adverse effects such as reducing the stock of scarce human capital at home, the erosion of the domestic tax base, the failure to form a middle-class of educated people, a stabilizing factor in most societies.

In higher per capita income developing countries the consequences of the outflow of human capital could to be less dramatic. In China the Ministry of Science and Technology estimates that most internet-based ventures were started by Chinese returnees from the United States. In Taipei (Taiwan), half of all the companies emerging from the largest scientific park in Taiwan, the Hsinchu, have been started by returnees from the United States. In India, however, in the year 2000, it was estimated that some 1,500 highly qualified Indians returned from the United States, although more than 30 times that number depart each year (OECD, 2002).

The outflow of human capital is not only led by better opportunities for study and work in the developed countries (pulling factors) but also by economic and political conditions at home (pushing factors). In Latin America a massive exodus of professionals, scientists and intellectuals took place in the late 1960s and the 1970s. In those years, military regimes in Brazil, Argentina, Uruguay, Chile and others countries targeted universities and other academic centers for ideological cleansing and to abate sources of internal opposition and criticism. This experience suggests a direct correlation between the emigration of scientists and intellectuals and the existence of authoritarian regimes that suppress civil liberties and curtail academic freedom. The restoration of democracy in Latin America in the 1980s and 1990s led to some return of scientists and intellectuals, although this flow would have been probably larger if the economic conditions in universities and research centers --salaries and resources available for research-- were better[4]. There seems to be no clear relationship between political, academic freedoms and democracy and resources devoted to universities and research activity. This can be illustrated by the recent experience of post-socialist countries such as Russia, Poland and others. In these countries, particularly Russia, the end of communism and the transition to markets and democracy in the 1990s has coincided with a net outflow of skilled professionals, scientists and information technology specialists[5]. For example in Russia it is estimated that around 1,000-2,000 people employed in "science and scientific services" have left Russia since the early 1990s. Germany and Israel account for 86% of the Russian emigrants in this category in 2000 (Gokhberg and Nekipelova 2002). The outflow of scientists in Russia is largely attributed due to a squeeze in the budget of the science and technology sector that cut salaries, research budgets and deteriorated

2 The Africa Journal (2002).

3 Aredo, D. (2002).

4 See Pellegrino, A. and J. Martinez (2001); also Hansen et.al. (2002).

5 For an interesting albeit dramatic account of how emigration of the most talented individuals of the German Democratic Republic used as a state policy during communism to get rid of active opposition and discontent, debilitated so much the GDR contributing to its unexpectedly rapid after demise the end of the communist regime in 1990, see Hirschman (1995).

working conditions in the S&T sector. This, along with changes in legislation that recognized the right of national citizens to take employment abroad (a right restricted under communism), seems to be an important variable explaining the outflow of scientists and professionals from Russia since the early 1990s (Gokhberg and Nekipelova, 2002).

III. The world distribution of science and technology resources

An important determinant of the international migration of scientists and technology experts is the availability of resources to conduct research, including higher salary levels for researchers, in receipt countries relative to those at home.

Assessing the volume of resources devoted to science and technology present various statistical and definition problems. They range from the definition of science, which in the Anglo-Saxon world is meant to cover only natural sciences (physics, biology, etc.) to the non-reporting of research and development (R&D) expenditure in poorer developing countries that makes more difficult international comparisons[6]. Intertemporal and international comparisons of resources devoted to science and technology in former socialist countries and western economies is also difficult due to different definitions of S&T activities (and national output) used during the socialist period.

With these caveats in mind, the available information shows very large disparities in the world distribution of resources devoted to science and technology (S&T) between developed economies on one side and developing countries (and transition economies) on the other.

6 UNESCO and OECD have developed a broad concept of "science and technology activities" (STA) which includes R&D, "scientific and technical services" (STS), and "scientific and technical education and training" (STET). STS covers activities in museums, libraries, translation and editing of Science and Technology (S&T) literature, surveying and prospecting, testing and quality control, etc. STET refers to S&T education and training, notably tertiary education (see UNESCO, 2001, pp.2).

In fact, according to UNESCO (2001) the developing countries that account for 78 % of world population (and 39 % of world GDP) only contributed to 16 percent of global research and development (R&D) expenditure in 1996/97. In contrast, the developed economies with 22% of world population account for some 84 percent of global R&D expenditure, (see table I and figure 1).

According to table I the U.S has the largest share of world R&D expenditure: 36.4 percent in 1996/97. The European Union accounts for 25.2 percent and Japan 15.2 percent. In the developing world, China accounts for 3.9 percent, of world R&D expenditure; the Newly Industrialized Countries of South-East Asia 4.9 percent; India 2.0 percent and Latin America and the Caribbean 3.1 percent. Particularly low shares in global R&D spending are found in Russia: 1 percent and in Sub-Saharan Africa: 0.5 percent.

Another indicator of the domestic effort in science and technology is as the share of GDP devoted to R& D. This coefficient ranges from 2.9 percent in Japan and 2.6 percent in the U.S. to 0.9 in Russia, 0.5 percent in Latin America and the Caribbean and 0.3 percent in Sub-Saharan Africa (see figure 3).

There is also a significantly lower availability of resources (i.e. salaries, research budgets, equipment) per researcher in the developing countries and transition economies than in industrial countries (see figure 4)[7]. For instance while in Russia the average R&D expenditure per researcher was U$ 10,000 (in purchasing power parity dollars) in 1996/97, that ratio was U$ 167,000 in the European Union, and U$ 203,000 in the United States. These are ratios of 1 to 17 and 1 to 20. In Latin America the R&D spending per researcher is U$ 48,000 and in the Asian Newly Industrialized Countries U$ 111,000, all in PPP dollars (see table I and figure 4).

These indicators point-out to a very unequal distribution of world resources in science and technology that mimics also large disparities in per capita income across nations. Rich countries spend more (as a share of GDP) in science in technology than middle income and poor countries. However, there are some significant outliers such as China and India whose ratios of spending in science and technology to GDP are significantly higher than the international average corresponding to their income per capita levels. These international differentials in resources devoted to S&T must be correlated with the observed outflows of scientists and technology experts from developing countries/transition economies to the U.S. and other OECD countries where they find more resources (included better pay) to carry out their scientific research and technology work.

7 The number of researchers of the developing countries as a share of world total 28 percent is above their corresponding share of world R&D expenditure (16 percent), see table I and figure 2.

IV. Matching, complementarities increasing returns and the productivity of human capital

As already mentioned high skill and talented people leave their home countries for a variety of reasons: the possibility of acquiring knowledge and first rate education in the best centers of the world (education phase), the lure of interacting with peers of international recognition, the aim of pursuing a successful career abroad.

In scientific work (generation of new knowledge) individual researchers benefit from interacting with a critical mass of other researchers and scientists working in the same field. Intellectual creation is rarely a purely individual endeavor: interactions with peers is a critical ingredient of the creative process.

Human capital depends, positively, on the availability of human capital, in other words there are increasing returns in knowledge creation. In the decision to emigrate physicists seek other physicists, biologists seek other biologists, economists seek other economists, etc. Matching, complementarities and increasing returns are thus an essential part of the story of emigration of human capital. As the literature on growth and development emphasizes this can lead to virtuous circles and also to poverty traps[8]. Receiving countries can set in motion a cycle of vigorous knowledge creation and application by

8 See Easterly (2001) and ECLAC (2002).

attracting the most talented from abroad, who combine with an often strong knowledge base in the host country. Conversely, sending countries can enter in a phase of stagnation in the development of science, technology and knowledge following the outflows of talent as a critical mass of scientists and technical experts disappear, deteriorating the milieu for knowledge generation and assimilation at home.

V. Brain drain or brain cycle? The human capital emigration-return cycle

The possibility of virtuous cycles of knowledge creation along with "knowledge traps" associated with the international mobility of human capital depend also on the nature of the emigration-return process. Empirical evidence on foreign students studying and working after graduation in the United States, provided by the U.S. National Science Foundation, seems to show a pattern that combines a "*brain cycle*" with "brain drain"[9]. The "brain cycle" would be roughly the following: a foreign student comes to study abroad (in a developed country, for example the U.S.) to earn a graduate degree, Master or Ph.D. After graduation, talented students, from MBAs to scientists, very often get good job offers in the host country.

Thus, the foreign student chooses to remain abroad after completing higher education. The duration of the stay abroad can range from a few years, a decade to eventual retirement. If after a few years of work abroad the individual returns home, the emigration of human capital can be understood more as a "brain cycle" and not an irreversible loss.

In the case that the emigrant decides to stay abroad during his whole productive life the loss for the sending country is larger and the

[9] See National Science Foundation (1998).

situation resembles more the "brain drain" symptom. To what extent the home country erodes its qualified human resource pool due to the student decision to remain abroad after graduation? In a world of lower transport costs and easy communications the talented individual living abroad may maintain contact and professional exchange with its peers at home, including periodic visits to his native country thus contributing (indirectly or directly) to national development in his or her area of expertise.

The data of the NSF study shows that about 47 percent of the foreign student on temporary visas who earned doctorates in 1990 and 1991 were working in the United States in 1995. In turn, the majority of the foreign doctoral recipients in 1990-91 coming from India (79 percent) and China (88 percent) were still working in the U.S. in 1995. In contrast, only 11 percent of South-Koreans who completed science and engineering doctorates from U.S. universities in 1990-91 were working in the U.S. in 1995 (see tables II and III).

In turn, the NSF study reports that foreign doctoral recipients in science and engineering that were working in the U.S. after 10 or 20 years tend to remain in the country (no significant net return migration). The point is that we seem to observe a *"human capital emigration–return cycle"* (brain cycle) whose shape (duration of stay-rates) varies from country of origin. Understanding better the determinants of stay-rates is another important subject for future research.

VI. Scientific diasporas

Diasporas, coming from the Greek *diaspeirein*, mean dispersion, scattering. The term is often associated with people and communities dispersed from their home country for various reasons: wars, political and/or ethnic persecutions at home, natural disasters, economic disasters (famines) and other causes[10]. Diasporas often tend to maintain emotional, historical, family attachments with their homeland.

Recent literature[11] has identified "scientific diasporas". These diasporas, that maintain an attachment to their home countries, create knowledge networks of nationals belonging to a certain scientific field that work or study abroad.

A main purpose of these networks is to connect professionals and scientists scattered around the globe who are interested in maintaining contact among themselves. In addition, they are also interested in helping to promote the scientific and economic development of their home countries. These networks may have a link with national governments or be fully independent. Examples of these networks are the Chinese Scholars Abroad (CHISA), The Colombian

10 See Shuval, J. (2000).
11 See Meyer and Brown (1999).

Network of Engineers Abroad (Red Caldas), The Global Korean Network, The Syllicon Valley Indian Professionals Association (SIPA), and several others.[12]

Scientific knowledge generation taking place in the world to networks, in principle, de-link the contribution of scientists to their physical residence in the home country and thus can be in interesting vehicle for transferring developing countries.

[12] Other examples are the Polish Scientists Abroad Network, the Reverse Brain Drain Project of Thailand, the Tunisian Scientific Consortium, the South African Network of Skills Abroad (SANSA), The Program of Venezuelan Talent Abroad and several others.

VII. Entrepreneurial migration

An important feature of migration, relatively neglected in the discussions of brain drain, is the international mobility of entrepreneurship. This is people that settle in other countries—developed and developing—and have a talent for business creation and job generation. Historically, world-wide successful entrepreneurs and bankers in the late 19th and early 20th century in the United States and Europe such as Mellon, Vanderbilt, Carnegie, Rockefeller, the famous banking dynasty of the Rostchilds with operations in London, Zurich and other financial centers were foreign-born or first descents of immigrants[13]. In this case, it is interesting to note that the Mellons, Rockefellers and others, besides accumulating a large wealth, had an interest in creating centers of education and learning. In fact, they helped to establish universities and created private foundations devoted to education purposes.

Carnegie in particular, was one of the pioneers in the formation of the system of public libraries in the United States at the turn of the 20th century. Later on, names such as George Soros, an immigrant from Central Europe escaping nazi persecution in the 1930s, turned abroad into a very successful financier. Soros is another case of a talented entrepreneur with a philanthropic gist manifested in creation of the Soros Foundation and the network of Open Society Institutes throughout the world.

[13] See Ferguson (1999).

Some studies have observed a connection between ethnic diasporas and entrepreneurship[14], (see box 2). Classic examples of this, is the Jewish emigration to the United States. In fact, it is estimated that the contribution of the Jewish community in America to business creation and banking is far larger than their share in the total population of the U.S. In the context of developing countries, Chinese emigration has played an important role in building a business community (of Chinese origin) in several very dynamic economies of South – East Asia. In turn, immigration from Germany, Italy, Syria, Palestine, Lebanon to Argentina, Chile, Brazil at the turn of the 20th century, played a very important role in building the textile sector, banking, agriculture, mining sectors in these Latin American countries[15].

There is considerable variation in the scale of the business activity created by the entreprenuership of foreign migrants. Not all entrepreneur immigrants operate at the economic scale of the Rockefellers, Rotschilds or Soros. There is, indeed, a plethora of them operating at the level of family business and small firms. A typical example is the ethnic restaurants (e.g. Chinese cuisine, Indian cuisine, Brazilian cuisine, French cuisine, Italian cuisine etc.) in the large cities of the developed countries.

Moreover in the carpet and furniture business in these cities there is a predominance of Turkish, Indian, Pakistani, Moroccan owners. This pattern of immigrant entrepreneurship do not mobilize large amounts of financial resources but they can be quite labor intensive and their business add to services variety in the host countries. The sociological profile of these endeavors is interesting: business are usually owned and run by members of a specific ethnic group and the employees (many times family members) tend to be also of the same ethnicity[16].

The connections between ethnicity, entrepreneurship and migration and their patterns of integration/exclusion with the local economy and society are themes that deserve further inquire.

The relationship between endowments of human capital and entrepreneurship is also an interesting subject. Entrepreneurs are not necessarily people with a high stock of formal education; in addition, the " psychology of the entrepreneur" is certainly different from that of the scientist or the intellectual who we usually identify with "human capital". Typically the entrepreneur is prone to risk-taking, has a talent for combining capital, labor and for entertaining a vision of opportunities and the prospects for profits[17]. In contrast, professionals, scientists engineers are often employees rather than owners and are supposed to be more risk averse.

[14] See Kloosterman and Rath (2000).
[15] See Solberg, C.E. (1970).
[16] See Ndoen, M. Gorter, C. Nijkamp and P. Rietveld (2000) and Kloosterman and J. Rath (2001).
[17] See Schumpeter (1954).

VIII. Impact on global output, global inequality and national development

What are the economic consequences of the international mobility of human capital and talent? Who gain? Who losses?

In a world without barriers to the movement of people across nations, individuals should be expected to migrate from places where their productivity (and income) is lower to places where their productivity is higher, regardless of national borders.[18]

Then, human capital will go from lower net returns to higher net return places discounted the costs of moving (including some psychological costs of leaving home). Unless there are some significant negative externalities, "world income" should be higher with more mobile human capital as at the margin the marginal productivity of human capital will be equalized around the world. This, however, does not consider the distributional impact of such migrations flows between sending and receiving nations.

We live in a world of large disparities in levels of per capita income across countries[19] and the movement of human capital from low income countries to rich nations may tend to accentuate these income per capita differentials. In fact, the emigration of the highly skilled increases the stock of human capital in advanced receiving

[18] This is a simplification since individual attachments to family, language, traditions and culture in the home country also matter in the decision to emigrate.

[19] See Solimano (2001a).

countries and reduces it in lower per capita income (sending) countries. If, as mentioned before, there are increasing returns in human capital and it tends to concentrate in places where the availability of human and physical capital is already high the result may be an unequalizing process of income and knowledge concentration across countries that tend to be persistent over time. Under increasing returns, the international mobility of talent and human capital from poor to rich countries may exacerbate global inequalities.[20]

The impact of the outflows of human capital on national development of the sending countries can be negative in the short run as these outflows deprive the home country of their contribution to science, productivity and ultimately domestic output, reduce a source of revenues and weakens the middle class. In the medium and long runs things can improve. National talent may return home after years of work abroad, as in the "brain circulation "model sketched above, and the greater circulation of human capital can yield other benefits to developing nations.

[20] See Krugman and Venables (1995) for a center-periphery model with increasing returns.

IX. Policy issues

What can developing countries do to revert the outflow of human capital? How to increase their share in the process of global generation of knowledge? How to improve the world distribution of resources for science and technology?

A first point is to recognize that legal impediments for international migration of human capital and/or stiff taxation of those flows are unlikely to succeed and can be ultimately counter-productive. Those measures are likely to stifle individual preferences for mobility and dampen the motivation of scientists, technical experts and other skilled individuals. In the era of globalization and rapid technical change the international mobility of human capital is unavoidable[21]. The crucial point is how to create better economic and professional conditions for the high skilled and talented to return home, after studying or working abroad. The data shows that the share of GDP devoted to R&D in many developing countries is well below world averages. This reflects the existence of other priorities for resource allocation such as physical infrastructure and social spending over the development of science and technology. In the medium to long run, the neglect on the science and technology sector is likely to be reflected in lower productivity growth and competitiveness, hampering the development potential of these countries.

21 Solimano (1999b).

There is a role also for foreign aid in the area of science and technology to developing countries. Foreign aid in S&T can take several forms: support for universities and high-quality research centers in LDCs to enhance research capabilities and induce the repatriation of scientists and professionals. Another mechanism is creating programs of international exchange of scientists in which technical experts of developed countries can spend time in developing countries interacting with local researchers, thus contributing to the local development of the science and technology sector. The use of the internet and support for local libraries in upgrading their collections of books, data bases, specialized journals and the like are concrete measures to help in this area.

This aid can be channeled bilaterally or through international organizations such as UNESCO, The World Bank, OECD and others. Currently, the World Bank has a lending program for supporting the development of science in LDCs through the Millenium Science Initiative (MSI). The loans go to national governments that provide matching funds and give financial support - often through grants- to the formation and maintenance of "centers of excellence" in science in their countries. There is a role also for international private support of science and technology in developing nations through private foundations with an international scope such as Ford Foundation, Rockefeller Foundation, Bill and Melinda Gates Foundation and others. These foundations can target programs in pure and applied science for development. The Gates Foundation’s support development of vaccines and cost efficient drugs for Africa seems to be an excellent precedent in this regard.

X. Concluding remarks

The globalization of human capital and talent is an inescapable feature of globalization, the expansion of the knowledge economy and the rapid pace of technical change of today's world.

Our paper shows that there are large disparities in the world distribution of resources of science and technology between developed countries on one hand and developing countries and transition economies on the other. In fact the economies of the OECD account for near 85 percent of world expenditure in research and development. This concentration of resources in the S&T sector in advanced economies is positively correlated with the outflows of human capital from developing countries and transition economies to the developed world.

Human capital flows can take several forms and include the international circulation of scientists, information technology experts, intellectuals, artists and entrepreneurs. The evidence shows that traditional “brain drain”, say a permanent and irreversible outflow of human capital, co-exists also with cycles of emigration and return of national talent (“brain circulation”). Thus, for developing countries, the emigration of domestic talent need not be always a permanent loss. However, although return rates vary from country to country; and poor regions such as Africa suffer particularly hard from the almost permanent emigration of domestic talent.

The historical and recent evidence of Latin America and some post-socialist countries indicates a complex relationship between democracy and the emigration of scientists and intellectuals. In Latin America the authoritarian regimes of the 1960s and 1970s, that suppressed civil liberties and restricted academic freedoms, led to outflows of scientists and intellectuals. Some of them returned with the advent of democracy in the 1980s and 1990s. In contrast in post-soviet Russia, the transition to democracy and the market has coincided with outflows of skilled professionals and scientist due to a squeeze in the budgets for science and technology activities in Russia.

Current imbalances in the international distribution of resources for science and technology calls for more resources and better incentives for the science and technology sector in developing countries and transition economies. This requires action at several fronts: national governments of developing countries need to give a greater priority to science, technology and knowledge generation at home recognizing its pay-off in enhanced productivity, competitiveness and long-run development. Developed countries in turn can increase the transfer of knowledge to LDCs and redefine foreign aid priorities towards science and technology in developing countries. These national and international public sector effort in S&T can be complemented by grants from international foundations to support science and technology in developing countries supporting for example the creation, of centers of excellence among other initiatives. All this would be a powerful signal to stem the outflow of talent away from the developing world.

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Annex

Table I

KEY INDICATORS ON WORLD GDP, POPULATION AND R&D EXPENDITURE AND PERSONNEL, 1996/97

Regions/ countries	GDP Billion PPP$	GDP % world GDP	Population Million	Population % world Population	R&D expenditure (GERD) Billion PPP$	R&D expenditure (GERD) % world GERD	R&D expenditure (GERD) % GDP	R&D expenditure (GERD) GERD per inhabitant (PPP$)	R&D researchers Researchers (thousands)	R&D researchers Researchers % world total	R&D researchers Researchers per million inhabitants	GERD per researcher (thousands PPP$)
WORLD	**34381.9**	**100.0**	**5483.3**	**100.0**	**546.7**	**100.0**	**1.6**	**100.0**	**5189.4**	**100.0**	**946.0**	**105.4**
Developing countries	**13366.8**	**38.9**	**4258.9**	**77.7**	**85.5**	**15.6**	**0.6**	**20.0**	**1476.2**	**28.4**	**347.0**	**57.9**
Developed countries	**21015.1**	**61.1**	**1224.4**	**22.3**	**461.3**	**84.4**	**2.2**	**377.0**	**3713.3**	**71.6**	**3033.0**	**124.2**
Americas	**11333.8**	**33.0**	**782.2**	**14.3**	**225.8**	**41.3**	**2.0**	**289.0**	**1410.5**	**27.2**	**1803.0**	**160.1**
North America	8169.0	23.8	295.1	5.4	209.0	38.2	2.6	708.0	1062.2	20.5	3599.0	196.8
Latin America and the Caribbean	3164.8	9.2	487.1	8.9	16.8	3.1	0.5	34.0	348.3	6.7	715.0	48.2
Europe	**9186.0**	**26.7**	**714.2**	**13.0**	**157.7**	**28.8**	**1.7**	**221.0**	**1768.2**	**34.1**	**2476.0**	**89.2**
European Union	7404.4	21.5	373.1	6.8	137.9	25.2	1.8	370.0	824.9	15.9	2211.0	167.2
Central and Eastern Europe	679.2	2.0	115.4	2.1	5.6	1.0	0.8	49.0	167.5	3.2	1451.0	33.5
Comm. of Independent States (in Europe)	810.4	2.4	213.5	3.9	7.6	1.4	0.9	35.0	733.1	14.1	3434.0	10.3
Other	292.0	0.8	12.2	0.2	6.6	1.2	2.3	539.0	42.7	0.8	3499.0	154.2
Africa	**1246.5**	**3.6**	**626.5**	**11.4**	**3.8**	**0.7**	**0.3**	**6.0**	**132.0**	**2.5**	**211.0**	**28.5**
Sub-Saharan Africa (excl. Arab States)	759.0	2.2	464.0	8.5	2.6	0.5	0.3	6.0	52.5	1.0	113.0	49.1
Arab States (in Africa)	487.6	1.4	162.5	3.0	1.2	0.2	0.2	7.0	79.5	1.5	489.0	14.9
Asia	**12172.8**	**35.4**	**3331.6**	**60.8**	**152.3**	**27.9**	**1.3**	**46.0**	**1790.6**	**34.5**	**537.0**	**85.1**
Japan	3000.3	8.7	125.8	2.3	83.1	15.2	2.9	661.0	617.4	11.9	4909.0	134.6
China	3542.8	10.3	1215.4	22.2	21.1	3.9	0.6	17.0	551.8	10.6	454.0	38.3
Newly Industrialized Economies	2322.5	6.8	405.1	7.4	26.7	4.9	1.1	66.0	240.9	4.6	595.0	110.7
India	1529.5	4.4	945.6	17.2	10.8	2.0	0.7	11.0	142.8	2.8	151.0	75.8
Comm. of Independent States (in Asia)	168.1	0.5	71.0	1.3	0.6	0.1	0.3	8.0	97.1	1.9	1368.0	6.0
Arab States (in Asia)	398.2	1.2	71.2	1.3	0.8	0.1	0.2	11.0	3.7	0.1	52.0	211.4
Other	1211.3	3.5	497.5	9.1	9.3	1.7	0.8	19.0	137.0	2.6	275.0	67.6
Oceania	**442.8**	**1.3**	**28.7**	**0.5**	**7.2**	**1.3**	**1.6**	**251.0**	**88.3**	**1.7**	**3071.0**	**81.7**
Selected countries/regions												
United States	7511.3	21.8	265.2	4.8	198.8	36.4	2.6	749.0	980.5	18.9	3697.0	202.7
Russian Federation	643.7	1.9	147.7	2.7	5.7	1.0	0.9	38.0	561.6	10.8	3801.0	10.1
Comm. of Independent States (All)	978.5	2.8	284.5	5.2	8.2	1.5	0.8	29.0	850.8	16.4	2991.0	9.6
South Africa	297.0	0.9	39.9	0.7	2.0	0.4	0.7	50.0	41.1	0.8	1031.0	49.0
Arab States (All)	885.8	2.6	233.8	4.3	2.0	0.4	0.2	8.0	83.2	1.6	356.0	23.6
OECD Countries	21601.0	62.8	1096.8	20.0	463.0	84.7	2.2	422.0	2822.3	54.4	2573.0	164.0

Source: UNESCO estimates August 2000.

Table II

PERCENTAGE OF 1990-91 FOREIGN S&E DOCTORAL RECIPIENTS FROM U.S. UNIVERSITIES WHO WERE WORKING IN THE UNITED STATES IN 1995, BY COUNTRY OF ORIGIN

Country	Foreign S&E doctorates	Percent working in the United States
Total	**13878**	**47**
China 1/	2779	88
India	1235	79
Japan	227	13
South Korea	1912	11
Taiwan	1824	42
England	142	59
Germany	177	35
Greece	240	41
Canada	417	46
Mexico	194	30

1/ The high stay rate of Chinese students is attributable to a one-time granting of permanent residence status in the United States (Chinese Students Protection Act) following China's response to student demonstrations

Note: Includes foreign doctoral recipients with temporaryvisa status at the time of receipt of degrees in 1990-1991 (not permanent residents).

Source: NSF, 1998.

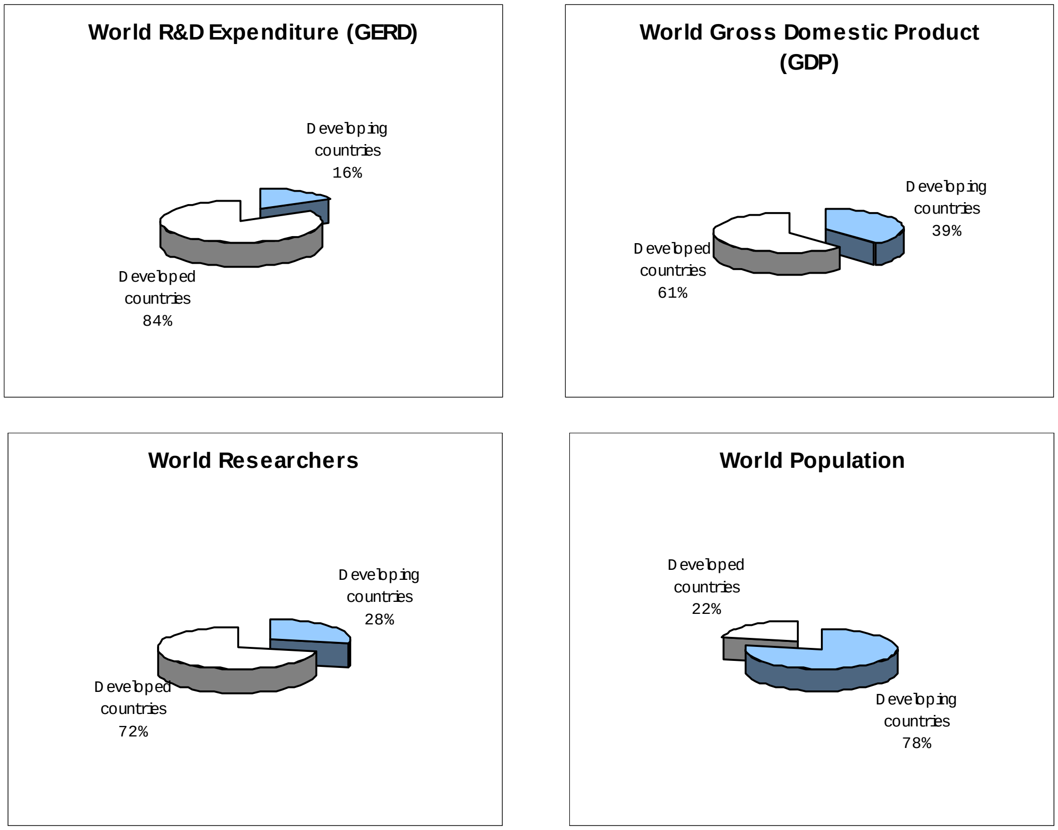
Table III
CHINESE STUDENTS STUDYING ABROAD AND RETURNING
1978-99

Year	No. of students studying abroad	No. of students returning
1978	860	248
1980	2124	162
1985	4888	1424
1986	4676	1388
1987	4703	1605
1988	3786	3000
1989	3329	1753
1990	2950	1593
1991	2900	2069
1992	6540	3611
1993	10742	5128
1994	19071	4230
1995	20381	5750
1996	20905	6570
1997	22410	7130
1998	17622	7379
1999	23749	7748

Source: OECD 2002.

Figure 1

WORLD GDP, POPULATION AND R&D RESOURCES IN DEVELOPED AND DEVELOPING COUNTRIES 1996/1997

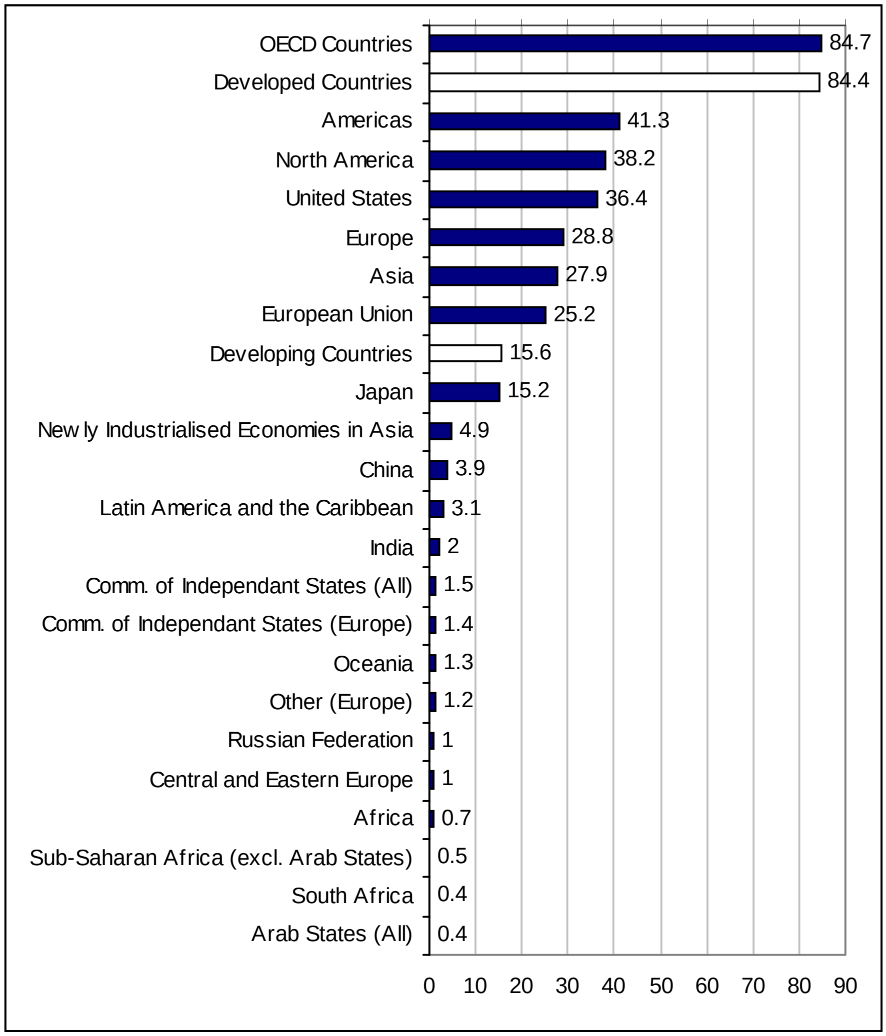


Source: Table I.

Figure 2

SHARES OF WORLD R&D EXPENDITURE (GERD) BY PRINCIPAL REGIONS/COUNTRIES 1996/1997

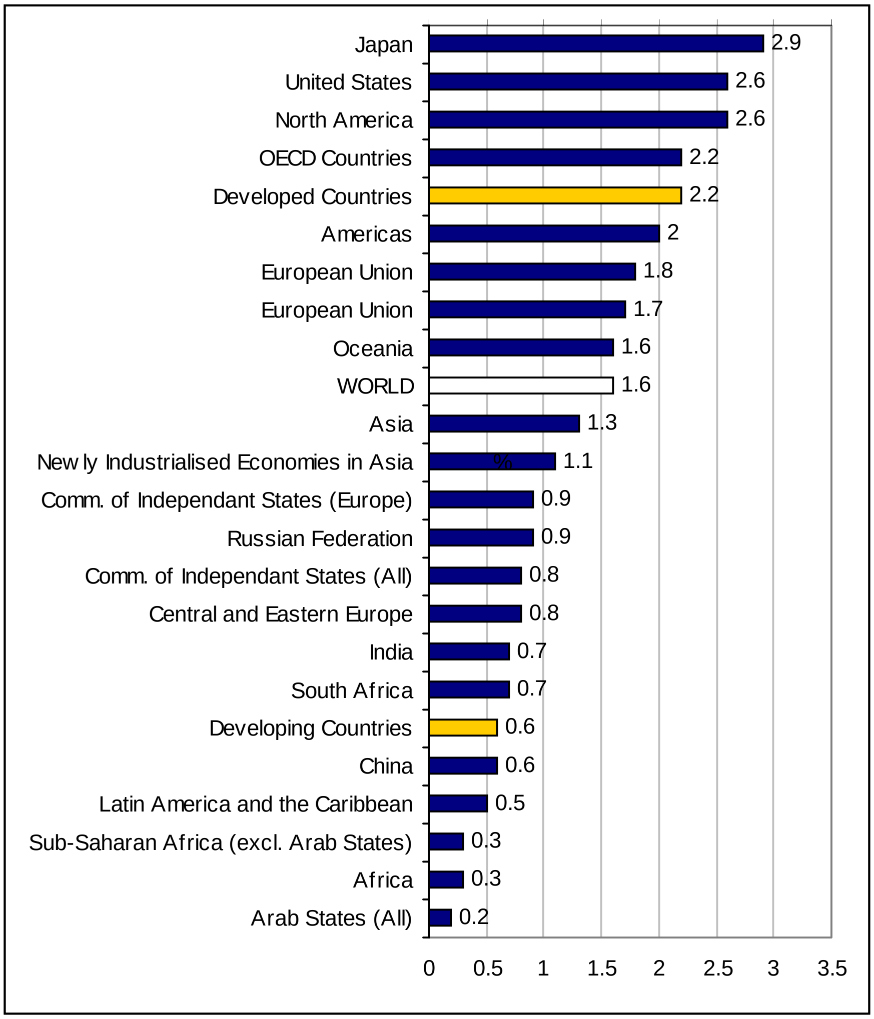
(%)



Source: UNESCO estimates August 2000.

Figure 3

GERD AS A % OF GDP BY PRINCIPAL REGIONS/COUNTRIES 1996/1997

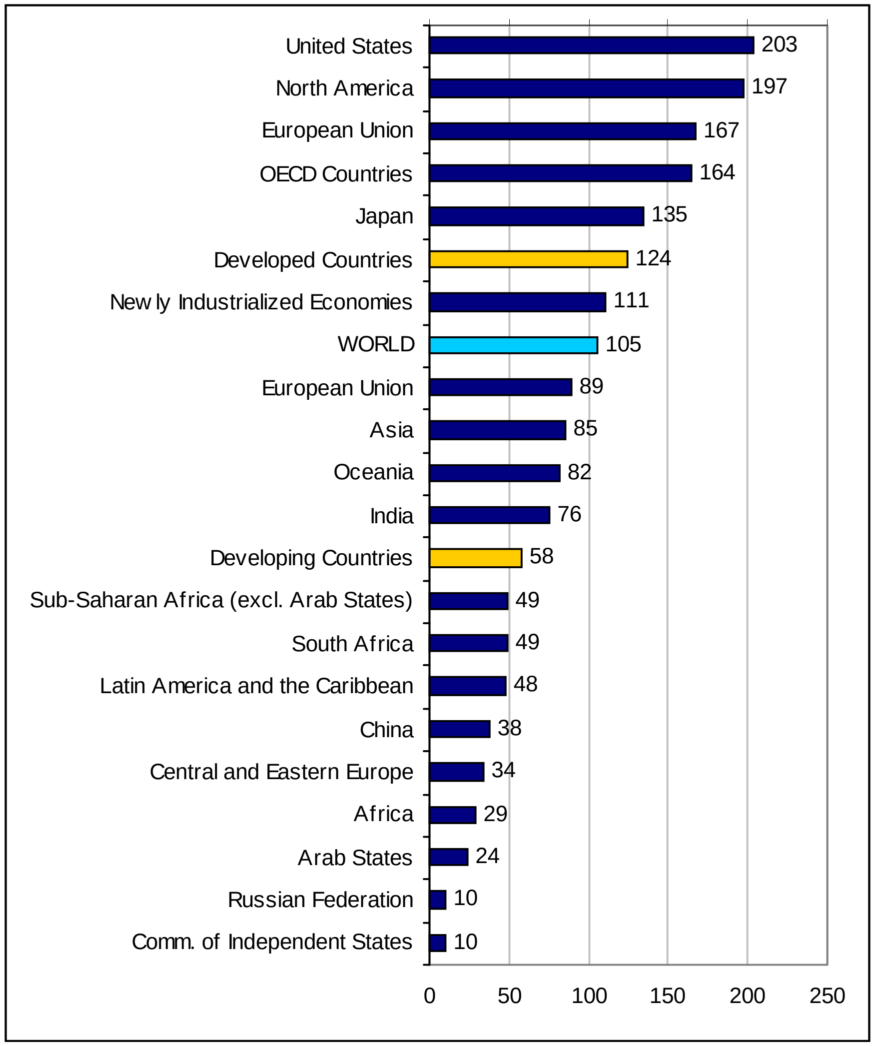


Source: UNESCO estimates August 2000.

Figure 4

R&D EXPENDITURE (GERD) PER RESEARCHER BY PRINCIPAL REGIONS/COUNTRIES 1996/1997

(thousand ppp US$)



Source: UNESCO estimates August 2000.

BOX 1

RECENT POLICY INITIATIVES IN OECD COUNTRIES TO ATTRACT FOREIGN TALENT

Canada (Quebec Province): The provincial government of Quebec is offering five-year income tax holidays (credits) to attract foreign academics in IT, engineering, health science and finance to take employment in the provinces' universities.

European Union: As a follow-up to the Bologna Charter on education, efforts are under way to harmonize educational certification and qualification systems among member states in order to encourage greater student mobility within the EU.

Finland: The government has taken steps to encourage the enrolment of foreign students in Finland, including from Asia.

France: Several recent measures seek to facilitate the temporary migration of foreign scientists and researchers. In 1998, the government established an agency, EduFrance, with a budget of FRF 100 million to attract a greater number of students to France, particularly from Asia and Latin America.

Germany: The government seeks to increase foreign student inflows through grants and fellowships schemes. In addition, it launched a program to issue 20000 immigration visas to fill IT job vacancies. In the second quarter, only one-third of the visas had been granted, mainly to people from India and Eastern Europe who were hired by small firms.

Ireland: The shortage of skilled workers, especially in IT, has led to government campaigns in 2000 and 2001 to attract foreign workers as well as former Irish emigrants. Government-sponsored job fairs have been held in Canada, the Czech Republic, India, South Africa and the United States. In addition, work visas were introduced in 2000 specifically to allow the entry of highly skilled workers in areas where shortages exist in Ireland (MacEinri, 2001).

Japan: The government seeks to double the number of foreign students through the use of scholarships.

United Kingdom: In 1999, the UK government launched a major campaign to increase the number of international students in higher education from 198000 to 248000. The strategy is based on: i) a promotional/marketing campaign; ii) streamlining of visa procedures and rules on employment for foreign students; and iii) special scholarships for top achievers.

United States: The US Congress has temporarily increased the annual cap on the number of temporary visas granted to professional immigrants under the H-1B visa program whose statutory limit in 2000 is presently set at 195000 visas per year until 2003.

Source: OECD (2002).

BOX 2

ASIAN VENTURE CAPITAL IN THE SILICON VALLEY

According to estimates from industry sources, there are several dozen Asian venture capital firms in Silicon Valley – 31 from Chinese Taipei alone and others from Japan, Hong Kong (China), Korea, Singapore and Malaysia. Most of their money goes to start-ups that specialize in the Internet or semiconductors. A handful of venture funds, such as the Taipei-based InveStar Capital Inc., founded in 1996, invest more heavily there than in Asia. In 1998, 80% of their investments (more than USD 100 million) went to Silicon Valley firms. While there are no venture funds and few private financiers from the Indian subcontinent, the community is overflowing with local Indian investors who provide enough early funding to give companies the momentum to attract the attention of mainstream venture capital firms. As the San Francisco Bay Area's Asian ethnic communities reached a critical mass in the 1990s, their networks and associations have expanded. Among the largest Chinese and Indian associations are the Monte Jade Science & Technology Association (1000 members), formed in 1990 by wealthy individuals from Chinese Taipei, and the Indus Entrepreneurs (600 members), founded in 1993 by businessmen from South Asia.

Source: OECD (2002).

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