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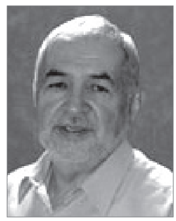

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Mobility or Brain Drain? The Case of Mexican Scientists

Developing countries display a variety of modes of external scientific “mobility”, a phenomenon better described as “brain drain”. Some countries lose scientific human resources because of social instability and “coup d’etats”, others because of lack of scientific infrastructure or low salaries. Still others leave their home countries in search of better opportunities of development in their areas of research. The case of Mexican scientists centers mostly in the “no return” phenomenon. Since the early 70s the Mexican government gave a great impulse to the granting of PhD scholarships to good prospects interested in going to study abroad. Although statistics vary, they indicate some relevant percentage of "no returns". This is detrimental to the country's scientific development effort, since the investment in the preparation of a PhD is not recovered. This paper shows how the authorities make efforts to repatriate scientists working abroad and what the results are. To reduce brain drain, long range planning that involves both the creation of science positions and research centers coupled with the arrival of new PhDs is recommended. The paper also explores the converse phenomenon, "brain gain", as proposed by several authors.

Keywords: "no returns", brain drain, lost of talents, Latin American science

Introduction

The term *brain drain* has been at the center of discussions about international scientific migration for several decades. This is partly because the term has gained increasing attention in public opinion as well as the political establishment. It also gained recognition in the context of a debate between what is perceived as 'political correctness', in terms of scientists' loyalty either toward national goals in scientific efforts or furthering their own academic career and mobility. This explains why brain drain is a concept that is often distorted in the literature for the lay reader. Thus, many scientists feel the literature has been misleading and the concept has been increasingly proven to be meaningless.

According to Gaillard and Gaillard (1997), brain drain is rooted in an ideology nurtured by Third World countries, which have presented the phenomenon of out-migration with an image of a social problem. Brain drain has become the subject of many intellectual arguments and is addressed in numerous studies. Thus, brain drain as an academic term has been used regularly to condemn the flight of highly trained minds from developing countries to rich ones, as a one-way phenomenon, because it often combines the notion of loss, conveyed in the term *drain* with migration of educated and professional individuals.

In spite of being a renewable academic interest, *brain drain* has been a recursive topic in political programs of developing countries that recognize this as a handicap for their progress. Indeed, brain drain has occupied a place in the agenda of S&T policies in Latin America since the 1960s. As such, this phenomenon has been recognized as one of the main obstacles for development (Gaillard and Gaillard, 1997).

Governments of Latin American countries, in one measure or another, have been making efforts to repatriate the migrated brains they have supported. In Mexico, the government office in charge of scientific policy is the National Council for Science and Technology (CONACYT), which has instrumented a repatriation program that appears to have achieved some success. However, a crucial problem in measuring that success is the inability to obtain reliable data on the number of people that have left Mexico.

Scholars confront many obstacles in their attempts to quantify the brain drain phenomenon: I) the data collected by different censorial organizations, mostly from the industrialized world, do not address it in any specific form, II) the ambiguous nature of the scientist's role given science's own special status, III) thus, the lack of a clear understanding, as we have suggested, as to what exactly constitutes a drained brain, IV) the delicate character of handling information of the type needed to be able to trace individual scientists' personal history and trajectory, among others. Given these difficulties, it is no surprise that views on migration of highly trained scientific personnel are many and varied. Indeed, perceptions vary from a net loss, from the perspective of developing countries unable to retain their scientific personnel, to countries that actually encourage migration of scientists as any knowledge they can obtain of advanced science and technology in developed countries will eventually render fruits for their own country's scientific and technological development.

The objective of this paper is therefore, to reflect on the phenomenon in Latin America and in particular in the case of Mexico, where the phenomenon of migration of highly trained scientific and technological personnel is viewed as a net loss, a brain drain. At the same time, to reflect upon the ambiguous nature of the term. In the first part, we will touch on the evolution of the phenomenon throughout history, in order to set the stage for and review the complex sociological nature of migration. In a second part, we will dwell on the specificity of Mexico. We will provide pertinent statistics referring to what is perceived as the negative impact of the phenomenon in the country. Specifically, we will focus on the institutions that are responsible for the development and management of the country's scientific and technological human resources, and how they have dealt with the problem of migration of these. Next, we will reflect somewhat upon the dual nature of the social phenomenon of migration of highly qualified human resources, both negative and positive, and provide examples given by some authors of the latter. Finally, we will explore some ways in which other countries have dealt with the issue, and provide some proposals aimed at reducing the negative impact of highly qualified migration in Mexico.

Background

The difficulty in studying *brain drain* is that it can hardly be restricted to a univocal concept. It appears to encompass a multifaceted phenomenon. It is actually an overloaded term that conveys a large number of explicit and implicit connotations. Consequently, its definition cannot be easy. It is often used to describe or analyze migratory phenomena that are dissimilar. A retrospective examination of the successive uses of a variety of expressions, such as *brain drain, brain gain, brain overflow, reverse transfer of technology, brain waste, brain escapees, leak of talents, brain mobility* — only to mention a few of the expressions in the spectrum of the archetypal brain drain — is indicative of the diversity of the phenomena and the emergence of new orientations. However, Gaillard and Gaillard's interpretation as a mere problem of perspective, (the Third World's) can hardly be sustained either.

The phenomenon is even recognized by the United Nations as a real problem pertaining to developing countries. That organism defined the term *brain drain* as a one-way movement, or an exodus, that only covered migratory flows from South to North, from the developing to the developed countries, and only benefited the industrialized ones (Gaillard and Gaillard, 1997: 195). For Wagner (2008: 63), it is a situation in which nations with few resources lose their most valuable people with capable, highly gifted minds to more developed nations. Educated in more developed countries, scientists and engineers from the developing world contribute to the scientific prowess and economic growth of the countries where they practice their profession, not to those in which they were born and publicly funded throughout their entire basic, secondary and part of their tertiary education. For the purpose of this paper, *brain drain* refers to the exodus of highly qualified scientists and technologists from the Third to the First World, where they subsequently work and develop further in scientific and technological fields.

The journey of scientists throughout the world is as old as science itself. From its beginning, science has been built up through the voyage of people and their ideas. Thus, mobility of scientists may be viewed as a socio-anthropological phenomenon. In Ancient Greece many of the most eminent scholars left their native land in search of wisdom, learning and research. Some of them returned, while others continued their travel or established schools in strange lands like Pythagoras (c. 570 BC) who established a philosophical school around the Mediterranean in the area of modern Italy.

Medieval universities were also instances of geographic mobility for science practitioners, because in the beginning many of these individuals were itinerant. Furthermore, teachers and students, who came from many different regions of Europe, settled in a particular city for a few years and then moved elsewhere. In Bologna 1265, practitioners from the Romagna province, were joined by others from several realms, such as the French from Île de France, Spaniards, English, Picards, Burgundians, Norman-French, Catalonians, Hungarians, Poles, Germans, individuals from Gascony, Provence, Poitou, and Touraine. In such cases, there was no brain drain; instead, migration was seen as a brain gain since it afforded access to the benefits of science as scholars return to their home town (Kibre, 1948).

Mobility became a precondition to scientific growth and to dissemination of knowledge. In the view of several authors, to understand scientists' migration dynamics better, it is necessary to comprehend, on the one hand, the presence of an external attraction, and on the other, the lack of scientific policies to enhance the cultivation of science in the home countries.

Research on Latin-American brain drain

The migration of highly qualified scientists is a growing concern that is frequently incorporated to plans and policies on technological and scientific development in Latin America. From the point of view of these countries this is a negative phenomenon because migration involves great loss of talent. This phenomenon counteracts the efforts carried out by the governments of these countries to be inserted in the so called «knowledge society». The brain drain, as scientists' migration is known, is partially originated because most developed countries act as poles of attraction for scientists and technicians of countries in the periphery.

In a 1966 path-breaking conference, the notable Argentinean scientist Bernardo Houssay stated that the problem of migration, known also as *leak of talents*, was «particularly severe for nations in process of development, as this phenomenon deprives these countries of elements that should act as decisive factors of evolution that should convey them to higher levels of economic progress and social organization». Temporary emigration is beneficial, as it promotes learning and improvement of citizens of Third World countries, but, on the contrary, *permanent emigration damages these countries seriously*. Losing potential intellectual capital represented by committed youths is, in his opinion, a kind of suicide. Most emigrants go to the United States, but another important contingent goes to Europe.

The deficit of professionals and scientists in developed countries is a force of attraction for Latin American highly trained resources. Three main causes that would incite a scientist to emigrate are synthesized as follows: full confidence about himself, dubious confidence about the country and lack of scientific tradition in his country of origin. Scientists willing to emigrate decide to do so because they are seeking:

(a) Greater prestige;
(b) Better working life;
(c) To improve their know-how and their capacities;

(d) Better future in their scientific career and better social acknowledgement.

As can be inferred by the above research, scientists' emigration has had a negative connotation in Latin-American scientific literature. The phenomenon is being regarded as a human capital loss, strongly decreasing the quality of national development strategies. From a more radical point of view, like the «theory of dependence», migration of talents is regarded as another dimension of the looting effected on Third World countries, because brain drain costs these countries many millions of dollars per year invested in the education and training of people who, when graduated, are incorporated to the qualified labor force of developed countries (Houssay, 1966).

Currently, this phenomenon is also recognized by the World Bank: «More than one million students of developing countries conduct their tertiary studies abroad; many of them, especially the ones that obtain a doctorate, never return to their native land, where the opportunities are usually scarce and with low salaries. Some of the better students formed in developing countries emigrate also for the same reasons. These two types of emigrants represent an important loss, with consequences even more serious, because their education is total or partially subsidized by the State» (World Bank, 1999).

From a liberal perspective, emigration is considered as a normal flow in the human capital market. The fact is, as this perspective recognizes, that massive migrations of Third World country scientists are not compensated with an equivalent incoming flow.

From individual migrants' perspective, however, they feel attracted by the prestige of the universities in developed countries, which are regarded as an obligatory stage in the education and training of researchers and highly qualified scientists. On the other hand, higher education has become a flourishing and competitive market in developed countries.

«In this market, the universities are positioned now in function of their capacity to receive foreign students. As a result of this, specific programs for Third World countries students proliferate» (Albornoz, *et al*, 2002: 69).

Brain drain in numbers

According to data from the International Labour Organization (ILO), developing countries lose between 10 % and 30 % of their human resource in science and technology (HRST) to industrialized countries (Lowell and Findlay, 2001), and in some regions of the world the outflow is considerably higher. For example, it is estimated that nearly 75 % of all individuals from Africa, 50 % of those from Asia and 47 % of those from Latin America who migrate to industrialized countries possess tertiary qualifications. Another estimate indicates that at least 400,000 scientists and engineers from developing countries are carrying out research and development activities in industrialized countries, compared to approximately 1.2 million involved in such activities in their countries of origin (Meyer and Brown, 1999).

It is difficult to estimate the magnitude of brain flow with reasonable certainty, as there is no accurate international system of information for recording the volume and education of migrants, while at a national level many countries of origin do not collect such information on their emigrants. A recent contribution of great relevance is the database prepared by Adams (2003) for the World Bank which includes HRST source countries. It uses estimations on education levels and the volumes of migration from United States and OECD databases. Adams' estimations (2003) are based on 2000 data and update those that Carrington and Detragiache (1998) prepared for the International Monetary Fund (IMF) using data from 1990.

According to the Open Doors Report on International Educational Exchange 2008, of the Institute of International Education (IIE, 2008), in 2007/2008, 126,123 international scholars were teaching or conducting research at U.S. campuses, an increase of 8 % from the previous year. The top 20 places of origin of International Scholars, 2006/07 & 2007/08 are shown in Table 1.

Table 1. Top 20 places of origin of international scholars, 2006/07 and 2007/08.
Source: Open Doors Report on International Educational Exchange 2008, IIE
(http: // opendoors.iienetwork.org/page/131572/)

Rank	Place of Origin	2006 - 2007	2007 - 2008	2007 - 2008	
				% of Total	% Change
	WORLD TOTAL	**98,239**	**106,123**	-	**8.00**
1	China	20,149	23,779	22.40	18.00
2	India	9,138	9,959	9.40	9.00
3	South Korea	9,291	9,888	9.30	6.40
4	Japan	5,557	5,692	5.40	2.40
5	Germany	5,039	5,269	5.00	4.60
6	Canada	4,398	4,758	4.50	8.20
7	France	3,588	3,802	3.60	6.00
8	Italy	3,148	3,273	3.10	4.00
9	United Kingdom	2,877	2,823	2.70	-1.90
10	Spain	2,193	2,320	2.20	5.80
11	Taiwan	1,813	2,185	2.10	20.50
12	**Brazil**	**1,862**	**2,071**	**2.00**	**11.20**
13	Russia	2,102	1,945	1.80	-7.50
14	Israel	1,591	1,698	1.60	6.70
15	Turkey	1,362	1,539	1.50	13.00
16	**Mexico**	**1,218**	**1,396**	**1.30**	**14.60**
17	Australia	1,175	1,163	1.10	-1.10
18	Netherlands	959	1,018	1.00	6.20
19	Poland	877	840	0.80	-4.20
20	**Argentina**	**834**	**781**	**0.70**	**-6.30**

The case of Mexico

The principal country of destination for HRST emigrants has traditionally been the United States. We can estimate how many Mexicans educated to tertiary level reside in the United States thanks to the availability of information used to measure the volume of human resource migration towards the United States, and determine their level of education (Adams, 2003). However, this information is not available for the other destination countries receiving Mexican HRST.

Tejada and Bolay (2005) assert that in 2000, Mexico was the principal source of emigrants to the United States with a total of 6,374,825 (migrants over 25 years old). It is also the principal country of origin for human resources with a tertiary education (Adams, 2003), with a total of 895,515 Mexicans fitting this category, 6.67 % of whom had undertaken higher studies (postgraduate, Master's degree or PhD). These figures are quite high, considering that almost half of Mexican adults living in the United States in 2000 had only completed primary education, and they show that the most important migratory flow in America at present is that of low-skilled workers originating from Latin American countries, especially Mexico, and moving towards the United States (GCIM, 2005).

The marked trend to migrate to the United States as the principal country of destination for Mexican migrants can be observed also in student preferences of where they choose to study. Data from the Atlas Student Mobility (Open Doors Report on International Educational Exchange, IIE, 2008), in Table 2, show the top 10 destinations and total number of Mexican students studying abroad in 2007. This distribution is expressed graphically in Figure 1.

Table 2. Top 10 destinations of Mexican students abroad in 2007.

TOTAL	24,073	%
United States	13,644	56.68
Spain	3,200	13.29
United Kingdom	1,843	7.66
France	1,440	5.98
Germany	1,174	4.88
Australia	416	1.73
Sweden	171	0.71
Italy	164	0.68
Switzerland	137	0.57
Japan	132	0.55
Rest of the world	1,752	7.28

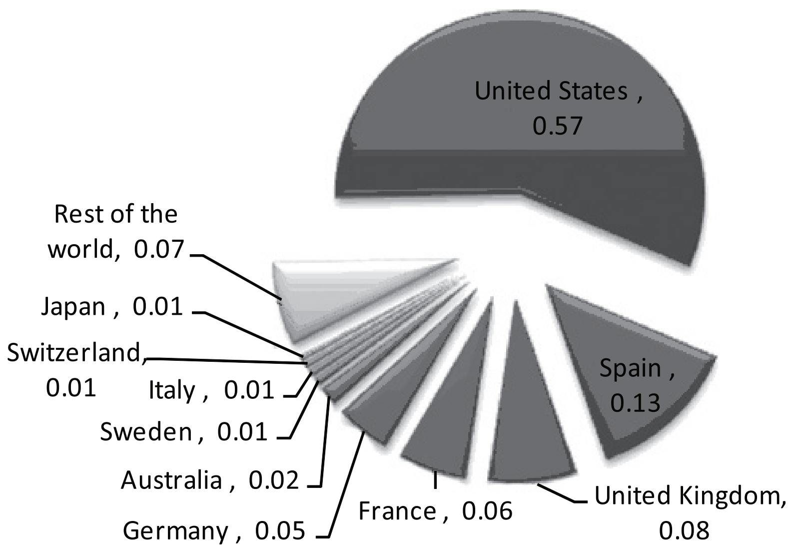

Figure 1. Distribution of the top 10 destinations of Mexican students abroad in 2007.

As Table 2 shows, potentially, the brain drain towards the United States is much higher than any other country in the world. Mexican students primarily choose to study abroad in either the United States (57 %) or the European Union (33 %). These two areas by themselves add up to 90 % of the total.

CONACYT, the National Council for Science and Technology, which has been the major provider of graduate scholarships since its inception in 1970, has throughout its history led to an increase in the development and training of human resources dedicated to the production of scientific knowledge and technological innovation in Mexico. The graduate Scholarship Program has also been one of the main sources of support for Mexicans wishing to continue their education either in Mexico or abroad. CONACYT estimates that about 75 % of the scholarships offered by public and private institutions in Mexico are granted through its own Scholarship Program (Ortega Salazar et al., 2002).

The CONACYT Scholarship Program has been justified in different ways throughout its history. However, it is invariably recognized that graduate education –in all fields of knowledge — is an important contribution for the country's development. In the decade of the seventies, in addition to fulfilling the essential objective of facilitating graduate studies, the Program was oriented to increase the stock of professionals and to complement their education with short-term specialized courses. In addition, support was granted for the conclusion of thesis and for language courses.

In the following decade, the Program was oriented to teacher training with the aim of strengthening the university and the national graduate system, the research centers and institutes, as well as industry in general. The most important impulse was directed at the education and training of university cadres. Scholarships were granted for specialization and master's level studies, and to a lesser degree in doctoral studies.

In the nineties, the Scholarship Program was focused exclusively on graduate education, and the upper nineties period, decidedly on doctoral education. In this period, special attention was placed on performance and merit, and continued emphasis was placed on the quality of the program to which the student aspired to participate in.

In that same decade, scholarship demand expanded exponentially, in contrast with previous years, as can be seen in Figure 2.

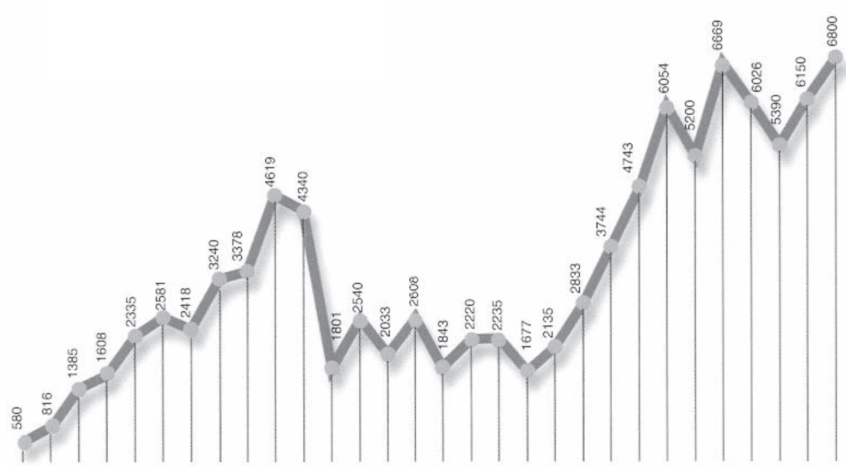

Figure 2. Distribution of scholarships awarded from 1971 to 2000. (CONACYT, 2000)

As Figure 3 shows, the greater part of total scholarships awarded by CONACYT are granted in the areas of applied sciences, engineering, natural and basic sciences, and administrative and social sciences.

For each 100 scholarships, 28 were awarded in engineering, 23 in the area of natural and basic science, and 19 were awarded in social and administrative sciences. This proportion diminishes to 10 % for the areas of human and behavioral sciences; and to only 6 % for the health sciences.

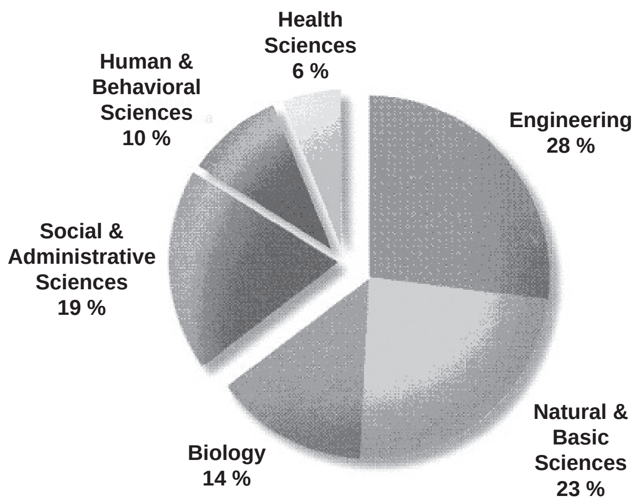

Figure 3. Distribution of scholarships by area of knowledge 1971 — 2000. CONACYT (2000).

In thirty years of the Scholarship Program (1971–2000), a total of 100,021 scholarships were awarded, with 74 % of these being for studies in Mexico and 26 % for studies abroad, as shown in Figure 4.

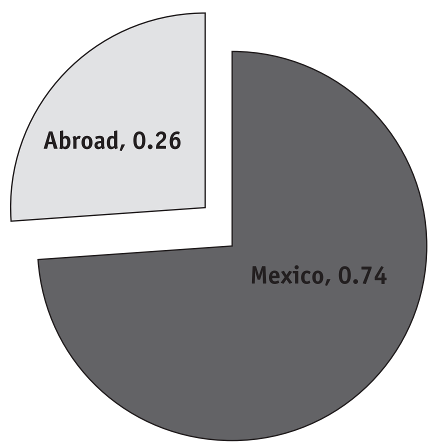

Figure 4. Scholarships awarded by CONACYT during the period between 1971 and 2000.

Most of the scholarships for Master's degrees are awarded for studies in Mexico, while the majority of doctoral studies are conducted abroad. More than half of the scholarships granted for study abroad were assigned to institutions of higher education in the United States. In order of importance, the remainder was for studies conducted in France, Great Britain and Spain. CONACYT believes that its Scholarship Program for postgraduate study abroad forms part of the internationalization of science and technology and allows the country's researchers to keep in contact with the global scientific community (Valenti, 2002).

CONACYT optimistically estimates that only 5 % of former scholarship holders live and work outside Mexico, and thanks to the major opportunities and the low level of unemployment in Mexico, only 4 % of the 26 % Mexican former scholarship holders who received a job offer from abroad actually accepted. This official data suggest that the Mexican brain drain is not large enough to cause concern, and in fact the CONACYT considers it little more than a fanciful idea (Valenti, 2002).

CONACYT argues that the minimal outflow is a selective loss which is not based on the scarcity of professional opportunities, but rather on the infrastructure limitations confronted by scientific and academic institutions in Mexico, and depends on whether HRST enjoy a satisfactory level of professional development that also allows them to make positive contributions to the institutions in which they work (Valenti, 2002). Despite the fact that the decision to migrate can result from distinct aspirations, it is evident that the main motor behind the intensification of migratory pressures is the non-existence of satisfactory opportunities in the countries of origin (ILO, 2004).

However, Casta os-Lomnitz, Rodríguez-Sala and Herrera (2004), in analyzing students who have acquired their PhDs mostly through CONACYT scholarships, have obtained other results. The authors explored the Mexican brain drain by monitoring full-time academic personnel in institutes for higher education and scientific research who have carried out postgraduate studies abroad during more than one year without returning full time to the institution of origin or who did not become a member of the National System of Researchers (SNI). This is a distinction accompanied with economic stimulus that is granted to scientists who have proven capability for scientific production. The results show that the defection of full-time academics during the period 1980–1991 totaled 953 people, 49 % of whom were located outside of Mexico (external outflow), while 45 % changed institutions upon their return to the country (internal outflow).

Licea de Arenas (2004) studied the brains drained during the period from 1980 to 1998, and observed that 1,678 students received their PhDs from universities in the United States. Of these only slightly more than 20 % applied to the SNI to explicitly seek recognition for their scientific activities. The author refers to those graduates who do not become part of the Mexican scientific community, and who total nearly 80 %, as "cerebros fugados" or *brain escapees*, assuming that only those who belong to the SNI are considered scientists.

The results of these studies question the effectiveness of the CONACYT Scholarship Program in relation to its objective of increasing the formation of human resources dedicated to the production of scientific and technological knowledge in Mexico. Although these studies show that the productivity of the Scholarship Program is not high in terms of returns of HRST to the Mexican scientific community, it is also important to take into account the contribution of repatriates to society in general. Many scholarship alumni return to positions of high responsibility in Mexico and to other professional areas which are of national interest, or even to the academic world, albeit in private institutions, where science is not traditionally cultivated.

Government migrant policies have mainly focused on matters concerning remittances and looking after the interests of Mexican communities in the United States. However, they have paid little attention to identifying the tools and mechanisms that permit the government to interact with HRST expatriates, not only in the United States, but in other destination countries as well, in order to estimate the positive impact of their knowledge, experiences and social resources on development.

It is only recently that the literature on migration concerning Mexican HRST has started to toy with the idea of taking advantage of expatriate élites (Didou, 2004; Licea de Arenas *et al.*, 2003; Casta os-Lomnitz, 2004; Valenti, 2002).

Science policy to reverse the brain drain in Mexico: the Mexican Researcher Retention and Repatriation Program

The strategies employed by the Mexican government to reverse the brain drain have basically been the traditional approaches of retaining, repatriating and attracting HRST.

The Mexican Researcher Retention and Repatriation Program, also known as the "Repatriation Program", was created in 1991 by the Mexican government through CONACYT, its aim being to retain HRST in Mexico and reverse the brain outflow. The institution facilitates the return of Mexican scientists from abroad and seeks to incorporate them into higher education institutions, or scientific research centers, and the SNI, in order to increase and strengthen scientific development and the advancement of human resources in science and technology. According to information from the SIICYT, this program succeeded in repatriating and retaining 1,859 researchers between 1991 and 1999, a figure that corresponds to approximately half of the scholarship students and almost a third of the members of SNI in 1999. The majority of repatriates came from six countries, as indicated in Figure 5.

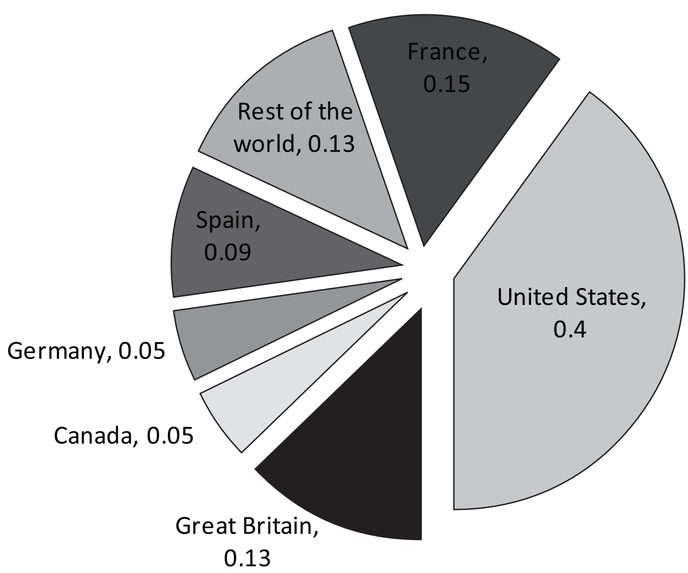

Figure 5. Origin of repatriated researchers reported by the SIICYT in 1999.

According to CONACYT, approximately 1,400 Mexican researchers were repatriated in the period between 1991 and 1997 (an annual average of 200), and this required an investment of approximately 126.6 million pesos during these seven years (approximately US $11.5 million). Despite the elevated cost, the Repatriation Program has not been able to effectively implement its objectives because of the lack of opportunities in Mexico for scientists wishing to return and form part of a research center. Furthermore, the laboratories, equipment and other materials that are needed to guarantee the continuity of the research projects of repatriated scientists are usually insufficient.

In this respect, the Mexican academic sector will unquestionably find itself left behind because of insufficient government support and the lack of alternatives in Mexico. Casta os-Lomnitz *et al*. assert that this situation could, however, be improved if there were stronger links between the private and academic sectors (Casta os-Lomnitz, Rodríguez-Sala and Herrera, 2004). In overall terms, the Repatriation Program does not have the capacity to redress the international imbalances that attract the highly qualified élite towards the centers of major scientific and technological advancements in the industrialized world.

Brain drain or brain gain?

Wagner (2008: 64) states that it is not possible to force a scientist educated and trained in a developed country to return home in the developing world if he or she doesn't wish to do so, but rather wishes to remain in the host country if for nothing else but his or her personal and professional development. Science is, after all, a calling, and as such, a scientist must be expected, and indeed, encouraged, to follow his calling to science over any other, including national allegiance. To do otherwise is at best, naïve, for a scientist will stay anyway, no matter how much beckoning, how much national allegiance is invoked, if he does not find support, recognition and infrastructure to conduct science, to further his academic/professional career.

Some authors (Wagner, 2008; Meyer and Wattiaux, 2006; Mahroum, *et al*, 2006; Tremblay, 2005) have called for a reassessment of the brain drain phenomenon with fresh eyes. They have suggested that all is not lost as highly qualified research personnel and students remain in the developed host country, and they have called to explore the possibility of brain gain. Generally, the notion deals with the idea that even though away from home, highly qualified personnel and students can still contribute to their home countries' scientific and technological development.

Wagner claims, for example, that many researchers maintain some sort of liaison with the home country, through their *alma mater*, or other government research institutions, and thus aid in furthering that country's scientific goals. In particular, their involvement in aiding and promoting other PhD students whom like them, undertake graduate studies abroad. The author explains that many expatriate scientists, well established by now in a developed country and working in research, find ways to contribute to scientific development in their countries of origin. Many accomplish this through international collaboration, as revealed by a study made for the Rand Corporation showing that as many as one third of the scientists who were collaborating internationally, were doing so with someone from their own home country:

"These foreign-born scientists and engineers were also more likely to accept and train talented people from their home country, fueling the cycle of knowledge creation and capacity building" in their own country (Wagner, 2008: 66).

This can be very beneficial, especially for students from non-English speaking countries, where collaboration with someone that shares a cultural common ground can be a most welcome feature when studying abroad, amidst a milieu of strange cultural patterns, customs and behaviors, in addition to the myriad of language-based colloquial idiosyncrasies. Foreign-born researchers thus become important catalysts between the developed and developing worlds, by collaborative research and other ways, like consulting as science advisers to organizations in their home country, and in this way, are helping advance scientific capacity there, many times with funds from developed countries.

Other authors confirm Wagner's assumptions. Meyer and Wattiaux (2006) relate how during the last decade of the twentieth century, groups of highly skilled expatriates originating from developing countries and scattered in the OECD countries emerged and started to make connections among themselves and with their motherland. They introduce the term Diaspora Knowledge Networks (DKN), which, according to the authors, represent a subset of the numerous international knowledge networks. This is an example of Wagner's new invisible colleges, that have long existed in the S&T sphere and that have multiplied and expanded in the last twenty years.

"Diaspora knowledge networks have deeply changed the way in which highly skilled mobility is looked at. They have conceptually subverted the traditional "brain drain" migration outflow into a "brain gain" skills circulation by converting the loss of human resources into a remote although accessible asset of expanded networks" (Meyer and Wattiaux, 2006).

The authors base their position on empirical evidence collected from two networks that came into being in the late 1990s: The Caldas Network (Red Caldas — Red Colombiana de Científicos e Ingenieros en el Exterior) and SANSA (South African Network of Skills Abroad) in association with the University of Cape Town in South Africa. Some of the most salient features and important activities of these two networks, coinciding with Wagner's appreciations, appear to be (Meyer and Wattiaux, 2006: 7–8):

- Exchange of scientific, technical, administrative or political information, as for example in the creation of a new Colombian National S&T system in the early 1990s;
- Specialist knowledge transfer, for example, the agreement between the École Polytechnique Fédérale de Lausanne-Switzerland, and the Universidad del Valle, Cali-Colombia;
- "Scientific or technological diplomacy" or promoting the home country in the R&D and business community of the host country as in the case of South African medical research in England;
- Joint projects, partly on a virtual basis;
- Training: attending home-country sessions and meeting/mentoring students abroad;
- Enterprise creation to assist the possible return of expatriates on a part-time or permanent basis as could be the employing of returnees in science parks;
- *Ad hoc* consultations, for example, on research/development projects.

Both networks, according to the same authors, have had a fair amount of response from expatriates (the Colombian network drawing over 800 members from 25 countries at its peak, and the South African SANSA almost 2500 from 65 countries), although a far cry from the total highly skilled population from those countries that had migrated at some point (10 percent and 25 percent respectively — Meyer and Wattiaux, 2006: 8).

Whereas Meyer and Wattiaux (2006) delve in a more exploratory study concerning diaspora networks, Mahroum, Eldridge and Daar (2006) have a more assertive approach. Their aim is to propose ways in which, given that Diasporas and international labor mobility are a reality that cannot be reversed or diverted, source countries can still benefit from them. The authors go further and identify the single most important actor in the process: those countries' governments themselves.

Increasingly, the authors state (Mahroum, *et al*, 2006: 27), the focus seems to be shifting from viewing migration as a one-way path to conceptualizing it as a dynamic process of networking and linkages. In that light, the approach for source countries requires connecting expatriate knowledge networks through the internet and other means of communication (Mahroum, *et al*, 2006: 28).

"Knowledge and technology transfers are a primary way for developing countries to benefit from highly skilled emigrants...Whether emigrants are permanent, or a short –to medium-term temporary loss, their linkages to their source country create opportunities to increase the available knowledge and technologies to boost productivity" (Mahroum, *et al*, 2006: 29).

This can be done without physical relocation, in what the authors propose as digital knowledge networks, that is, using advanced information and communication technologies and other means, such as online options. Actual cash remittances may be another form of taking advantage of diaspora, and in fact, remittances remain the most obvious benefit, say the authors (Mahroum, *et al*, 2006: 29).

Foreign investments by expatriates in their home countries are another source of benefit from a diaspora. Expatriates are, according to the authors, relatively more likely to invest in their own country of origin, because they are better placed to evaluate investment opportunities and possess contacts to facilitate this process. Expatriates may also encourage investments in their country of origin by foreigners (Mahroum, *et al,* 2006: 31). Government intervention, indicate Mahroum, Eldridge and Daar, can help make things less challenging for expatriates, either in the case of physical repatriation or building of networks:

"In the Republic of Korea, efforts to encourage repatriation have been coordinated by the Ministry of Science and Technology (MOST), and in Taiwan by the National Youth Commission (NYC). In both contexts, government support for development of research centers and high technology clusters has played a key role in the repatriation strategy" (Mahroum, *et al,* 2006: 32).

In addition, Korea has supported and subsidized professional associations of Korean scientists in Canada, China, Europe, Japan and the United States, and China has been trying to attract the Chinese diaspora back to the country. It has financed the development of infrastructure to attract 200 scientists of the estimated 20000 abroad with the promise of "Western-style" salaries. (Mahroum, *et al,* 2006: 32)

Indeed, much can be said in favor of the potential gains to be had from diaspora for source countries, and the move away from viewing these as negative one-way flows of an already factual and irreversible trend as well as the lure to instrument impractical and improbable measures, short of forceful repatriation of scientists. The best stance, in our opinion, is that expressed by the Chinese government, in its efforts to bring back expatriate scientists from abroad: since the country needs to absorb foreign technologies anyway, it was not going to alter its "open door" policy on foreign emigration of allowing students to emigrate, while taking steps to build infrastructure to attract them back. It does not matter that not all students return to the country, so long as some do, even if it is less than half of them (Tremblay, 2005).

Strategies around the world

Various international agencies have recommended making use of the experience and knowledge of HRST expatriates in order to stimulate development. The recommendations go along the line of identifying policies, in the North as well as in the South, which can maximize the net benefits of HRST migration. The International Organization for Migration (IOM) recently launched a number of proposals directed at governments (those of industrialized countries as well as those of developing countries) to promote diaspora as agents of development (IOM, 2005).

We can see that there is a growing need to study new mechanisms, alternative to the traditional repatriation efforts, which have been implemented to reinforce the contributions of HRST expatriates to their countries of origin. We also need to understand the circumstances under which HRST expatriates have been able to contribute to the development of their countries of origin and to identify ways in which HRST expatriates have had a positive impact, if any, on development and poverty reduction in the countries of origin through a systematic use of knowledge, experiences and resources (for example, through their participation in the creation of micro-businesses, employment generation, scientific and technical cooperation, implementation of community development projects, creation of scientific and technological centers, attraction of investment for research and experimental development, etc.).

Recent research suggests that these strategic brain gain mechanisms demonstrate a great potential for mutually beneficial and effective North-South and South-South cooperation. This allows to emphasize the idea that there is another perception of HRST migration from the South that goes beyond the brain drain. These mechanisms can be categorized in three main groups of strategic action; none of them have been implemented in Mexico.

Creation of scientific Diaspora networks

Scientific Diasporas may be organized in networks in which HRST dynamically maintain and advance academic, scientific and entrepreneurial ties with the countries of origin, principally through new communication and information technologies.

Barré *et al*. (2003) state that scientific diasporas are motors for development, since their contributions and proposals can form part of public policies. As such, the role of scientific Diasporas as agents of development in the reduction of poverty and stimulation of growth are becoming increasingly relevant, in a debate that attempts to study the extent to which its potential ensures equal benefits for migrants, host countries and countries of origin (IOM, 2005).

The most representative examples of the impact of the scientific diaspora option are the already mentioned SANSA, from South Africa, and the Caldas Network of Colombia. Both have made outstanding contributions to the development objectives of their respective countries. The Caldas Network of Colombian Scientists and Engineers Abroad was set up in 1992 as an initiative by Colombian researchers and university students residing abroad, and it was one of the first projects in the world to reunite the scientific diaspora of a country, the aim being to link these highly skilled expatriates to scientific and technological activities in Colombia. Studies of the Caldas Network have shown the viability of this new formation of expatriate élites (Charum and Meyer, 1998); and in some cases, the cooperation between the members has endured and reached significant results (Posada Florez, 2002).

Investment in research and experimental development (RED)

Some countries have developed important scientific and technological centers in the countries of origin using the resources of expatriate HRST. The best known example of this is India, which boasts a well developed higher educational system, producing a considerable number of highly skilled HRST who increasingly occupy top positions in the world's most important and prestigious technology firms and research centers, especially those located in the United States.

The reference literature shows how Indian HRST expatriates, especially those residing in the United States, play an strategic role in terms of attracting investment for research and experimental development (RED) in India, the growth of industrial exports, the establishment of health and educational institutions and the creation of a development model that could be used as a blueprint for other developing countries suffering from brain drain (Tarifica Phillips Ltd., 1998; Khadria, 1999; Saxenian, 2000; Khadria, 2003). Some estimates suggest that HRST expatriates have facilitated a third of all the foreign investment in India since 1991 (Tarifica Phillips Ltd., 1998).

North-South Research Partnership Programs

North-South partnership programs encourage the participation of researchers from developing countries in research programs and temporary exchanges which give HRST from the South access to the knowledge, infrastructure and equipment of the North. These temporary exchanges permit the transfer of knowledge, skills and other social and cultural resources in both directions (North-South and South-North), and can be considered as alternative methods for preventing brain drain and transforming it into brain gain.

The end objective of such programs is to ensure that the new experiences and knowledge are applied in the countries of origin of the HRST, thereby contributing to the advancement of sustainable development (Bolay, 2004; Hurni, Wiesmann and Schertenleib, 2004).

Mexico: The drive to innovate

Innovation has for some time been recognized as an effective means to economic development and productivity growth. A path that is even more pressing to developing countries, given the globalized environment where knowledge-intensive production of goods and services is becoming each time more relevant. Historically, however, Mexico's efforts in promoting innovation have been less than vigorous. A recent study by the OECD (the *OECD 2009 Reviews of Regional Innovation: 15 Mexican States*) establishes the following existing conditions:

- Mexico has very high levels of inter-regional disparities in income levels and productivity. Investments in regional innovation systems and technology transfer mechanisms can facilitate the transition to a knowledge economy. Actions are needed to support a transition from "made in Mexico" to "created in Mexico".
- The national policy framework in Mexico does not effectively incorporate the region specific dimension of policies. Regional innovation system approaches can effectively build competitiveness. This is why in many OECD countries, trends in regional development policy, science and technology policy, enterprise policies (sectoral, SME (Small and Medium Enterprises) and FDI (Foreign Direct Investment)) and higher education policies increasingly adopt a regional approach to achieve national goals.

- States are increasingly encouraging clusters and regional innovation systems, but their efforts could be re-focused. Their approach tends to stress regulatory and infrastructure issues, with less attention paid to the policy requirements of knowledge economy factors. There is a positive trend, however, as states are incorporating more civil society actors into the decision-making and implementation process. With respect to clusters, what is required is a more realistic approach to what can be done to achieve critical mass, one option being greater inter-state co-operation. States also need to make more pro-active efforts to integrate S&T and innovation into their broader economic development and competitiveness agendas.

What is needed, however, is a more vigorous public policy to facilitate specially Mexican entrepreneurs with guarantees that these relationships are binding, that the State will not pull out with the next presidential administration, as has been the custom in the past. Indeed, as each incoming president "cleans slate", in terms of presidential initiatives and projects, at times condemning and obliterating the previous president's, simply to gain personal political capital and project his own future in some or other world organization, as was the case with Salinas (1988–1994), Zedillo (1994–2000), and Fox (2000–2006).

What to do?

Long-range national strategic planning

S&T has really never been considered as of national strategic priority in Mexico. Despite pronunciations of the executive power in terms of its importance, this has not been put into practice. The insufficient 0.4 % of the Gross Domestic Product (GDP) assigned year after year, as the S&T budget, is a demonstration of the little interest exhibited by the authorities, no matter which political party is in charge.

"No returns" could be diminished if long-range strategic planning is implemented at the national level. This policy is opposed by the fact that every presidential administration, by law, has to produce a 6-year national development plan in the first months of its administration. Therefore, the new administration may change priorities in terms of the National Scientific and Technological Development Plan. There is not continuity in terms of the realization of S&T development plans because, among other factors, CONACYT's scholarship policy is not linked with a policy of creation of both new S&T positions and centers. In other words, the formation of highly qualified human resources is not coordinated either with the creation of research centers reasonably synchronized with the arrival of new human resources, nor with the creation of new positions in the existing S&T centers. National S&T development plans should be observed irrespective of the federal administration in charge, and should be detached from the executive power and located in the legislature, as it is in many other countries like India.

Since most of the funding to study abroad comes from a single public institution, i. e. CONACYT, national scientific and technological policy should be the guiding principle which dictates the allocation of grants. This strategy, of course, has to have the ability to change as new fields in the world or in the country reach a high priori and the National S&T Plan has to be modified. This is an effective way of really implementing a national plan.

CONACYT has granted approximately nine thousand scholarships to study a PhD abroad from 1971, year of its start-off, to 2000 (SEP-CONACYT, 2000). The distribution of areas of study corresponds approximately to the objectives of the national development plans issued at the beginning of each presidential period. However, since this policy is not linked to a general S&T policy, the efforts do not consolidate in concrete results.

In order to formulate a long-standing scientific policy with a wide community support, a bottom-up planning process, including all stakeholders, should be called for. This process should include the participation of scientists, professors, academic and government officials, non-governmental scientific bodies, as well as science students, NGOs, and representatives of industry and services, and public interested. Appropriate planning methods should be used to let everyone express their views and, with the contribution of all stakeholders, reach a consensus on the long-run objectives science should pursue and the means to approach them. Pertinent methods to conduct such exercise are available, like Fred Emery and Eric Trist's *Search Conference* (Trist and Murray, 1993: 674), and Jiménez's *Reflection and Design Conference.* (Jiménez, 2008: 29).

National planning implies the provision of the proper research environment for the future researchers to develop a successful scientific career. Therefore, the granting of fellowships should be in congruence with the scientific plans to assure the new doctorates coming back to the country in 4 to 5-year time will have an institution in which to unfold their full potentialities according to the specialty they studied abroad, and thus reduce the "no returns".

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