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International Mobility of Researchers and Scientists

Policy Options for Turning a Drain into a Gain

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Abstract

High demand for researchers and scientists has led to an increase in skilled migration in recent years. The paper focuses on improving our understanding of the push and pull factors affecting the migration decisions of researchers and scientists from developing countries and discusses policy options for maximizing the potential gains associated with international mobility of advanced human capital. Evidence suggests that a reasonable salary level should be guaranteed but that return decisions of researchers and scientists are primarily shaped by factors such as the quality of the research environment, professional reward structures and access to state-of-the-art equipment.

Keywords: return migration, mobility, researchers, scientists, brain circulation, diaspora networks

JEL classification: F22, O15, I29

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1 Introduction

Building and maintaining a stock of researchers and scientists able to generate knowledge and innovate are key elements in increasing productivity and global competitiveness. For this reason, countries at the innovation-stage of economic development commit significant resources to graduate education and compete intensely to attract top scientists and researchers. Although mobility is not a new phenomenon, evidence suggests that a high demand for researchers and scientists has led to an increase in skilled migration in recent years. The number of foreign scholars employed by US universities provides an illustrative example. Between 1993 and 2003 this number rose over 70 per cent from about 60,000 to 84,000 scholars, the majority of which were in the hard sciences. A high proportion of these came from developing countries such as China and India (Open Doors 2004).

Developing countries not in a strong position to compete. Much has been written about the emergence of an international labour market for knowledge and talent, its underlying dynamic, and its political and economic impact (e.g. see Jonkers 2004). Notably, the weak position of developing countries in the market for talent has been examined under the heading of 'brain drain'. The problem is both one of stock and flow. According to UNESCO data, developing countries on average feature about 8 times less researchers in R&D per population unit than does the OECD (UNESCO 2004). Moreover, the average tertiary enrolment rate among low-income countries is about 10 per cent, which should be compared to the OECD average of 56 per cent (World Bank 2005). Hence, the effects of an outflow of researchers and scientists could potentially erode the science base of low-income countries without prospects of them quickly being able to replace skilled migrants with young researchers.

Brain circulation as a resource. Traditionally, the literature has discussed skilled migration as a loss of human capital and production capacity. In the 1970s this led to proposals such as a tax on brain drain imposed on nationals accepting employment overseas (Bhagwati 1976). However, the debate has since developed to include such issues as brain gain and brain circulation. Although remaining a concern, skill outflow is increasingly being regarded as a potential resource for the source country. Migrants returning with cutting-edge knowledge and networks of nationals abroad are considered important transmitters of technology and tacit knowledge (Davenport 2004). Drawing on this resource promises to increase source country productivity and develop new markets.

This paper is not intended to contribute to the extensive academic debate on assessing the impact of brain drain and gain on the source country. Rather, it rests on the assertion that—all else remaining equal—return migration and collaboration with nationals living in a foreign country is of benefit for developing countries. The focus of the paper is to try to better understand some of the push and pull factors affecting the migration decisions of researchers and scientists from developing countries. These decisions are not well understood and documented empirically, especially as regards researchers and scientists compared to other highly-skilled migrants. The goal is to tentatively identify and discuss various policy options for maximizing the potential gains associated with the decision of researchers and scientists to migrate on a temporary or permanent basis.

The paper is structured in the following way. Section 2 examines the determinants of migration and return migration drawing on the literature and data from the United States. Section 3 discusses policies for boosting return migration by analyzing individual-based and systemic approaches. Section 4 profiles how permanent migration can be used as a resource for technology transfer and the establishment of knowledge networks and section 5 concludes.

2 Determinants of return migration of researchers and scientists

No clear answers in the literature on the pull and push factors for return migration. Return migration is a multifaceted and heterogeneous phenomenon. Despite a very large literature on brain drain and migration surprisingly few facts have been established about the pull and push factors guiding the decisions of individuals going abroad or returning home. Among frequently sited push factors for migration are such phenomena as an oppressive political system, lack of job opportunities and social problems such as crime, insufficient health care and low quality education. These are counterbalanced by a number of factors that pull migrants back to their countries of origin. Among these are commitment to home, economic growth and increased demand for skills (Marks 2004). There have been few attempts to measure the relative magnitude of these and other factors. Due to lack of comparative data—particularly in regard to mobility of researchers and scientists as a group—our understanding of who returns when and why remains hazy. A deeper understanding of what motivates highly-skilled individuals would be essential to designing effective policy responses.

Neoclassical approach – the importance of wage differentials. As discussed by Cassarino (2004) the debate on return migration can for the sake of simplicity be captured in at least three major schools of thought. A first such 'school' is the neoclassical approach to international migration. At the centre of this approach is the economic gains an individual can achieve by migrating from a low- to a high-income country. In neoclassical economics of migration individuals are regarded as agents who maximize not only their earnings, but also the duration of their stay abroad. Hence, wage-differentials are at the heart of understanding why talented people migrate. No reference is made to the social, institutional and political environment. It follows from this approach that decisions to return are motivated either by diminishing income difference between home and host country or failure to obtain the income expected in the host country (Todaro 1969; Stark 1991).

Transnationalism—strong ties to home country. The transnationalist approach is based on the observation that expatriates keep close personal and financial relationships with the source country and they retain a strong national identity even years after migrating. Driven by shared national identity, migrants establish social networks with other expatriates from the same source country. This common identity perpetuates a commitment to the source country that drives cross-border linkages among nationals and decisions to return. A migrant has thus a natural gravitation towards the home country and repatriation takes place once enough resources, whether financial or knowledge, have been gathered and when the social and economic conditions at home are perceived sufficiently favourable. Hence, the main motivating factor is not one of personal utility but an identity marked by an attachment to one's birthplace (Portes 2001; Brand 2002; Al-Ali and Koser 2002).

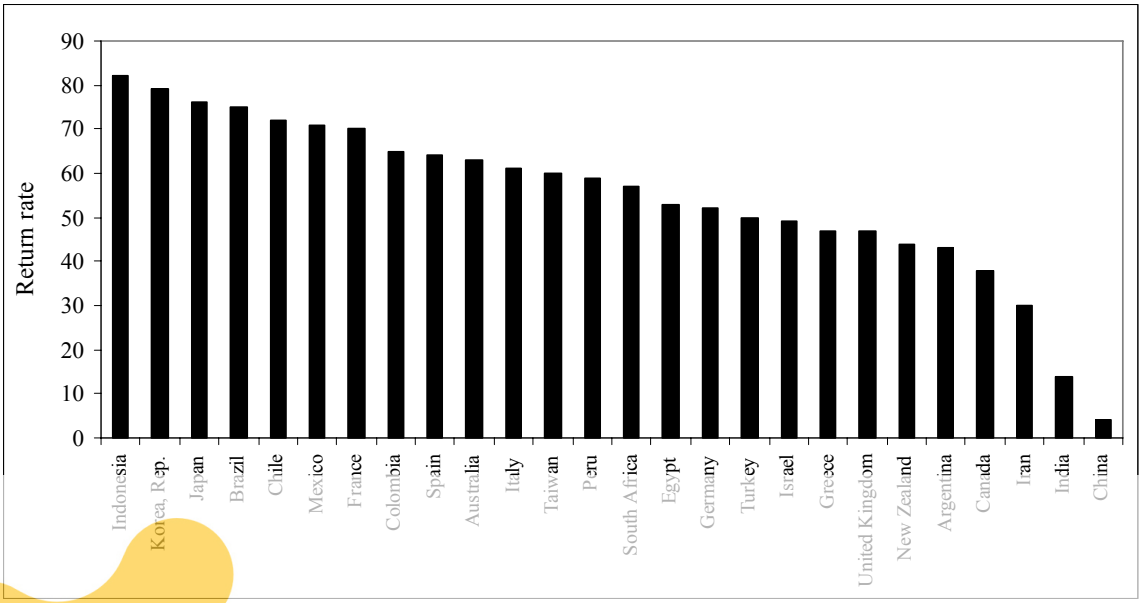
Social network theory—contextual and institutional factors. When transnationalists emphasize the importance of personal linkages and 'natural' gravity towards home, then network theorists emphasize the importance of voluntarily created linkages that are targeted on specific objectives. Expatriates are not passive respondents to social and economic conditions in the home country, but social actors that are motivated by their linkages with home institutions and social capital from which they benefited before migrating. Not only acceptable social and economic conditions are an important factor for returning, but opportunities that the home country provides for making use of the migration experience and established networks. Expatriates are thus regarded as well-informed agents that gather information about context and opportunities in their countries of origin.

Difficult to examine determinants of return migration empirically. The three perspectives outlined—neoclassical, transnational and network theory—provide an important menu of factors expected to shape the decisions of researchers and scientists to return home. However, due to lack of comparable data, these and other factors have not systematically been the subject of empirical research. Drawing on data from the OECD countries, Docquier and Marfouk (2004) have constructed a dataset for skilled workers' emigration rates for about 190 countries which incorporates information on immigrants' educational attainment. However, it is not possible to isolate researchers and scientists as a group. The data lack occupational information and do not differentiate between tertiary degrees.

Significant variance in stay rates among foreign PhD graduates in the US. One of the best available proxies for researcher repatriation are data from the United States on return rates among doctoral graduates in science and engineering (Finn 2003). The data have been constructed using the social security number of foreign doctoral recipients and data from tax authorities. If a foreign doctoral recipient paid taxes on earnings of US$5,000 or more, he or she was considered to stay in the United States. The data show that the proportion of foreigners receiving a doctorate in 1996 still working in the United States in 2001 differs widely by country. Less than one out of five doctoral recipients from China and India had left the United States. In contrast, more than 70 per cent did so from countries such as Indonesia and Brazil (see Figure 1). The data do not include information on the country of residence of doctoral recipients that left the United States. Hence, it should be factored in that not all repatriates returned to their country of origin and that this phenomenon may vary by nationality. Interestingly, the data show that skilled migration is not just a north-south phenomenon, but a multi-directional process. PhD students from OECD countries such as Canada, New Zealand and the United Kingdom show high stay rates in the United States.

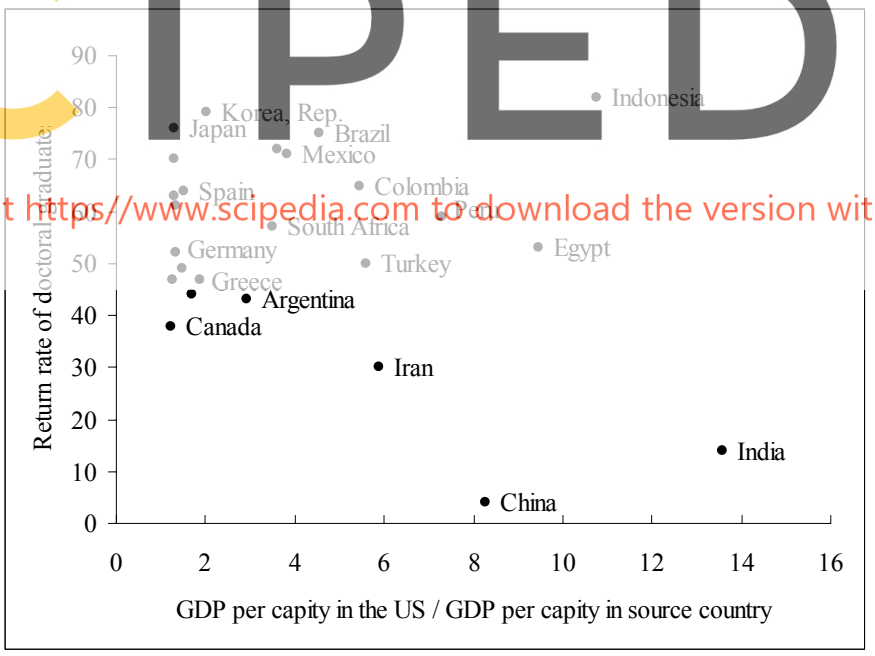
Income differential cannot be established as a strong predictor of return migration. With cross section of 26 countries, the available data are too weak to support strong conclusions based on statistical tests. Therefore, a simple bi-variant analysis was performed to tentatively examine the relation between income differential with the United States and the return rates. Income differentials are obtained by dividing GDP per capita (PPP US$) in the United States by the same variable for each country in the sample. The result is depicted in Figure 2. Based on the data available no simple correlation appears to exist between return migration and differences in income. A weak negative correlation is driven by two outliers—China and India. Indonesia, on the other hand, is a country where both income difference and return rates are high.

Figure 1 Percentage of temporary residents receiving a PhD in science and engineering in the United States in 1996 who had left the United States by 2001



Source: Finn (2003).

Figure 2 Correlation between return rates and income differential with the US, 2001



Source: Finn (2003) and World Bank (2005).

The available data do not allow an assessment of the impact of social and economic factors. A number of tests were performed to explore the assertion in the transnationalist approach that individuals with strong commitment to their country of origin will return when social and economic conditions at home are perceived sufficiently favourable. Different bi- and multi-variant models were explored using (i) data from the World

Development Indicators on economic growth rates; (ii) data from the WEF Global Competitiveness Report on the rule of law and the quality of public services; and (iii) OECD data on R&D expenditure as a percentage of GDP (World Bank 2005, WEF 2002 and UNDP 2004). However, none of the tested models were statistically significant. Consequently, the available data do not shed much light on what motivate researchers and scientists to migrate and return to their country of origin.

Do researchers and scientists constitute a distinctive group? Mahroum (2000) introduces a number of useful distinctions when analyzing the push and pull factors for skilled migration. He argues that large inter-group differences exist as to what guide decisions to move overseas. Engineers and technicians, for example, are reportedly pulled and pushed primarily by economic factors. They go where their skills are most needed and most rewarded. In contrast, mobility among researchers and scientists is a normal part of scientific life and a well-established norm. Researchers and scientists are motivated mainly by the content of their work and the concrete conditions under which they conduct their research. This assertion is substantiated by Shapin (1998) who—as part of an analysis of the role of trust in science—finds that scientists are attracted towards expertise and the institutions that have a reputation for being cutting-edge.

Survey data – research environment a key variable. A 2003 survey of foreign researchers and scientists working in Italian research institutes provides interesting qualitative information on some of the pull and push factors for skilled migration. The data find that professional pull factors—broader scope of research activities, job opportunities, access to cutting-edge equipment and the ability to form networks—are among the most important reasons for mobility of researchers and scientists (see Box 1). A reasonable salary level should be guaranteed but is, as suggested by Mahroum (2000), not a deciding factor. Although sketchy, evidence suggests that policies of brain gain should go beyond pecuniary rewards, highlighted by the neoclassical approach. Nuanced policies would have to take into consideration other factors such as those emphasized by the transnationalist approach and network theory without ignoring economic conditions and notably, concrete contextual and institutional factors tied to places of research (Choi 1995). The following will identify several policy options and discuss their viability for developing countries.

Box 1 Survey of pull and push factors for foreign researchers in Italy

The survey included 241 researchers working at 131 institutes. About a third of the respondents came from countries in East Asia, Africa, the Middle East and Latin America. The average age of respondents was 36 years.

Asked to state their chief motivation for leaving their home country the largest number of respondents pointed to a desire to form contacts with other research environments (86 per cent of respondents). Similarly, the desire to get access to scientific equipment (75 per cent) and have great freedom in work and life (54 per cent) were cited as important factors. A considerable number of respondents also indicated as the chief deciding factor an ambition to specialize in a field that was insufficiently developed in their country of origin (58 per cent).

Very few of the respondents cited difficulty in finding work adequate to their qualifications in their home country as their main reasons for leaving (33 per cent). Economic considerations also came well down the list of priorities (41 per cent).

Source: Todisco et al. (2003) and Avveduto and Brandi (2004).

3 Policies of return migration

A strong increase in the demand for skilled relative to unskilled labour has prompted countries to develop policies of return migration. As Table 1 shows, returnees bring with them networks established overseas, through which they can transfer technology, capital and information. They may also have access to foreign markets or imports that have high value in the domestic economy (Zweig et al. 2005). Hence, significant gains in productivity and competitiveness may be associated with luring back researchers and scientists from overseas.

Analyzing policies for return migration and their usefulness for developing countries, this section draws a distinction between 'individual-based approaches' and policies targeting the 'environment for research'. Roughly, the first can be characterized as a short-term policy response that seeks to shape the decisions of researchers and scientists individual-by-individual and the latter a medium to long-term approach that aims to stimulate return by improving framework conditions and opportunities. The two approaches are complementary in the sense that effective policy responses are likely to combine several instruments as both approaches come with benefits and drawbacks.

Table 1 Comparing returnees and domestically trained Chinese researchers, 2001 (per cent)

	Returnees	Domestically trained researchers
Brought in foreign visitors	36.9	16.3
Helped establish international projects	30.8	10.0
Imported foreign technology	47.7	21.3
Imported foreign capital	23.1	6.3

Source: Zweig et al. (2004).

Note: The table uses data from a survey carried out in five development zones: Suzhou, Guangzhou, Shanghai, Wuhan, and Hangzhou. *N* = 145.

3.1 Individual-based approaches

Mechanisms aimed at ensuring return by forcing or obliging the individual. A traditional policy instrument of return migration has been attempts to control the movement of individuals by preventing or restricting the flow of skills or to cancel their negative effects through taxation. The assumption is that the only way to respond to the loss of human capital is to either restrict the outflows or to evaluate its monetary cost and get financial compensation (Bhagwati 1976; Meyer and Brown 1999). From this perspective, excellence in science can be achieved by controlling the human capital component by means of forcing or obliging the individual scientist or researcher to remain in or return to the home country. A current example is Colombia's support programme for overseas graduate studies which requires beneficiaries to return to Colombia within 3 months of graduation and remain in the country for a predefined period (see Box 2).

Box 2 Colombia's COLFUTURO programme for overseas graduate studies

COLFUTURO is a small programme that finances 120 Colombian professionals per year to pursue graduate studies abroad and return to Colombia thereafter. Each student receives a so-called scholarship-credit of a maximum of US$25,000 per year for a maximum period of two years.

The beneficiary must return to Colombia within 90 days of the completion of his/her studies and must stay a predefined period. For students who return to Colombia, up to 45 per cent of the scholarships-credit can be condoned. If the agreement is violated the full amount must be paid back under an accelerated amortization plan.

Source: Angel-Urdinola et al. (2004).

Induce talented individuals to return. Several countries are providing economic support and inducements to lure researchers and scientists home. Malaysia, for example, is providing time-limited tax exemptions to nationals in order to compensate the loss of salary resulting from their decision to return home (Lowell 2001). Another example is the Presidential fund for Retention in Mexico. This fund aims to repatriate experienced Mexican-born researchers who reside abroad, or individuals who complete their PhD or postdoc in a foreign country. The fund covers salary expenses for the first year and expenses of the researcher and his or her family to settle in the selected location. Between 1991 and 2000, more than 2,000 researchers were repatriated at a total cost of 56 million US dollars (NSF 2000).

Targeting individuals is expensive and inadequately addresses the root cause of skilled migration. Repatriation programmes may bring back some researchers and scientists, but come with an inherent risk that the sector issues that made the individual leave in the first place still persist. In such cases, repatriated researchers and scientists are likely to migrate again at a later stage. Hence, considerable resources may be spent with little long-term impact. Attempts to lure skilled expatriates back to their home countries began in the 1970s but, reportedly, there was little success with these schemes (Marks 2004, Mutume 2003). More recent programmes mentioned above have not been subject to systematic impact evaluations.

Risk that repatriation programmes bring little additionality. Migrants may indeed have a strong commitment to home as the transnationalist approach to return migration suggests (see section 2). A survey of highly-skilled Colombians living abroad showed that three out of four respondents were considering returning to their home country. Only 20 per cent thought they would never again live in their country of origin (Meyer et al. 1997). If a majority of expatriates are expected to return, providing strong incentives to them may add little value. Ideally, programmes should be targeted at individuals whose preferences are such that he or she would return only if an inducement is offered. Governments typically have no means of identifying such individuals or assessing the required size of the inducement. Hence, imperfect information is expected to reduce the welfare gains associated with individual-based repatriation programmes.

Adverse selection and problems of conflicting incentives. Governments may also face adverse selection problems when trying to repatriate researchers and scientists individual-by-individual. There is reason to believe that the researchers and scientists

abroad attracted by such programmes may be the individuals with the least opportunities and qualifications (Angel-Urdinola et al. 2004). Again, the more targeted the programme and the better the information, the larger the expected welfare gain. Another concern is conflicting incentives. Programmes of inducements attract researchers and scientists back, but they may paradoxically also provide an incentive for individuals to leave the country as a reward awaits upon their return. On the one hand governments want to repatriate skilled scientists but on the other hand, if a stay abroad becomes a condition for getting top positions or salaries in the home country it may encourage migration, which is exactly the problem that they are trying to solve (Dillon 2001).

3.2 Creating a conductive environment for research

In contrast to repatriating researchers and scientists individual-by-individual, systemic approaches draw attention to some of the general institutional and contextual problems that triggered skilled migration in the first place. As such they are long-term policy responses that often integrate scientific, technological and economic dimensions. It is beyond the scope of this paper to cover all the measures developing countries can sensibly take to improve their national environment for research. Hence, the purpose of this section is to touch on a number of themes and raise questions for further investigation.

Retain and attract researchers and scientists by strengthening national innovation systems. Several analyses point to the important role of national innovation systems in shaping the inflows and outflows of highly skilled people (e.g. Mahroum 2000). Strengthening each element of an innovation system—private enterprises, public research institutes and universities—and articulating their relationship to one another is expected to create opportunities for research, innovation and entrepreneurship (Lundvall 1992). As the survey data presented in section 2 suggested, such opportunities may—to a greater extent than individual economic inducements—stimulate an inflow of researchers and scientists. As pointed out by Meyer et al. (1997) it is not by random that the most successful cases of return policies are found in countries such as Singapore, South Korea and Taiwan, countries with S&T and industrial sectors already quite advanced, where the manpower may effectively be employed. However, the response lies not necessarily in massively boosting spending on R&D beyond the reach of many developing countries. Evidence suggests that much can be achieved by a firm commitment to formulating coherent sector policies, getting incentives and reward structures right and strengthening public-private research linkages (Thorn and Holm-Nielsen 2005).

Competitive funding may improve the environment for research. Adequate funding of science and research is important, but equally important is the way resources are allocated. Many developing countries still manage research funds in a top-down fashion with allocations to universities and public research institutes on the basis of historical precedence and negotiation. The problem with such a system is twofold: first, the system is not based on research output and therefore does not encourage quality research, and second, the system tends to be bureaucratic and inflexible. Although no 'magic bullet' exists, competitive funding—awarding funding to the best research proposals—creates a far better environment for skilled scientists. Competition and transparent review criteria have several positive effects: they encourage quality research, reward the most productive researchers and increase the efficiency of research

funding. The disadvantages of competitive funding are that it tends to encourage short-term, 'safe' research as opposed to more creative, uncertain, long-term projects. Moreover, it generally favours top-quality elite institutions and hence may cause a concentration of resources.

Competitive funding has taken root in several developing countries. The Chinese research system—traditionally modelled on the centrally planned Soviet research system—provides an interesting example. Keen to lure back researchers and scientists, primarily from the United States, the government has implemented a large number of measures to improve the efficiency of its research system. Among the initiatives is the establishment of a number of competitive funds that support research on the basis of transparently selected and peer-reviewed proposals (Jonkers 2004). A similar approach has been adopted in Chile, Brazil, Mexico, Venezuela and Vietnam through the Millennium Science Initiative. This programme supports the set up of mechanisms to competitively select high quality research teams working in science nuclei and centres of excellence. The objective is to demonstrate how to improve the quality of research and provide opportunities for post-graduate training (See Box 3).

Large multi-purpose grants provide focus and stability. It is important for scientists to have the opportunity and security to engage in large-scale ambitious research projects. However, the funding system in developing countries is often characterized by a high degree of fragmentation, which means that scientists have to apply for several relative small grants to cover different costs categories. This is a time consuming process that takes focus away from core activities. A way to address this problem is to award large-scale multipurpose grants, which provide the stability and freedom that scientists need to conduct quality research. It creates a scientific setting that gives the scientist opportunities to plan as well as engage in creative and innovative research. In addition, multipurpose grants given on a competitive basis facilitate the establishment of networks and hence a research environment where talented scientists can get together with a common goal (Thorn and Holm-Nielsen 2005).

Box 3 The Millennium Science Initiative in Chile

Chile: Millennium Science Initiative (1999–2002) was designed to revitalize Chile's S&T system by supporting advanced training of human capital by world-class scientists engaged in cutting-edge research. The project provided competitive, merit-based grants to three scientific institutes and five scientific nuclei (selected from amongst 75 applicants).

The final evaluation report concludes that the programme helped establish a fair, open and merit-based selection process, which was welcomed by the scientific research community. In addition to assuring that the grants went to the most qualified researchers, the established process influenced other scientific funding mechanisms in Chile, prompting them to conform more closely to international best practice. The possibilities to fund high quality research projects attracted several Chilean scientists of international repute back to Chile. Moreover, about 40 per cent of PhDs and postdocs in supported centres and nuclei were foreigners conducting their research in Chile. Although the initiative ended in 2002, its achievements were carried on through subsequent programmes.

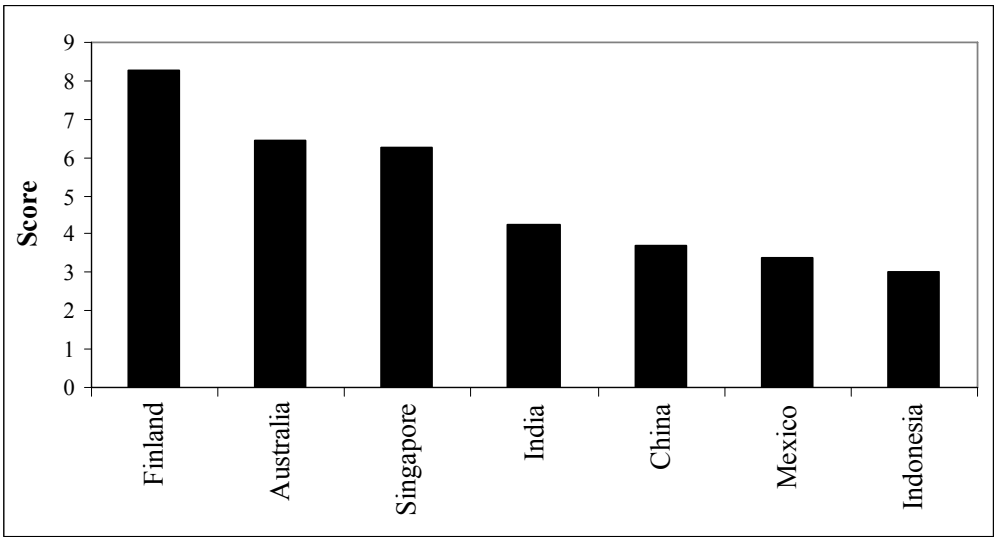
Source: World Bank (2002).

Reward structures are fundamental to reverse migration. In order to attract, retain and motivate young skilled scientists, reward structures that focus on merits are needed. Universities in the United States are particularly attractive because of their flexible and open career structure. The tough but transparent and fair career structure provided by the US tenure track system, which lays out a clear path for advancement, is especially attractive for talented young researchers and scientists (Bosch 2003). In contrast, many developing countries reward seniority (Hansen et al. 2002). A pay scale based on age does not provide accountability for performance and undervalues young researchers. Regulation and enforcement of intellectual property rights also have bearing on the attractiveness of a research environment. Lack of clarity and weak protection of intellectual property lowers the expected private return for researchers and scientists engaged in innovation.

Creating job opportunities for young researchers. Young researchers are often faced with a lack of employment opportunities in their country of origin. Few jobs for individuals with advanced degrees may be available, and those that exist represent poor financial rewards and inferior working conditions and facilities. To lure back researchers in their most productive years, several countries have launched initiatives to provide attractive opportunities for early career researchers and scientists. The strong focus by Taiwan in strengthening the island's infrastructure for S&T together with the creation of science-based industrial parks has opened many new avenues for young researchers returning from overseas to begin new challenging careers. Most employees hired to work in the science-based industrial parks are junior professionals returning from United States. Moreover, the private sector plays an active role in recruiting young researchers working overseas (NSF 2000).

University-industry collaboration is a central part in improving opportunities and conditions for researchers. Many developing countries have little tradition of cross-sectoral research collaboration and private sector involvement in R&D (Figure 3). In some countries industry does not represent a significant stimulus for the reform or expansion of graduate education in science and engineering (NSF 2000). Linkages between academia and industry are essential for developing an entrepreneurial culture in education and research and for strengthening the private sector's capacity to absorb knowledge (Cohen and Levinthal 1989). Diversified opportunities and possibilities to conduct cutting-edge research in innovative settings may create strong incentives for young scientists to return from overseas. The São Paulo region in Brazil, for example, features a mature science cluster, which has fuelled the emergence of one of the largest and most diverse production centres in Latin America. While the reasons for this are many, the strengthening of advanced education and policies to break down barriers between sectors have undoubtedly contributed to the state's economic success (Thorn and Holm-Nielsen 2005). Data are yet to show the impact of these efforts on return migration, although it should be noted that Brazil features one of the highest return rates among researchers earning their PhD in the United States (recall Figure 1).

Figure 3 Knowledge transfer between universities and industry in selected countries, 2003



Source: IMD (2003).

Note: The data reflect the perceived degree to which 'knowledge transfer between companies and universities is highly developed'. The data have been normalized on a scale from 1 to 10.

Table 2 Return rates of Chinese graduate students, 1957-99

Year	Number of graduate students graduating in China	Annual number of graduate students returning from overseas
1957	1,723	347
1965	1,665	199
1975	—	186
1985	17,004	1,424
1995	31,877	5,750
1996	39,652	6,570
1997	46,539	7,130
1998	47,077	7,379
1999	54,670	7,748

Source: China Statistical Yearbook (2000: 685).

Strengthening tertiary and notably graduate education. Evidence suggests that return migration of researchers and scientists is closely linked to the quality of tertiary institutions. Institutions with a strong prestigious background and reputation of scientific openness can capitalize on its prestige to attract the best scientists from around the world (Mahroum 2000). In China reverse migration is an integral part of the goal of establishing world-class higher educational institutions and developing its scientific and research base. Over the past two decades, the Chinese government has strengthened

graduate education and encouraged people trained overseas to return. The results are encouraging. Between 1995 and 1999, the number of graduate students returning from overseas increased at an average annual rate of more than 10 per cent (see Table 2). Since 1999, the return flows have risen further. According to Zweig et al. (2004), the number of returnees almost doubled between 2001 and 2002, reaching close to 18,000 in 2002. While the general boom in the Chinese economy has been a driving force, the set-up of a well-coordinated educational environment has played an important role. An example is the establishment of a special professorship system aimed at attracting outstanding young scientists. The goal is to boost teaching and research in Chinese universities and provide incentives for more diversified careers (NSF 2000).

4 Using researchers and scientists overseas as a resource

People move because of their desire to exploit the best opportunities. Yet, having moved abroad they retain connections and networks back to their home country. Technology transfer is a little studied outcome of high skilled mobility, but one that theoretically can yield significant economic benefits.

Significant gains associated with technology transfer from high- to low-income countries. Recent research supports Gershenkron's (1962) classic point about 'advantages of backwardness'. Investments in R&D buy greater increases in productivity for countries far from the technology frontier than for countries at the innovation-driven stage of economic development that must invent the new technologies that push the frontier forward. In a study on R&D and development, Lederman and Maloney (2003) find that the return to R&D in the average OECD country is somewhere in the range of 20-40 per cent. For medium income levels, such as Mexico and Chile, the average return is around 60 per cent and for relatively poor countries, such as Nicaragua, the average return is closer to 100 per cent. Thus, evidence suggests that using existing knowledge and technology allow developing countries to 'harvest low hanging fruits'.

...but tacit knowledge makes technology transfer difficult. Knowledge in codified form, e.g. written down, expressed in a formula, or in a design is relatively easy and almost freely transferable. For this reason, spillovers of codified knowledge are near to perfect. However, it is often impossible or too costly to codify all knowledge and part of it will remain tacit (Canton 2004). Transfer of tacit knowledge involves human interaction either by means of collaboration through personal interaction, research projects, networks and clusters or by means of human mobility. Intrinsically knowledge moves with people and networks and clusters are formed by personal relationships. Hence, stimulating the formation of networks with expatriates may be an important ingredient in boosting the transfer of technology and knowledge from high- to low-income countries (Thorn and Holm-Nielsen 2005).

Regarding expatriates as a resource for the home country. No matter how well-designed return migration policies are, some expatriates are not likely to return, at least not in the short term. Hence, there is a growing realization among developing countries that skilled workers will continue to migrate and that properly managed and harnessed, they can be a powerful and useful asset (Marks 2004). For this reason, developing countries increasingly depart from the traditional 'brain drain' perspective, which treats

emigrants as being irreparably lost to the home country. Instead, recent policies draw on the commitment and positive identification to home among expatriates as highlighted by the transnationalist approach. Highly skilled migrants are believed to play an increasingly important role in establishing and maintaining long distance interactions between research and innovation systems. Saxenian (2003) for example identifies a group of transnational entrepreneurs, consisting of skilled persons that commute back and forth linking high technology clusters in Taiwan and China to high technology regions in the United States.

Creating networks with nationals abroad. Diaspora policies are among the most recent initiatives that have come under full implementation in regard to skilled migration. They differ from return policies in the sense that they do not aim to physically repatriate nationals abroad. Diaspora policies aim at mobilizing the latent resource of nationals living and working in another country wherever they are located by creating formal, institutionally organized networks where ideas and knowledge can be exchanged. A promising perspective in such a strategy is that through the expatriates, the country may have access not only to their individual embodied knowledge but also to the socio-professional networks in which they are inserted overseas (Meyer and Brown 1999). An advantage of the diaspora option is that international linkages and networking does not require large infrastructural investments, as it consists in capitalizing on already existing resources. Hence, in theory, diaspora policies may bring significant benefits to developing countries at relatively little cost. The Internet has played a key role in giving momentum to diaspora initiatives as it provides a forum for the exchange of information irrespective of geography and time. According to Lowell (2001), 41 new e-based expatriate networks were founded during the 1990s.

Examples of diaspora networking linking expatriates. The South African Network of Skills Abroad (SANSA) established in 1998 is an example of an active diaspora network. SANSA has more than 2,200 members in 60 countries of which 85 per cent have received their education in South Africa. The goal of SANSA is to connect highly skilled expatriates in the field of science and technology with their counterparts in South Africa to create an environment for collaboration and skills transfer. The network was initiated by the Science and Technology Policy Centre at the University of Cape Town. SANSA has enjoyed success through the creation of an online community of local and expatriate South Africans who share a concern and passion for the country's development. This network is now managed by the National Research Foundation, a government supported research organization (Marks 2004). Other examples of diaspora networks are the Chinese Scholars Abroad (CHISA), the Colombian network of scientists and research professionals (Red Caldas), the Arab Scientists and Technologists Abroad (ASTA), and the Silicon Valley Indian Professionals Association (SIPA) (DESA 2004).

Common characteristics of diaspora networks. Brown (2000) finds that diaspora networks are similar in terms of their organization and administration. They all have a website used to disseminate information and compile member data which members can use to search for potential partners and network members in similar fields and geographical locations. Although generally perceiving themselves as independent organizations, most diaspora networks have links to government institutions such as departments of science and technology or education. These linkages suggest that some institutional support is necessary in order to stimulate action and concrete, purposeful activities that enable networks to fulfil their goals.

Are diaspora policies effective? There are few examples of diaspora networks in developing countries successfully making the transition from the initial start-up to a period of consolidation. Although CALDAS—an ambitious network of Colombian scientists and engineers abroad—showed a lot of promise at its inception as documented by Meyer et al. (1997), it eventually lost momentum and did not develop into the resource for Colombia originally envisaged. A key lesson learned is that researchers and scientists, situated next door or connected through international networks, must find it professionally relevant to interact and exchange information. An inherent problem of diasporas is indeed that they are heterogeneous and scattered. Hence, cognitive distances between potential partners make substantive collaboration difficult. Another difficulty is the lack of rewards and incentives tied to diaspora networks. Expatriate researchers and scientists are accountable to institutions in their host country and may not have the time or energy to contribute to ambitious projects or network activities. Hence, developing countries are well advised to be realistic about their impact and use the diaspora option in combination with other policies.

5 Conclusion

Based on three schools of thought—the neoclassical, transnationalist, and network approach—this paper discussed determinants of return migration. The available data do not allow firm conclusions to be made on the basis of empirical tests. Anecdotal evidence suggests, however, that return decisions of researchers and scientists are shaped by factors such as the quality of the research environment, professional reward structures and access to state-of-the-art equipment. A reasonable salary level should be guaranteed but appears not to be a deciding factor. A deeper understanding of what factors influences international mobility of researchers and scientists would be essential for designing policy responses that effectively stimulate 'brain gain' and 'brain circulation'.

Significant gains in productivity and competitiveness are associated with attracting and luring back researchers and scientists from abroad. For this reason, countries—at all levels of economic development—are designing policies of return migration. Individual-based policy responses regulate the flow of individuals or bring back researchers and scientists from overseas by providing an economic inducement. It was established that such policies are intrinsically difficult to design due to imperfect information about the propensity of expatriates to return, problems of adverse selection and conflicting incentives. Moreover, individual-based approaches do not address the systemic problems that motivated researchers and scientists to migrate in the first place.

Systemic approaches seek to attract and lure back researchers and scientists by strengthening the home country's national innovation system. Their main weakness is that developing countries often are not in a position to boost investments in R&D. There may, however, be something to gain from getting incentives and reward structures right. An approach successfully adopted by several developing countries is to fund research through competitions based on transparent eligibility and selection criteria. Other ways to attract researchers and scientists include linking career progression to performance rather than seniority and diversifying employment opportunities by strengthening public-private research collaboration.

Diaspora policies—creating formal, institutionally organized networks with researchers and scientists living overseas—are among the most recent initiatives that have come under full implementation. An advantage of the diaspora option is that it does not require large infrastructural investments, as it capitalizes on already existing resources. Hence, in theory, diaspora policies may bring significant benefits to developing countries at relatively low cost. Despite their intuitive appeal, diaspora policies are not a universal solution. Substantive collaboration is often made difficult by a low degree of commonality among expatriates and lack of time and incentives for these to contribute to ambitious network projects and activities.

This paper has made a first attempt to analyze return decisions among researchers and scientists and profile policy options. As is evident from the analysis, there is a clear need for more policy-related, evaluative research covering both high- and low-income countries. Much more could be known about the cost-effectiveness of return migration policies. This is not an academic exercise. Turning a drain of researchers and scientists into a gain is central to diversifying economies and placing developing countries on the path to sustainable growth.

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