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The Global Competition for Talent
Mobility of the Highly Skilled

Chapter 2

Knowledge Diffusion and Impacts of International Mobility

This chapter reviews the literature and the evidence on how the international mobility of skilled people influences the diffusion of knowledge across borders. It discusses recent analyses of the significance of the mobility of human resources in science and technology for knowledge formation and use, the motives for this migration, and the effects of mobility on both sending and receiving countries.

Why is mobility important?

The importance of the mobility of human resources for science and technology (HRST) stems from two dimensions of knowledge creation: formal (codified) knowledge and the diffusion of tacit knowledge. Each requires specialised human expertise, and each is vital for innovation. It is widely argued that the production and dissemination of codified knowledge is increasingly important in modern innovation (Cowan and Foray, 1997). The continued growth of formal research and development (R&D), the expansion of scientific publication and the rapid rise of patenting attest to this. Abramowitz and David (1996) argued that the secular expansion of education and the growth of occupations for HRST are in fact driven by the enhanced codification of technological knowledge. Tacit knowledge is often a vital complement to codified knowledge. At its broadest it refers to any knowledge that cannot be codified and transmitted through documentation, academic papers, lectures, conferences and other communication channels. Other, narrower, definitions focus on contextual understanding – the idea that people can be perceptually or intellectually aware of certain things that help them to interpret and make use of information but cannot easily communicate this awareness to others. In explaining why some knowledge cannot be codified, Gertler (2003, p. 78) says:

> "… the tacit component of the knowledge required for successful performance of a skill is that which defies codification or articulation – either because the performer herself is not fully conscious of all the 'secrets' of successful performance or because the codes of language are not well enough developed to permit clear explication."

Innovation requires learning and the creation of new knowledge through the use, adaptation and absorption of "what has gone before". Thus, both codified and tacit knowledge are vital, particularly since the latter often provides the spark that leads to advances in science and technology by providing the combination of information and temporal, spatial, cultural and social contextual understanding needed to create something new. For example, Zucker *et al.* (1998, p. 291) commented that mere knowledge of the techniques of recombinant DNA was not enough to allow scientists to take part in the first lucrative burst of biotechnology innovation – "the knowledge was far more productive when embodied in a scientist with the genius and vision to continuously innovate and define the research frontier and apply the new research techniques in the most promising areas".

A key challenge for organisations, both public and private, is how to access the increasing volumes of codified knowledge and how to share tacit knowledge in the workplace and across locations. It is thought that tacit knowledge is shared more effectively when people have a common social context, with shared values, language and culture that facilitate understanding and the building of trust. It is also thought that tacit knowledge is difficult to exchange over long distances (Gertler, 2003, pp. 78-79).

Mobility of skilled people is related both to codification and to tacitness. A great deal of HRST mobility takes the form of movement to places where codified knowledge is produced and used: examples are the movement of full-time students into formal education institutions, and the mobility of graduates and faculty into foreign universities or into formal R&D labs. But mobility is also an important method for transmitting tacit knowledge. In some cases, this knowledge is spread in exchange for a reward, in the form of wages or other remuneration. In other cases, it may take place via knowledge spillovers, with no direct reward to the source of the knowledge.[1] This type of "externality" – individuals, firms and organisations benefit from new knowledge without having to "pay" for it – is one argument for government action relative to the mobility of skilled people.

What induces mobility?

At a general level, economic incentives are a key driver of migration decisions. The flow of people internationally is from countries with low GDP per capita to countries with high GDP per capita, and it increases as the distance between countries lessens (Freeman, 2006). The source countries differ among advanced countries depending on historical ties and the influence of social networks; family reunification often further reinforces the pattern of flows. High-income countries' complementary inputs (such as higher capital/labour ratios, advanced technology and modern infrastructure) often yield striking improvements in income for migrants, compared with their situation at home.

However, recent survey evidence suggests that some distinction should be made between the incentives for migration in general and the incentives for HRST. While general migration has strong economic incentives, and often moves in conjunction with countries' relative economic performance, HRST mobility has additional, and complex, aspects relating to research opportunities, work conditions, and access to infrastructure. These can be compelling reasons to move. Already as students, individuals may opt to study abroad in order to access quality training and facilities and to maximise their work opportunities after graduation. Countries may also encourage their students to study for a time abroad, particularly in specialist disciplines where the domestic supply and demand are insufficient to reach the critical mass needed to achieve satisfactory

quality (Tremblay, 2002). This is common in scientific and technical research, as some experimental techniques involve high equipment and staff costs. The number of foreign students in OECD countries in 2004 exceeded 2 million (an increase of over 40% from 2000), with the United States receiving more than a quarter of the total, followed by the United Kingdom, Germany, France and Australia (OECD, 2007b, p. 53). The increase is likely a response to policy signals from many OECD countries in recent years, particularly concerning possibilities for work and residence following the completion of study.

For those in the workforce, opportunities for better pay, career advancement, higher quality research facilities, work with "star scientists" or in prestigious institutions (and access to the associated social networks), increased autonomy, more transparent systems of recruitment and reward, and freedom to debate are strong drivers of HRST mobility. Mobility is also a means of gaining the necessary credentials for career advancement at home. Ackers (2005) suggests in fact that career advancement in scientific research requires mobility in order to gain the necessary international experience. The weight attached to these various considerations varies among individuals, between genders and over the course of a scientific career, as personal and family priorities change.

Some data are available on the motivations for mobility among skilled people. For example, the OECD, in collaboration with Eurostat and the UNESCO Institute for Statistics, has been working to develop a system of indicators on the careers and mobility of doctorate holders – the Careers of Doctorate Holders (CDH) project. One of the objectives has been to collect data on the reasons or motives for their international mobility. Initial results are now available for the United States[2] and provide some information on motives and their evolution over time. Table 2.1 shows that the availability of scientific or professional infrastructure attracted foreign doctorate holders to the United States. Work or economic opportunities have become more prominent reasons than educational opportunities in the last five years. Family-related reasons are not particularly prominent at the aggregate level.

A study of Australian academic expatriates found that the reasons for moving were mostly employment-related and included better employment opportunities, professional development, career advancement and access to research funding and infrastructure. The reasons given for not returning to Australia were similar, but for those intending to return the focus was on lifestyle and family (Hugo, 2005). Research in Norway has shown that around one-third of the country's foreign researchers moved there for personal reasons and one-third for professional reasons, although "quality of life" factors were also important (Nerdrum and Sarpebakken, 2006, p. 227).

Mahroum (2001) argues that the international movement of the highly skilled differs according to the profession and the type of work. Engineers and

Table 2.1. **Reasons given by doctorate holders for coming to the United States over the last ten years, 2003**

Entered the country in the last five	Citizens of the country (by naturalisation)	Foreign citizens		Total
		Permanent residents	Non-permanent residents	
Educational opportunities in the United States	28.1	14.4	26.0	23.1
Family-related reasons	20.3		6.0	8.9
Job or economic opportunities	25.0	45.6	28.5	31.7
Scientific or professional infrastructure in my field	26.6	40.0	39.5	36.4
All reasons	**100.0**	**100.0**	**100.0**	**100.0**

Entered the country in the last five	Citizens of the country (by naturalisation)	Foreign citizens		Total
		Permanent residents	Non-permanent residents	
Educational opportunities in the United States	19.9	27.4	38.1	31.0
Family-related reasons	32.5	10.7	4.2	10.7
Job or economic opportunities	21.7	29.2	21.3	25.0
Scientific or professional infrastructure in my field	21.1	30.1	35.6	31.3
Other reasons	4.8	2.6	0.7	2.1
All reasons	**100.0**	**100.0**	**100.0**	**100.0**

Source: Auriol (2007).

technicians seem to be attracted by salary and labour market conditions, whereas researchers and scientists are motivated by the nature of the work and the research environment, including the prestige of the institution. According to Nerdrum and Sarpebakken (2006, p. 218), researchers are mobile to "keep up to date with state of the art; to have qualified feedback on the originality, relevance and quality of … [their] own research; and as a source of inspiration". In this case, intellectual curiosity or the opportunity to work with leaders in the field may be an important driver.

Advances in transport and telecommunications have also made international mobility a possibility for many more people. Being able to keep in touch with family and friends and to return home relatively quickly and easily reduces the personal costs of both permanent and temporary migration.

As well as these personal reasons, policy mechanisms to attract foreign and expatriate researchers can have a bearing on researchers' decisions to move. Research for Spain has shown that government intervention increased the number of researchers returning from abroad as well as the number of foreign researchers relocating to Spain (Cruz-Castro and Sanz-Menéndez, 2005). National research policies and ethics legislation may also

affect where researchers choose to work. For example, US federal grants cannot be used for research on embryonic stem cells. Therefore, researchers need to ensure that monies from federal grants do not accidentally help support research on banned cell lines; they must separate this research from other research, perhaps work in separate labs and sometimes separate buildings, and operate separate accounting systems. Belgium, Korea, Sweden and the United Kingdom, as well as China, India, Israel and Singapore, have less restrictive policies in this area (Walters, 2004). In addition, the regulation and enforcement of intellectual property rights may influence location decisions, particularly in basic research and certain fields that require strong protection.

Policy intervention plays a lesser role in terms of influencing choices related to lifestyle and family. However, policy can reduce political, technical and legal barriers to mobility in areas such as immigration legislation. In Spain, for example, international mobility in the public research system is limited because public service regulations make it difficult to hire non-EU citizens (OECD, 2007a), while in the United States security concerns have meant that visas have been refused for some foreign scientists and engineers (NSF, 2006). Recognition of foreign training and standards can also be influenced by policy mechanisms.

The economic performance of sending countries plays a large role in the return of mobile researchers and HRST personnel. For example, China and India are now encouraging the return of highly skilled scientists, engineers and researchers who have benefited from access to international graduate education and overseas work experience. Local companies are increasingly in a position to compete for skilled local labour and returning expatriates. The highly skilled return home because of improved career opportunities, the development of infrastructure, better living conditions and economic growth.[3] Moreover, greater local opportunities provide an attractive alternative to a career overseas.

How does mobility spread knowledge?

Internationally mobile workers diffuse their knowledge, both directly and indirectly, at different levels in their new location. At firm level, knowledge spreads to colleagues, especially to those in close contact or nearby. As geographic proximity is often crucial to the transmission of tacit knowledge, knowledge spillovers tend to be localised within a geographic region (Audretsch and Stephan, 1998). However, some authors assert that spillovers also occur at the level of "communities of practice", which straddle firms and spatial boundaries. This suggests that the knowledge gains from mobility are potentially large. These three levels are discussed below.

Firm or organisation level

At the level of the organisation, when skilled people move in the labour market, they take their knowledge with them and share it in their new workplace. Power and Lundmark (2004, p. 1027) assert that knowledge and innovation develop most commonly through interaction in the workplace, which is a vital channel for knowledge dissemination: "If it is in the firm and its various offices and factories that workers predominantly interact and form ideas and knowledge, then the flow of people in and out of such locations may be the most likely channels for local and extra-local sources of knowledge and ideas." Moving between workplaces speeds up knowledge dissemination and learning processes and creates new combinations of knowledge. International mobility fosters cross-border linkages between firms, workplaces and institutions and thus actively contributes to the building of clusters and networks that draw on a wide range of expertise and experience.

In a study of academic inventors from six European countries, Crespi *et al.* (2006) found that knowledge transfer was one of two key variables explaining the mobility of scientists from academia to industry (the other was stage of life). Using data from the European Patent Office, the authors developed a model of inventor mobility, which indicated that the value of a patent and the amount of cumulative knowledge (or non-separable knowledge) created by the inventor were positive and significant factors in mobility owing to their impact on the probability of a job offer. Crespi *et al.* suggested that as not all knowledge is codified in a patent, hiring the inventor gives the new employer access to the tacit components of the knowledge that the inventor is unable or unwilling to transfer by other means. Knowledge cumulativeness tends to increase the value of the inventor's tacit knowledge and thus further increases the probability of moving to a new job.

Ensuring that knowledge is efficiently and effectively transmitted in the organisation is important for maximising the benefits of hiring a new worker. Internal management and knowledge management systems need to create appropriate conditions for knowledge diffusion, mindful that international mobility brings together people with different cultures, languages and ways of working.

Local or regional level

The mobility of skilled people also spreads knowledge at the local or regional level, adding a geographic perspective. Close spatial proximity means that individuals can meet and exchange ideas at lower cost than those who are geographically separated. At the same time, co-located individuals are more likely to have "chance" encounters during which useful knowledge exchanges may occur. They are also more likely to develop social relationships, which can

also act as conduits for knowledge flows (Agrawal *et al.*, 2006). An internationally mobile worker may therefore influence a wide range of people.

Attempts to measure the extent to which knowledge spillovers are geographically localised give mixed results, perhaps owing to methodological difficulties. Arguing that knowledge flows leave a paper trail in the form of patent citations, Jaffe *et al.* (1993) examined citations of universities' and selected firms' patents in the United States on the assumption that if knowledge spillovers are localised, citations should come disproportionately from the same city, state or country as the patent. The authors found significant evidence that citations are more localised than one would expect from the concentration of technological activity, particularly in the first few years of the patent. The advantages created by geographic proximity for learning about the work of others fade as the work is used and disseminated. However, with a different methodology, Thompson and Fox-Kean (2005) found evidence of international localisation effects, but no evidence of localisation at the city or state level. Acknowledging the ongoing methodological debate, the authors concluded that new strategies were needed to understand the geographic nature of knowledge spillovers.

A clearer empirical finding is that, as proximity lessens, knowledge spillovers weaken. Clusters of innovative activity provide evidence of this. The propensity of innovative activity to cluster spatially is greatest in industries in which tacit knowledge plays an important role, because it is tacit knowledge – as opposed to information – that must be transmitted informally and typically through direct and repeated contact (Audretsch, 2003). Zucker and Darby (2006) find that "star" scientists and engineers (as defined by their level of authorship) show a clear tendency towards concentration by area and interpret this as reflecting both their motivation to cluster with their peers and greater commercial opportunities.

The movement of skilled individuals to a particular location can also influence the shape of the market in their area of expertise. Zucker and Darby (2006) show that "stars" play a significant role in firm entry into high-technology markets. In particular, the number of "stars" active in a region or country has generally positive and significant effects on the probability of a new firm entering a science or engineering field.[4] According to the authors, "Since the embodied knowledge, insight, taste and energy of the stars plays a role separate from their potentially disembodied discoveries, this evidence strengthens the case for the importance of the work of these extraordinary individuals for the economic development of regions and nations." (2006, p. 1)

There is a question of whether information technology can negate the importance of geographical proximity. Indeed, Feldman and Audretsch (1999, p. 411) commented that "[t]he importance of location to innovation in

a world increasingly relying upon e-mail, fax machines, and electronic communications superhighways may seem surprising, and even paradoxical at first glance". Information and communication technology (ICT) may increase the amount of knowledge that can be codified and increases the profitability of codification operations. It may also reduce the importance of face-to-face interactions by mimicking some of the features of such interactions; technologies that are rich in terms of immediacy of feedback (incorporating features of phone conversation) and that allow for interpretation of communication cues (sound, video and text) may act as "palliatives" to face-to-face interactions (Gallié and Guichard, 2005).

Nonetheless, it is likely that geographical proximity will remain an important factor in knowledge transfer for some time to come. The use of ICT still cannot completely replicate the factors at play in face-to-face communications and geographically proximate networks – in other words, the costs of transferring tacit knowledge across space are still relevant. In explaining why location still matters, Feldman and Audretsch (1999, p. 411) pointed to the distinction between knowledge and information: "While the costs of transmitting information may be invariant to distance, presumably the cost of transmitting knowledge, especially … *sticky knowledge*, rises with distance".[5] Von Hippel (1994) suggested that rather than facilitating "anywhere" problem solving, computerisation in a world of sticky information would enable researchers to transfer their work to and among field sites containing sticky information, would allow managers to move decision making to the sites of critical tasks, and would permit product designers to design products by working directly with users at user sites. ICT makes it easier to bridge the geographical divide but does not make it irrelevant.

Some evidence of the ongoing importance of face-to-face interaction comes from studies of scientific collaboration. For example, Gallié and Guichard (2005) sought to assess the potential of ICT for achieving efficient knowledge transfer and trust at a distance by gathering evidence from two French teams that participated in the International Sun-Earth Explorers (ISEE) project with the National Aeronautics and Space Administration (NASA). They found that in spite of teleconferences and e-mail, researchers still required face-to-face interaction for discussions about issues such as database construction and limitations, for meetings on important technical, organisational or scientific problems, and for specialised project discussions requiring multidisciplinary expertise. ICT reduced delays for transferring codified knowledge and facilitated the resolution of average technical problems without face-to-face meetings. But it did not decrease travel and did not replace face-to-face interaction for building trust among team members. In fact, some researchers in the project "deplored the fading of working and social interactions among local scientists in parallel to the blooming of distant collaborations".

One factor that may lessen the need for geographical proximity for knowledge transfer is co-ethnicity. Using data on the Indian diaspora resident in the United States, Agrawal *et al.* (2007) estimated a model that suggested that co-location and co-ethnicity, as types of relationship that facilitate knowledge flows between inventors, are substitutes rather than complements. Among inventors who share the same ethnicity, the marginal benefit of co-location is minimal; it is four times larger for individuals who do not share the same ethnicity. In terms of facilitating access to knowledge, co-location appears to offer much greater benefit to individuals who are not otherwise socially connected. The authors say that through a mix of choice of location (relative to the location of related innovative activity) and recruitment decisions (in terms of social connections or ethnic diversity), firms may be able to influence their level of innovation:

> "Indeed, the increased pace of recruitment of international talent in academia and private-sector labs as well as the rapid expansion of multinational R&D to international locations over the past quarter century suggests that firms may have already well recognized these important determinants of knowledge flow patterns." (2007, p. 20)

This phenomenon is discussed further below in the context of the diaspora.

Communities of practice and networks

Other studies suggest that knowledge spillovers may travel across regional and national boundaries if workers are part of a strong "community of practice" (Gertler, 2003). Such a community is defined as a group of workers informally bound together by shared experience, expertise and commitment to a joint enterprise, and may include workers from a number of organisations, plus suppliers and customers. In this case, internationally mobile workers may become part of a new community of practice and share their tacit knowledge with this community and build its collective knowledge base.

Similarly, Sorenson *et al.* (2006) argue that membership in a "collaboration network" facilitates the flow of knowledge among actors. A collaboration network serves to establish social proximity, with closer relationships (for example, direct collaboration on a patent) giving better access to knowledge. The authors suggest that collaboration networks are particularly important for knowledge of moderate complexity, in which knowledge components interact to produce the desired outcome and small errors in reproduction cause large problems. In this case, being part of a network facilitates "high-fidelity transmission" and allows people to more easily "fill in gaps" and correct "transmission errors", and thus more accurately receive and better build on knowledge. As with communities of practice, internationally mobile workers

may join new collaboration networks and impart their knowledge through these channels.

This strand of the literature is a useful reminder of the importance of relationships in knowledge diffusion, although Gertler (2003) notes that it is still unclear what underlying forces shape the degree of "relational proximity" that allows tacit knowledge to flow despite physical, cultural and institutional divides. Some commentators argue that communities of practice cannot function across geographical space, as the social ties that enable flows of knowledge are embedded in the geographically specific social systems in which they arise.

A caveat regarding factor mobility

While the movement of skilled people is undoubtedly an important way in which knowledge is diffused, there are other channels as well. Much work has been done on the positive links between trade and foreign direct investment (FDI) on the one hand, and knowledge spillovers on the other. For example, using cumulative R&D expenditure as a proxy for knowledge stocks, Coe and Helpman (1995) found that both domestic and foreign R&D had a positive impact on a country's total factor productivity, with trade in goods and services acting as the conduit for knowledge spillovers. The authors also found that the effect of foreign R&D capital stocks on domestic productivity increased as the share of imports in GDP rose. Recent empirical work by Branstetter (2006) finds evidence that FDI is a channel of knowledge spillovers for Japanese multinationals undertaking direct investments in the United States. The spillovers function in both directions, with knowledge spillovers received by the Japanese investor strongest via R&D and product development facilities, and knowledge spillovers received by American inventors from investing Japanese firms strongest via Japanese greenfield facilities.

In addition, trade and investment flows are bigger than the international flows of people. In an attempt to compare the economic importance of these different flows, Freeman (2006) compared immigration, trade and foreign capital flows relative to the global workforce, global production and global investment activity, and contrasted the dispersion of wages with the dispersion of prices of goods and cost of capital. The first set of comparisons suggested that trade and capital flows were a larger proportion of activity in goods and capital markets than immigration in labour markets, "presumably because governments have reduced trade barriers and liberalized capital markets but have not lowered barriers to immigration" (2006, p. 150). The second set of comparisons found that wages in similar occupations vary more around the world than prices of similar bundles of goods and the cost of capital, again suggesting that labour flows are less "globalised" than other flows.

Nevertheless, mobility remains important. Flows of people can be a vital complement to flows of goods and capital, especially in high-technology production areas (Freeman, 2006). The extent to which labour specifically complements or substitutes for other factors of production in particular industries remains a question to be answered. One general study by Dolman (2008) confirmed a positive correlation between migrants and bilateral trade flows, with a 10% increase in the number of migrants from a particular country estimated to raise bilateral trade with that country by 0.9%. The data further revealed that migrants have a larger effect on the direction of trade than on its volume, as lower trade costs due to migrant knowledge tend to shift the direction of trade. Bilateral investment patterns showed that migrants increase investment between their country of residence and their country of birth, with a 10% increase in the number of migrants from a particular country estimated to raise bilateral investment with that country by 1.7%. Contrary to trade, there was no strong evidence that the increase in bilateral investment was accompanied by a reduction in investment with other countries.

How much knowledge moves?

The previous section highlighted international mobility's potential for spreading knowledge to firms, to regions and to wider networks. But the impact depends crucially on how much knowledge actually moves. This section explores factors that affect the size of the knowledge transfer, essentially by asking: Does all of a person's knowledge go with him or her and get transmitted when he or she moves?

First, the ability of workers to produce and share tacit knowledge may be constrained by differences in the institutional environment to which they move. This relates to "institutional proximity" – the shared norms, conventions, values, expectations and routines commonly encountered in institutional frameworks (Gertler, 2003). National institutions such as education systems, labour markets and capital markets shape organisations and their decisions about production, technology use, interaction with innovation partners and competition. In doing so, they create or block possibilities for producing and transmitting tacit knowledge. These institutions are built up over time, and their influence is subtle, so that firms and individuals are often not fully conscious of their impact on their choices, practices, attitudes, values and expectations. Gertler concludes that tacit knowledge transfer across major institutional-contextual boundaries will be subject to "formidable obstacles" and that "technological fixes and corporate will may not be sufficient to overcome these obstacles. Nor will occupational similarity or even mobile 'knowledge enablers'." (2003, p. 95)

A second issue is specialisation versus diversity – that is, whether knowledge flows are greater when a skilled HRST moves to a location that is specialised in their field or to an area that hosts a range of scientific and technological fields. Some evidence on this can be gleaned from the literature on economic geography, which has debated how externalities are shaped by the composition of a location's economic activity. One view suggests that greater industry concentration facilitates knowledge spillovers across firms, while an opposing view suggests that exchanges of complementary knowledge among a diversity of firms and economic agents yield greater returns.

Using a database of manufacturing product innovations, Feldman and Audretsch (1999) found support for the diversity thesis. Innovative activity tended to be weaker in industries located in cities whose economic activity specialised in that industry, while the strong presence of complementary industries sharing a common science base[6] was particularly conducive to innovative activity. Duranton and Puga (2001) proposed a microeconomic foundation for this, suggesting that firms seeking new products and processes will do so in a diversified environment, so as to learn from others without having to relocate. Once a process or product is more mature, firms relocate to specialised locations to take advantage of specialised inputs and economies of scale. The authors tested this "nursery" city hypothesis using data on firm relocations in France between 1993 and 1996 and found that most relocations, particularly in the areas of R&D, pharmaceuticals and cosmetics, IT and consultancy services, and business services, followed the predicted pattern. This supports the view that innovative activities are associated with diversity. Nevertheless, there are some methodological questions, especially regarding the appropriate way to measure diversity (*e.g.* Ejermo, 2005), and empirical studies will no doubt continue in this area.

A third issue is organisational context. Since much knowledge is created in organisations through the interaction and collaboration of workers in a specific context, the question is whether this knowledge can be transferred without all of the people and supporting systems. In its 2006 survey of talent, *The Economist* pointed to a study of security analysts in investment banks, which found that in spite of their transportable skills, analysts' performance immediately dropped if they switched employers. The magazine suggested: "Talented people may think that their brainpower allows them to walk upon water, but in reality many are walking on the stones that their employers have conveniently placed beneath them." (*The Economist*, 2006, p. 14)

The transfer of knowledge also relies on being employed in a position suitable for the person's level of expertise and experience. Analysis of the correspondence between levels of education and job qualifications of immigrants to OECD countries finds that immigrants are more likely to be overqualified for their jobs than the native-born (OECD, 2007b, p. 136). This is

particularly clear for women and for individuals from outside the OECD area. Being overqualified likely reduces the amount of knowledge that a skilled person can impart, as their work responsibilities and colleagues may not be ready to receive the benefits of knowledge diffusion and spillovers. While language abilities and literacy can explain around one-third of immigrants' relative over-qualification, the place of education is also a crucial explanatory factor, reflecting differences in terms of the content and quality of schooling and perhaps also employers' interpretation of educational levels. Internationally mobile workers thus benefit from good information flows about standards of education and efficient qualification recognition systems.

A further issue is absorptive capacity. Gertler (2003, p. 81) notes that "the ability of workers and firms to absorb tacit and codified knowledge may depend *inter alia* on their prior investments in research and development, training, and the general level of education and skill of the workforce. Without this prior investment, individuals workers and firms will likely be poorly prepared for engaging in learning by doing and interacting." The importance of absorptive capacity is relevant not just in the workplace but for the wider economy as a whole.

Fourth, the personal characteristics and cultural/language background of mobile workers are also likely to affect the amount of knowledge transferred in a new setting. Their level of education and career status will affect their mobility decision and the amount of knowledge they take with them. The extent to which mobility indicates knowledge transfer also depends on their ability and opportunity to learn from the organisation in which they were previously employed. In turn, this is likely to depend on their duration of employment and their education, as well as the position or occupation held in the organisation (Nås *et al.,* 2001). Cultural and language differences may also affect the amount of knowledge transferred or, at least, the length of time it takes to share knowledge.

A final point is that the amount of knowledge a person can potentially impart is not always easy to discern. "Quality" may relate to seniority and experience, and migration patterns may reflect this, but at the same time, career advancement and migration are also driven by networks and connections, which may undermine the idea of meritocratic and efficient processes. Ackers (2005, p. 107) says, "From a research point of view, it is necessary to take into account the level (seniority or experience) of migrants and to capture, as far as is possible, their relationship to 'excellence' and potential".

From diffusion to creation

While the discussion above suggests that a number of factors may detract from a potential one-to-one relationship between mobility and knowledge

transfer, at the same time, a number of mechanisms suggest that knowledge can be extended through mobility. Thus, while not all of a person's knowledge may go with him/her, what is transferred may be enhanced through mobility.

For instance, Kuhn and McAusland (2006) suggest that if knowledge workers move to a country with a larger market, they have an incentive to improve the quality and quantity of their work (*i.e.* knowledge creation), as their potential returns are larger. Spillovers and combining knowledge with that of new colleagues also serve to improve the quality of work.

Highly skilled immigrants can also alter the institutions and organisations of a country's innovation system in such a way that the system's capacity for innovation increases (Hart, 2007). Hart argues that the effectiveness with which inputs to the innovation process (such as human capital and R&D) are translated into outputs depends fundamentally on the organisational and institutional contexts in which the innovation process is embedded. Highly skilled immigrants, who participate in mainstream institutions without dissociating themselves from their native milieu, may change the structure of transaction costs and the management of uncertainty in the innovation system. In this way, immigrants alter the trajectory of the innovation system. Hart notes:

> "Systems that are able to capitalise on the differences between immigrants and native-born – in their social networks, technical styles, and norms and routines, for instance – to reduce transactions costs and generate new combinations of native and imported ideas and practices, may become more innovative than they would have been without any influx of foreign talent." (2007, p. 51)

However, Hart warns that this outcome is neither certain nor fully amenable to government policy. Existing norms, power structures and habits of thought and behaviour act to constrain change, and lower risk/lower reward equilibria may prevail.

In sum, while internationally mobile workers may not transfer the entirety of their knowledge stock in the context of their new job, offsetting mechanisms enhance the benefits of the knowledge they are able to share.

The effect on the receiving country

Immigrants, both high- and low-skilled, represent a large and growing share of the labour force in OECD countries. Their integration into the labour markets of receiving countries has improved over the last five to ten years, with differences in participation rates between the native-born population and immigrants declining in most OECD countries (OECD, 2007b, p. 23). Immigrants also contributed strongly to employment growth – the percentage of immigrants in net job creation between 1995 and 2005 was higher than the

proportion of immigrants in the working population in 2005 in most countries. Box 2.1 outlines some key trends in the integration of immigrant labour in OECD countries in recent years.

Box 2.1. **Immigrants' labour market performance in OECD countries – recent trends**

In 2005, the number of foreign-born accounted for an often large, though variable, proportion of the labour force in OECD countries. While in Korea, Japan and central European countries, fewer than 2% of workers were born abroad, the proportion was nearly 45% in Luxembourg, 25% in Switzerland and Australia, and 20% in Canada. The numbers of foreign-born workers have increased greatly over the last five years, with a growth rate of over 20% in nearly all OECD countries.

During the last five to ten years, differences in participation rates between the native-born population and immigrants have tended to diminish, except in Austria, although there are large differences in terms of origin and gender. For example, immigrant women tend to have lower participation rates than immigrant men and usually lower than native-born women. Most differences in participation rates can be explained by the duration of residence, the institutional, historical, linguistic and cultural links between the host country and the country of origin, and the characteristics of the migrants themselves (reasons for entry, level of education, demographic composition, etc.).

From 1995 to 2005 there was much stronger growth in immigrant employment than in the labour market as a whole. For example, in the United States, more than half of the net job creation over the past decade involves jobs held by persons born abroad, 3.5 times more than their share in the total labour force in 2005. Part of this can be explained by an increase in the employment rate of immigrants, but new entries of foreign workers, many with higher levels of skills, have played the bigger role. Nevertheless, while higher educational attainment helps immigrants to find a job, it seems not to be enough to put them on an equal footing with the native-born population since the difference in the employment rate between the native-born and immigrants also remains at higher education levels.

The difference in terms of unemployment between the native-born population and immigrants has, in most member countries, tended to decrease over the past ten years. However, immigrants continue to be over-represented among the unemployed, notably the long-term unemployed. Immigrants also tend to be over-represented in the construction, hotel and restaurant sectors, as well as in the health-care and social services sectors, where their share in employment is on the whole higher than their share in the overall labour force.

Source: OECD (2007b).

A great deal of work has been done on assessing the impact of permanent migration on receiving countries, particularly the impact on labour markets. Although immigration to OECD countries over the past decade has been marked by an increasing share of tertiary-educated migrants, a large and growing share of immigrants is unskilled. This inflow of unskilled immigrants is driven by economic and family reunification motives and is the main cause of labour market concerns among natives (Jean *et al.*, 2007).

Theory suggests that immigrants will reduce the earnings of people and factors of production when they are substitutes and raise them when they are complements (Freeman, 2006). This leads to adjustments in investment, firm creation and potentially in trade patterns. Differences in behaviour between migrants and natives may have additional effects, for instance on production locations. The combination of these and other factors (such as employment protection policies) makes the impact of immigration complex and the size and persistence of that impact on the labour market therefore remains a largely empirical issue (see Box 2.2).

Box 2.2. **Labour market impact of migrants**

Analysis by the OECD suggests that, in aggregate, pressures on real wages from immigration are limited and vanish within a few years (Jean *et al.*, 2007). However, immigration does influence relative wages for individual categories of workers, depending in particular on the skill mix of immigrants. This result is also found in more sector-specific analyses. For example, using data on doctorates awarded in 22 science and engineering fields, Borjas (2005) found that an immigration-induced increase in the supply of a narrowly defined highly skilled group lowers the wage of that group by 3%.

Natives with skills most similar to those of immigrants do not suffer from a strong rise in their unemployment rate relative to other categories of natives. At the aggregate level, an increase in the share of immigrants in the labour force increases unemployment of natives, but the impact is temporary and vanishes between four and nine years after the shock. The extent and duration of the unemployment impact of immigration depends partly on government policies; for example, anticompetitive product market regulation increases the magnitude and persistence of the impact on unemployment for natives (Jean and Jiménez, 2007).

The impact of highly skilled immigrants

The mobility of highly skilled people has a wide range of effects on receiving countries. Table 2.2 presents a selection of these effects. While the empirical evidence is sparse for some, there are some indicative data. Notably, a

Table 2.2. **Possible effects of highly skilled international migration on receiving countries**

Possible positive effects	Possible negative effects
Science and technology • Increased R&D and economic activity due to availability of additional highly skilled workers • Entrepreneurship in high-growth areas • Knowledge flows and collaboration with sending countries • Immigrants can foster diversity and creativity • Export opportunities for technology *Higher education systems* • Increased enrolment in graduate programmes and keeping smaller programmes alive • Offset ageing of university professors and researchers *Labour market* • Wage moderation in high-growth sectors with labour shortages • Immigrant entrepreneurs foster firm and job creation • Immigrants can act as magnets for accessing other immigrant labour (network hiring effects)	*Higher education systems* • Decreased incentive of natives to seek higher skills, may crowd out native students from best schools *Science and technology* • Technology transfers to foreign competitors and possible hostile countries

Source: Guellec and Cervantes (2002).

number of potentially dynamic effects are related to knowledge flows, R&D and creativity. These effects are likely to contribute positively to economic growth.

Mobility of highly skilled labour can also support the increasing internationalisation of business research and the trend towards open innovation in OECD countries. With open innovation, purposive inflows and outflows of knowledge are used by firms to accelerate internal innovation and expand the markets for external use of innovation (see Box 2.3). Movement of HRST is an important means of linking domestic firms to foreign knowledge and stimulating spillovers from foreign R&D sources to local R&D units and the local economy at large. The benefits are two-fold: at the microeconomic level, a more open innovation model generates new revenues from the knowledge developed in house that is largely unused; at the same time it saves costs and time by leveraging external development. At the macroeconomic level, open innovation creates a much larger base of ideas and technologies for driving innovation and growth. A potential drawback for the individual firm is the possibility of unintended leakage of information to external parties.

The trend towards open innovation also has implications for the future mobility patterns of skilled HRST in the private sector. In searching for new ideas and attractive research and production locations for bringing new products, services and processes to market, companies are increasingly open

Box 2.3. **Open innovation**

The open innovation model is one in which companies look "outside-in" and "inside-out" to advance their technology. Companies' boundaries become semi-permeable and innovation moves more easily between the external environment and the companies' internal innovation process.

What does it involve? Increased R&D co-operation and higher reliance on external sources have become important ways of sourcing knowledge in order to generate new ideas and bring them quickly to market. At the same time companies commercialise both their own ideas and innovations from other sources, notably academic research. Companies may also spin out technologies and intellectual property that were developed internally but are judged to be outside their core business and better developed and commercialised by others. Multinationals link up to start-up firms, spin-offs and the public R&D system through their permeable boundaries.

Source: OECD (2008, forthcoming).

to investing in a wide variety of countries. As developing countries improve their science and technology capabilities, the opportunities for closer links with international firms involved in R&D and innovative production will also improve, opening up options for domestic employment. Indeed, in most OECD countries, the share of R&D performed by foreign affiliates has increased as multinationals have acquired foreign firms and established new R&D facilities outside their home country. More than 16% of business R&D in the OECD area was performed by foreign affiliates in 2004. While most are still in the OECD area, there is fast growth in Asia, where increases in scientific and technical talent, rapidly expanding markets and lower wages offer fertile ground for new investment (OECD, 2006b, p. 11).

However, foreign inflows of HRST, particularly highly skilled scientists and researchers, should not be used to delay the reform of domestic policies or institutions that may be limiting the domestic supply of HRST. With more and more countries wishing to attract talent, relying on current international flows of people may be risky, and countries must ensure that the domestic environment for skills creation and innovation does not inhibit the domestic supply of HRST.

The effect on the sending country

The effect of migration on sending countries is complex, depending on the type of migrant, the duration of migration, and the economic situation in both sending and receiving countries. As noted by Docquier and Rapoport

(2007), in a world of perfect competition, free mobility of labour is pareto-improving: migrants receive higher incomes, natives in receiving countries share the immigration surplus, and residents remaining in the sending countries benefit from a rise in land/labour and capital/labour ratios. However, the reality is more complex and nuanced, and it is challenging to disentangle the various effects. Empirical work often needs to be based on simplifying assumptions, even though some subtlety is lost.

The large body of theoretical and empirical literature on the labour market impact of immigration is not balanced by an equal amount on the impact of emigration. This may be due to data constraints, as many source countries do not record information on those who leave. One available example is a study of the labour market impact of Mexican emigration. This study found a strong and positive impact of emigration on wages in Mexico, with a 10% decrease in the number of Mexican workers due to emigration in a skill group (defined by schooling and experience) increasing the average wage in that skill group by 4% (Mishra, 2007). Overall, the outflow of Mexican workers to the United States between 1970 and 2000 was estimated to have increased the wage of an average Mexican worker by around 8%, with the greatest increase for higher wage earners. This effect persists over time and is robust to the undercount of illegal migrants. Mishra also used a competitive partial equilibrium framework to calculate changes in welfare; the emigration loss to Mexico due to the outflow of workers between 1970 and 2000 was 0.5% of Mexico's GDP in 2000 (with workers gaining 5.9% of GDP and owners of fixed factors losing 6.4%). However, the loss was less than official worker remittances to Mexico (not including large unrecorded remittances) and the emigration loss would also be outweighed by the gains of the migrants themselves.

Much migration literature focused on sending countries looks at effects associated with South-North migration and, in particular, brain drain and the economics of migrant remittances. However, there is also a body of literature suggesting that highly skilled emigration can have beneficial effects on sending countries (both developed and developing), particularly through channels relating to the transfer and creation of knowledge. This section provides a (non-exhaustive) overview of studies showing that emigration of highly skilled people can bring benefits to all participants. (For an in-depth discussion of migration and development issues, see OECD, 2007c.)

Remittances

Migrant remittances are a particularly important factor to consider for South-North migration. In 2002, China, India and Mexico were the developing countries that received the largest total remittances. China and India each received over USD 14 billion (OECD, 2006a, p. 143). As a percentage of GDP,

however, Tonga, West Bank and Gaza, and Lesotho were the top three, receiving between 41 and 25% of GDP as remittances. Migrant remittance flows are unequally distributed throughout the world, with Asia receiving the majority, commensurate with its population and large diaspora.

Much research on migrant remittances has looked at the links with economic growth (see OECD, 2006a, pp. 154-156). Some studies focus on whether remittances offset the declines in output experienced by countries as a result of emigration. The results depend on a number of factors, including the post-emigration capital/labour ratio, the factor intensities of goods, and openness to foreign capital, and they range from positive, to indeterminate, to negative. However, it is clear that migrant remittances are an important source of income for many low- and middle-income households in developing countries, provide hard currency for imports and may contribute to additional savings for economic development.

Some studies suggest that remittances are treated differently from other sources of income and are more often saved or directly invested and thus have a stronger impact on economic development. However, even when not invested, remittances can have an important multiplier effect, stimulating demand for goods and services and thus output and employment. Empirical evidence indicates that multiplier effects can substantially increase gross national product.

However, Ellerman (2006, p. 32) warns of the danger that migrant remittances will relieve the pressure to deal with pressing problems: "Many governments in developing countries have now discovered the 'oil well' of remittances, which help them paper over problems and pay the costs of not changing."

Recent research on migration from developing countries shows that emigration can have positive impacts on child health, child labour and fertility, owing to remittances and more general influences on behaviour (see Box 2.4). This suggests that migration can help developing countries achieve their goals for poverty reduction, education, health and women's empowerment, although the magnitude of the effects will depend on each country's specific circumstances.

Highly skilled migration and knowledge flows

Highly skilled migrants can have particular effects on sending countries (Table 2.3). Of interest here is the influence highly skilled migrants may have on knowledge flows and knowledge accumulation in sending countries. From a policy perspective, increasing such returns is the key to achieving mutual benefits from migration. Three knowledge-based effects are especially important: additional knowledge creation as a result of emigration; the

Box 2.4. **Further impacts of emigration on developing countries**

Recent research from the World Bank has found a number of positive effects of emigration on developing countries. Some are related to remittances, while others are more related to behavioural change. For example:

- A study of households in rural Pakistan found that migration has a positive impact on all measures of educational attainment. Children from migrant households (in which a family member has migrated) are more likely to attend school, stay in school during the age range of peak dropout rates, have higher completed grades, and progress through school at a significantly better rate than children in non-migrant households. There are significant gender effects – girls in migrant households complete almost two years more schooling than girls in non-migrant households.
- Consistent with the findings on increased schooling, migration and remittances also reduce the labour force participation of children, with the impact on girls greater than that on boys.
- A study of child health in Guatemala found that remittances have a positive impact on weight for age and height for age, as well as health inputs, particularly child delivery by a doctor and vaccinations. Data from Nicaragua also found positive impacts in these areas, although only doctor-assisted delivery was statistically significant. The impact was particularly strong for low-income families. In Pakistan, migration had a large positive effect on weight for age and height for age, with gains for girls greater than those for boys.
- A general finding from the gender-specific studies is that the allocation of resources to daughters is more responsive to income shocks than the allocation of resources to sons. That is, resources allocated to daughters tend to be marginal – thus the positive impact of migration and remittances on daughters' education and labour outcomes is typically larger than for boys.
- Evidence from Morocco, Turkey and Egypt suggests that migration from high-birthrate to low-birthrate countries can transmit ideas about demographic modernity and reduce high birth rates in countries of origin. This occurs as migrants adopt ideas and behaviour prevailing in the destination countries relating to family structure and pass these ideas on to non-migrants in their home country. This could be regarded as a positive externality of international migration. Similarly, migrants to modern democratic societies may also have a positive impact on social, economic and political institutions in their home countries via the transmission of new ideas.

Source: Özden and Schiff (2007).

Table 2.3. **Possible effects of highly skilled international migration on sending countries**

Possible positive effects	Possible negative effects
Science and technology • Knowledge flows and collaboration, return of natives with foreign education and human capital, increased ties to foreign research institutions • Export opportunities for technology • Remittances and venture capital from diaspora networks • Successful overseas entrepreneurs bring valuable management experience and access to global networks *Human capital effects* • Increased incentive for natives to seek higher skills • Possibility of exporting skills reduces risk/raises expected return to investments in personal education • May increase domestic economic return to skills	• "Brain drain" and lost productive capacity due to (at least temporary) absence of more highly skilled workers and students • Lower returns to public investment in tertiary education (waste of national public resources)

Source: Guellec and Cervantes (2002).

concept of "brain circulation"; and the diaspora. Understanding more about these effects will help OECD countries to develop migration management policies that support economic growth while maintaining coherence with other policy initiatives.

Brain drain?

The term "brain drain" can be used in a general sense to refer to the transfer of highly educated people from one country to another, or more specifically to the migration of scientists, engineers and other tertiary-trained specialists. It is often used in the context of migration from developing to developed countries and has usually been regarded as having detrimental consequences for the sending country. For example, Lazonick (2007, pp. 9-10) suggests that the science and engineering brain drain has been a major problem for the developing Asian economies:

> "By one account over 30 000 college graduates went abroad from [Chinese Taipei] between 1956 and 1972, with only 2 586 returning … Nearly 60 per cent of those who left had science or engineering educations, and they tended to be the best students … In the 1950s and 1960s Korea also had a serious brain drain. In the period 1953-1972, 10 412 students, of whom 5 376 were in science and engineering, requested permission from the Korean Ministry of Education to study in the United States, with over 90% not returning after graduation … One study estimated that, given the cost of educating scientists and engineers and their lost value-added,

India transferred USD 51 billion to the United States between 1967 and 1985."

However, brain drain in one period may be the source of brain regain later: Lazonick (2007) goes on to point out the significance of return flows of HRST to both Korea and Chinese Taipei in their periods of rapid growth in the 1970s and 1980s (see below).

The brain drain can be measured in absolute or relative terms. From a sample of 195 countries in 2000, China, India, Mexico, the Philippines, Poland and Vietnam were the leading sending countries in terms of absolute numbers, while Pacific and Caribbean islands experienced the highest rates of skilled emigration (Docquier and Rapoport, 2007). For low- and middle-income countries with populations of over 4 million, it is clear that for migrants who acquired their education in the sending country, skilled migration has been highest in countries that have suffered from civil war and political instability during the last decades (Ghana, Haiti, Lebanon, Sierra Leone and Somalia) and is also particularly strong in Central America and Sub-Saharan Africa.

The World Bank (2006) posits several reasons why migration of highly skilled workers may decrease living standards and growth in developing source countries. First, the total return to education may be greater than the private return, as highly educated workers may be more productive when interacting with similar workers, and they may also help train other workers. Second, the productivity of firms may increase with size. Third, emigration of highly skilled workers may impose a fiscal cost as education is usually heavily subsidised by the state in developing countries. Fourth, emigration of highly skilled workers will increase the price of services that require technical skills.

Some studies further suggest that brain drain may affect economic development not only by holding back the production of goods and services and wasting public expenditure on education, but also by holding back institutional development in less developed countries. Kapur (2001) suggests that if the origins of successful institutional development lie in a critical mass of individuals with high levels of human capital, then the most detrimental consequences of brain drain may be for institutional development in the country of origin. Ellerman (2006) raises a similar point, arguing that increased exit decreases the pressure to break through barriers to structural change. Ellerman also argues that understanding migration dynamics is crucial; if migration flows are part of a critical mass dynamic, sending regions will be driven towards a low-level equilibrium, as key people are "cherry-picked" and the economics of disagglomeration trigger a self-reinforcing downward spiral.

Ongoing concerns about brain drain from developing countries have ensured that it remains a popular indicator of a country's economic well-

being, and measures of brain drain feature in a number of comparative studies of world economic performance. For example:

- The IMD World Competitiveness Yearbook (2006) ranks Iceland, Ireland and Austria as the top three performers in terms of whether brain drain hinders competitiveness in the economy: on a scale of 1-10 these countries scored above 8, suggesting that brain drain did not hinder competitiveness. Out of the 61 countries or regions surveyed, South Africa, Venezuela and Russia fared the worst; New Zealand was the worst-performing OECD country.
- The top three performers in the Global Competitiveness Report 2006-07 are the United States, Qatar and Japan: on a scale of 1-7, where 1 indicates "your country's talented people normally leave to pursue opportunities in other countries" and 7 indicates "your country's talented people almost always remain in the country", these countries scored 6.1, 5.7 and 5.7, respectively. In this report on 125 countries, Guyana, Lesotho and Zimbabwe fared the worst; Italy was the worst-performing OECD country (World Economic Forum, 2006).

However, the World Bank (2006, p. 67) argues that the costs of emigration must be evaluated against the benefits, in terms not only of wages and remittances but also of utilisation of human capital. The Bank notes that the impact of highly skilled emigration will be limited if it is difficult for highly skilled workers to find productive employment in their country of origin. This may be the case if: *i)* the investment climate is so poor, due to political instability or other reasons, that workers cannot pursue their professions; *ii)* a significant proportion of highly skilled workers are not trained in professions required by the economy; and *iii)* the country lacks the economic scale to employ productively a large number of specialised professionals. As Rapoport (2004, p. 93) suggests, "one has to correctly qualify the no-migration scenario and wonder about the right counterfactual when it comes to evaluating the growth effects of the brain drain".

Furthermore, recent literature suggests that brain drain can encourage human capital formation in the sending country. In particular, the possibility of emigration may encourage skill creation, potentially increasing human capital and growth in the sending country. Regets (2001) notes that the incentive for natives to invest more in their own human capital may be: *i)* an increase in the domestic return to skills due to the relative scarcity created by the "brain drain"; *ii)* an increase in the expected value of an individual's human capital investment if migration is an option; and *iii)* a reduction in the risk associated with the return to individual human capital investment if migration serves as a labour market stabiliser.

The central proposition of this "beneficial brain drain" theory is that if the possibility of emigration encourages more skill creation than skill loss, sending countries may increase their stocks of skills as opportunities to move or work

abroad open up. As well as private gains for those who acquire skills, there may be public gains, for example through enhanced intergenerational transmission of skills or spillovers between workers, as some newly skilled workers remain in the sending country or only migrate temporarily (Commander *et al.*, 2004). The key criterion for a beneficial brain drain is a positive probability of emigrating for the marginal person increasing his/her educational level. The greater the imperfections in foreign firms' screening processes – that is, how quickly and how accurately they discern true ability – the wider the range of people in the sending country who will acquire further education.

Empirical findings on the beneficial brain drain have been mixed. Using a small survey of overseas doctors working in the United Kingdom, Commander *et al.* (2004) found that the possibility of migration did not appear to exert a systematic positive effect on education decisions. Nevertheless, they also noted that around half of the sample indicated they would return home, and around one-fifth had been unemployed prior to migrating, suggesting that migration does not necessarily accompany skill shortages in the sending country. Also questioning the evidence for a beneficial brain drain, Schiff (2006) argues that the brain gain is reduced by uncertainty surrounding the benefits to education, and that welfare may be negatively affected by increased education expenditure if it results in reduced public and private expenditure on other items such as infrastructure and health.

However, using data from 37 developing countries, Beine *et al.* (2001, p. 277) found that "the possibility of a beneficial brain drain cannot be rejected". According to their model, economies with very low GDP per capita were particularly likely to benefit from increased migration. Among sectoral studies, a survey of 225 software firms in India and 98 in the United States suggested that the growth of the software industry had been accompanied by a strong educational response in India (Commander *et al.*, 2004). More recent empirical work also suggests that emigration prospects can raise the expected return to human capital and foster investment in education. A new data set on emigration rates by educational levels covering 127 developing countries in 1990 and 2000 revealed that doubling the emigration rate of the working age (25 years and over) highly skilled induces a 5% increase in gross human capital formation among the native population (Beine *et al.*, 2006). In countries with low levels of human capital and low migration rates of skilled workers, the overall effect is positive, while it appears to be negative in countries where migration of the highly educated is above 20% and/or the proportion of those enrolled in higher education is above 5%. At an aggregate level, however, brain drain migration increases the number of skilled workers worldwide and the number of skilled workers living in developing countries. Beine *et al.* conclude: "This suggests that the traditional perception of the brain drain, often viewed as a kind of predation through which rich countries extract the most valuable

human resources from the poor countries, has no empirical justification at an aggregate level." (2006, p. 28)

As this literature is still relatively recent, it is likely that further conceptual and empirical work will be invaluable in establishing the extent to which a beneficial brain drain can be achieved.

Recent literature also suggests that the movement of "brains" to larger, wealthier economies can be in the interest of the source country, as these "brains" produce better knowledge (such as more effective medicines or software) abroad than if they had remained at home (Kuhn and McAusland, 2006). This is particularly relevant for the mobility of researchers who produce "public" goods that can be shared across borders, as the gains can be accessed in the source country. There is also more general evidence that people who move to denser areas experience faster human capital accumulation, as evidenced by a wage growth effect (Glaeser and Maré, 2001). This effect is due to factors such as higher rates of interaction with other highly skilled individuals, a broader range of experience, a bigger pool of role models, better job matching and greater specialisation. Areas of denser economic activity are also associated with higher labour productivity; for example, Ciccone and Hall (1996) found that a doubling of employment density in a United States county resulted in a 6% increase in average labour productivity. Mobile HRST who move to a location with a greater density, particularly scientific density, may well see similar effects.

There is also evidence that R&D conducted in a foreign country has a positive effect on domestic multi-factor productivity. Using data from 16 major OECD countries from 1980-98, Guellec and van Pottelsberghe de la Potterie (2001) estimated that the long-term elasticity of foreign R&D on productivity is in the range of 0.45 to 0.5; this suggests that R&D conducted in other countries can have a significant positive effect, provided that the country has the capacity to absorb technology from abroad. Thus, while higher productivity certainly benefits the receiving country, it may also increase knowledge creation and opportunities for knowledge flows back to the source country, as well as positive productivity effects.

Brain circulation

Brain circulation has been put forward as one answer to concerns about the possible negative effects of brain drain. In some cases, it may be a longer-term phenomenon, with stocks of overseas migrants choosing to return after a period overseas – this is essentially "return migration". These stocks of migrants are viewed as a "precious resource" rather than a "brain drain". In India, politicians refer to the emigration of Indian IT professionals as a "brain bank" (Khadria, 2004). The development of the ICT industry in Korea is a prominent

example of wide-scale repatriation of highly skilled scientists, engineers and researchers (see Box 2.5). Korea created high-skill employment opportunities, with sufficiently high salaries and challenging jobs, to attract nationals back. Lazonick (2007, p. 23) cites a *Wall Street Journal* article from 1989:

Box 2.5. **Brain circulation: Korea's ICT**

The seeds of the brain drain reversal (or brain circulation) in Korea began during the 1960s, when semiconductor manufacturers from the United States started to establish assembly plants in a number of Asian countries. Although the impetus to offshore was the search for low-wage labour, other considerations such as political stability and labour productivity also entered into the location decision.

The transformation of Korea's education system after 1960 was vital to its initial and ongoing attractiveness as a location. It ensured the availability of an indigenous supply of relatively low-wage, highly skilled labour to perform engineering and managerial jobs, which was critical for firms upgrading their productive capabilities so as to maintain competitiveness. A dynamic process was created whereby the companies invested in higher value-added activities and created more high-end employment opportunities, while the government invested in research institutes and graduate programmes that generated attractive high-technology employment opportunities.

Of particular importance was the repatriation of Korean scientists and engineers who had worked abroad. In 1968, some 2 000 Korean scientists and engineers lived abroad. The Korean government saw the creation of an industrial research complex as a way to bring back expatriates to contribute to the development of Korea's knowledge base. Two new science research institutions were initially created, and to attract key personnel from abroad, they paid high salaries and offered incentives such as relocation expenses, free housing and education expenses for children. While their numbers were small, the repatriates brought knowledge, experience, connections and leadership to Korea.

Furthermore, as the industry developed, it began to draw on links to skilled Koreans still offshore. In a 1983 investment by Samsung to design and produce chips, the product development process involved two parallel groups: one in Silicon Valley that employed 300 American engineers led by five Korean-Americans with PhDs and design experience at major American chip companies; and the other in Korea, led by two Korean-American scientists as well as by Korean engineers. Samsung's Silicon Valley unit also trained the company's Korean engineers as part of the process of transferring technology from the United States to Korea.

Box 2.5. **Brain circulation: Korea's ICT** *(cont.)*

Domestic investment by business and government is now driving the development of indigenous high-technology capabilities in Korea. Lazonick (2007, p. 18) says: "In the 2000s there is no question that Korea has the research capability to serve the high end of the high-tech market. The brain drain has not only been reversed; with MNCs now locating in Korea to access highly skilled ICT labor, it can no longer be taken for granted that the center of the world of high-end work is the United States or even Japan."

Source: Lazonick (2007).

> "'Koreans in the US have become a precious resource for us', says Chin Hail Sool, a director general at Korea's Ministry of Science and Technology. The big players in Korea's booming semiconductor industry – Samsung, Goldstar Co. and Hyundai Electronic Industries – are all headed by recent defectors from Intel Corp., Honeywell Inc. and Digital Equipment Corp."

The move back to the home country may be important for knowledge diffusion. Regarding Indian professionals in the United States, Kapur (2001) suggested that the advanced technological frontier in the United States allowed Indian technology professionals to upgrade their skills substantially and then diffuse their technological knowledge through imitation when they returned home or circulated between the two countries. In China, Zhang and Li (2002) find that international mobility also promotes international academic exchanges so that Chinese schools are quickly informed about the scientific and technological frontier.

The networks maintained by repatriates with their former host country can also be vital to the knowledge transfer associated with brain circulation (see Box 2.6 for a discussion of network types). For example, Saxenian and Hsu

Box 2.6. **Networks**

"Network" is a term often used in the migration literature, but it may have several meanings. The types, forms and functions of networks vary considerably, and their effects depend on the particular social, political and economic structures in which they are located. Understanding networks is useful, as they help explain *processes* (for example, the integration of migrants into host societies) that are not revealed by quantitative indicators or policy assessment alone.

Box 2.6. **Networks** *(cont.)*

Social and/or ethnic networks are perhaps the most studied. They focus on personal ties and the trust that facilitate flows of information, capital and job opportunities among those in the network. Some studies describe social networks as underpinning migration systems – the ties that connect migrants, former migrants and non-migrants in sending and receiving countries actually increase the likelihood of migration by lowering the costs and risks. Migrant organisations are a formal manifestation of social networks. Some of these are more structured than others, and the quality of their governance and their level of legitimacy affect their effectiveness. Trans-nationalism is the broadest network concept discussed in the migration literature and is described as a situation in which migrants forge and sustain social, economic and political relations that link sending and receiving countries and enable migrants to have a lifestyle that involves two countries simultaneously. While social networks are considered important where formal institutions fail or are not easily accessible to migrants, some studies suggest that their impact is generally overstated. Some also find that family ties play the greatest role.

Business and management literature also uses the concept of networks, as related to business development and economic activity. Such networks can provide a bridge between migration and trade and investment. Networks may consist of supply chains and link companies through their production of goods or services. These networks may be at the local, national or international level. Clusters may also be considered networks, with firms in geographical proximity operating with closer ties. Global production networks, which combine notions of both supply chains and clusters, are important for understanding the potential for economic development in sending countries, as they encompass integration into production chains through backward linkages. However, laws, policies and labour issues are important in this context.

The "success" of a network can also be interpreted in various ways. It can be viewed in terms of financial measures, market expansion, advancement of technological know-how or reputation, or wages and working conditions. It can also be viewed from a number of perspectives – that of the immigrants themselves, the immigrant community, the city or region, the business sector and the country as a whole. And it can be evaluated from the perspective of the sending and receiving country. Examples of "successful" networks should therefore be seen as case studies and examples rather than as strong guides for policy.

Source: Rindoks *et al.* (2006).

(2001) highlight the strong links between Silicon Valley in California and the Hsinchu-Taipei region of Chinese Taipei. They argue that these links have been built by a repatriate community of United States-educated engineers, who not only transferred capital, skill and know-how on their return to Chinese Taipei but also maintained links with Silicon Valley's Chinese network and helped to create a social and economic bridge between Silicon Valley and Hsinchu. The authors argue that this community has been a central but largely unrecognised factor in the development of Chinese Taipei's IT industry and that government policy makers and global companies in Chinese Taipei have relied on it to remain abreast of state-of-the-art technical knowledge and leading-edge markets in the United States.

In other cases, brain circulation may be a short-term phenomenon. For example, in the European Union, there is a trend towards more temporary and circular migration. Short-term stays are encouraged by the extension of the free right of movement, as well as cheaper travel costs and new communications options (Ackers, 2005). "Split living", where the family remains settled in one region while the worker commutes internationally, is becoming more common, especially as the number of dual science careers increases. The Silicon Valley-Hsinchu connection described by Saxenian and Hsu (2001) provides another example of temporary/circular migration, with a growing population of "astronauts" working in both places, acting as go-betweens and co-ordinating economic linkages between the two regions. These workers – engineers and executives as well as angel investors and venture capitalists – travel between Silicon Valley and Hsinchu once or twice a month to pursue their business interests. This mobility has contributed to the creation of a "two-way thoroughfare" of technology and skills between the two regions.

However, it is also true that mobility becomes more "sticky" as people advance in their careers and lives, thus reducing mobility (and the propensity to return) for individuals over time (Ackers, 2005). At this point, scientific mobility may take place via conferences and research collaboration, whereby workers may spend up to one or two months over the course of a year in foreign locations. This is not migration *per se*, and highlights the increasing blurriness between permanent migration, temporary migration and "travel for work". These forms of mobility do not necessarily occur in a linear fashion but instead reflect a spatial manifestation of career and family-related mobility, and the challenge is to understand the flow of knowledge that occurs with each form (Ackers, 2005).

Return flows associated with brain circulation may not lead to an equivalent transfer of knowledge. As Ackers (2005, p. 116) points out, "To achieve such transfers, returning scientists need to be able to re-enter local labour markets and work in an environment conducive to the exercise and nurturing of their skills and knowledge." In other words, skills or knowledge

are crucially linked to the environment in which they are used. A different environment, or indeed, the lack of conditions for harnessing the skills of returning workers, will result in quite different outcomes. In policy terms, this suggests that it is not sufficient to encourage return migration; policies must also address the underlying causes of the initial departure of skilled people.

The absorptive capacity of the home country also needs to be sufficient. UNCTAD (2005) points out that a certain basic level of innovative capability is needed to connect with global networks of knowledge creation. However, countries vary greatly in this respect, with gaps not just between developed and developing countries, but also within the developing and transition economies (Box 2.7). Furthermore, capacity is needed to harness new organisational and management techniques brought back by returnees, which can be just as beneficial as technology-related skills. Policy issues related to the scientific and research infrastructure and environment, and the attraction of returnees, are discussed in Chapters 4 and 5.

A question related to brain circulation is the potential cost of "churning", in terms of reduced productivity while workers settle into their new jobs and

Box 2.7. **Innovation capability – a measure of absorptive capacity**

To examine the ability of countries to attract and benefit from R&D by multinational companies, UNCTAD (United Nations Conference on Trade and Development) constructed a measure of national innovation capabilities, the UNCTAD Innovation Capability Index (UNICI). It measures two dimensions: innovative activity and the skills available for such activity. Its components include: R&D personnel per million population; US patents granted per million population; scientific publications per million population; literacy rate as a percentage of the population; secondary school enrolment as a percentage of the age group; and tertiary enrolment as a percentage of the age group.

The use of these proxies, as well as data constraints, means the index should be interpreted with caution and seen mainly as a broad indicator. For 2001, of 117 countries, Sweden, Finland and the United States ranked highest (*i.e.* most capable of innovation) while Angola, Djibouti and Mozambique ranked lowest. Innovative capabilities are highly skewed in the developing world, with Southeast and East Asia at the high end and Sub-Saharan Africa at the low end of the spectrum. Within Southeast and East Asia, the three leaders (Korea, Chinese Taipei and Singapore) are well ahead of other economies. Each has invested heavily in education and skills development.

Source: UNCTAD (2005), pp. 111-116.

locations, and whether this implies an "optimal" level of mobility. The amount of time that workers take to reach their former, or improved, productivity level, is likely to differ depending both on the new environment and their personal characteristics. The "turnover" costs of these individual adjustment phases must be balanced against the benefits of mobility stemming from knowledge flows and from better matching of workers to jobs. In discussing optimal employee turnover rates for business in Australia, based on firm-level data, Harris *et al*. (2003) suggested that employee turnover had a statistically significant, but non-linear, effect on productivity. The optimal turnover rate, which maximised firm productivity, was around 20% a year for a sample of small to medium-sized businesses. In an Expert Group Report to the European Commission (the Aho Report 2006), it was suggested that human resources are inefficiently used in the European Union because of a lack of mobility and that 10% of the research workforce should be moving across science/industry/government boundaries each year, with as high a proportion as is feasible as cross-border movement. This sample of studies clearly shows that, while positive levels of mobility seem to be beneficial, the question of an optimal rate is still open to debate.

Diaspora and knowledge flows

In general terms, the diaspora provides a source for building networks and a means for keeping in contact with emigrants. Some commentators point to their potential downsides, seeing diaspora policy as a policy of "resignation", for example, whereby countries give up hope of attracting their workers back and instead try to benefit in other ways (Ackers, 2005). Some authors also suggest that diaspora communities act as bridgeheads for further emigration. Kapur (2001, p. 271) argues that the diaspora, functioning as networks, "create self-sustaining migratory flows that gradually delink from the conditions that generated immigration in the first place".[7] Kapur also warns that diaspora networks can discourage some aspects of economic liberalisation: "Diaspora businesses have less incentive to press for a fully open or universally accessible economy to emerge and the family control and long-term, trust-based relationships that have served diaspora network capitalism well could be viewed by others as unfairly preferential, nepotistic, or collusive." (2001, p. 277)

However, the diaspora also has a number of positive aspects. For example, by mentoring and serving as role models, they can boost confidence in sending countries and in overseas investors, who become more familiar with the country and its culture through interaction with the diaspora. Kapur (2001, p. 273) notes:

> "Companies like Yahoo, Hewlett Packard and General Electric have opened R&D centers in India largely because of the confidence engendered by the

> presence of many Indians working in their US operations. This points to the cognitive effects arising from the projection of a coherent, appealing, and progressive identity on the part of the diaspora that signals an image of prosperity and progress to potential investors and consumers."

The diaspora can also contribute to knowledge creation and diffusion by acting as a conduit for knowledge and information flows back to the sending country. For example, there is evidence that a skilled individual's social links to his/her home country may increase the probability of knowledge continuing to flow there even after the individual has moved away. Agrawal *et al.* (2006) explore the role of social relationships in mediating knowledge flows. The authors collect data on "movers" (inventors who have patented in one location in the United States and then patented in another location in the United States) and test whether knowledge generated in the new location flows disproportionately back to the prior location. Examining knowledge flows between these inventors and regions using patent citation data, Agrawal *et al.* find that knowledge flows are 50% more likely to go to the inventor's prior location than if the inventor had never lived there. The authors suggest this is due to "enduring social relationships", and find that 20% of the effect is due to relationships with individuals who were former co-inventors and who were at one time associated with the inventor's prior organisation, 62% is due to relationships with individuals who were associated with the inventor's former organisation but were not co-inventors, and 21% is due to other affiliations (through social groups, links to common third parties, etc.). The authors conclude:

> "… it is the result of personal relationships, formed within an institutional context, that endure over time, space and organisational boundaries. … the focal and citing inventors may not have a direct personal relationship but … their temporary common institutional affiliation in the same geographical location may facilitate broad social networks that in turn facilitate subsequent knowledge flows" (2006, p. 583).

While these results are for domestic moves within the United States, the supporting theory also fits international moves.

Further evidence on the positive impact of ethnic scientific and entrepreneurial communities and their ties to their home countries comes from Kerr (2008, forthcoming). Kerr examined whether a larger ethnic research community in the United States improves technology diffusion to foreign countries of the same ethnicity through the acquisition and transfer of codified and tacit knowledge from the United States to the foreign country. He found that foreign researchers cite American researchers of their own ethnicity 30-50% more frequently than researchers of other ethnicities, even after controlling for detailed technology classes. Using patenting and manufacturing output data, Kerr also found that growth in American ethnic

scientific communities increased foreign output with elasticities of 0.1 to 0.3, with output expansion coming both through employment and labour productivity gains. Outcomes were particularly strong in high-technology sectors and for Chinese ethnicity. Taking a different methodological approach, an investigation of the response to the Immigration Act of 1990, which increased immigration quotas, found that growth in American ethnic research communities increased foreign output with elasticities of 0.3 to 0.4, providing support for the earlier results. Kerr concluded that technology transfer offers a potential benefit from highly skilled immigration to advanced countries.

Recent work suggests a complementarity between brain circulation and the diaspora. Drawing on a survey of CEOs of Indian software firms, Nanda and Khanna (2006) found that entrepreneurs who had previously lived abroad and returned to India made greater use of diaspora links than those who had not lived abroad. This allowed entrepreneurs located outside India's main software industry hubs to rely much more on the diaspora for information and capital; the diaspora may have served as a substitute for local business networks. Nanda and Khanna suggest that developing countries could gain from links between the diaspora and smaller cities and call for further research into whether access to the diaspora reduces location constraints and allows individuals to locate outside existing hubs of activity.

A variety of factors affect a diaspora's role in technology and knowledge transfer, including the types of people that form the diaspora, their reasons for leaving, the political and economic situation in their home country, the income gap between the sending and receiving country, the institutional structures in the home country, and the demand or willingness of the home country to accept outside influence (Kapur, 2001). Kuznetsov (2006) offers a stylised description of how a diaspora engages with the home country, based on conditions in the sending country and the size and sophistication of the skilled diaspora. His six cases show different trajectories and associated policy activities that could help build engagement and leverage diaspora talent (Table 2.4). In the best case, with favourable growth conditions and a large diaspora of talent, there is vibrant brain circulation and return of talent, and the diaspora acts both as a search network and direct provider of expertise and capital. Here, expatriates are a key resource in the transition to a knowledge-based economy.

Overall, successful diaspora networks combine three main features: they bring together people with strong intrinsic motivation; members play both direct roles (implementing projects in the home country) and indirect roles (serving as bridges and "antennae" for the development of projects in the home country); and initiatives move from discussion to transactions (*i.e.* there are tangible outcomes) (Kuznetsov, 2006). In building a successful diaspora, individual "champions" are essential. These people initiate the process, invest their own social capital to bring people together, and build the credibility of

Table 2.4. **Level of diaspora engagement based on country conditions and diaspora characteristics**

Characteristics of the diaspora	Country conditions		
	Unfavourable	*Moderately favourable*	*Favourable*
Relatively large, mature, and well organised (sophisticated diaspora network)			
Role of expatriates	Antennae and role models	Launching pad to move to knowledge-intensive value chains	Key resource in transition to knowledge-based economies
Activities	Engage diaspora in dialogue about reform and engineer visible demonstration projects	Form brain circulation networks; encourage return migration	Encourage return migration; form sophisticated brain circulation networks
Country examples	Armenia, Bangladesh, Sri Lanka	El Salvador, India, Vietnam	China, Korea, Chinese Taipei
Relatively disengaged (emerging diaspora networks)			
Role of expatriates	Antennae and role models	Gradual engagement	Entry point to knowledge-intensive growth
Activities	Engage diaspora in dialogue about reform and engineer visible demonstration projects	Create expatriate networks; initiate activities to encourage return of talent	Establish brain circulation networks; encourage return migration
Country examples	Colombia, Comoros, Nigeria, Russian Federation, Ukraine	Brazil, Mexico and other Latin American countries; Pakistan; South Africa; some transition economies	Croatia, Chile, Hungary, Slovenia, smaller Asian tigers (Malaysia, Thailand)

Source: Kuznetsov (2006).

the network. Starting with small commitments and projects to achieve early tangible results, the diaspora can gradually move to larger and larger projects with increasing engagement of members.

However, to sustain the diaspora, good quality home institutions are critical. A survey of Argentinean professionals residing in the United States, for example, revealed strong willingness to develop science, technology and education in Argentina, but also concerns about the need for in-depth changes in productive and institutional systems. The problems cited included a lack of national policy on education, science and technology, weak articulation between science and innovation on the one hand and business development and commercialisation on the other, corruption, lack of economic stability, and a lack of investment (Kuznetsov *et al.*, 2006). Kapur (2001, p. 276) also commented that "the home country has to be prepared to make use of the remittances and/or investments of the diaspora, which means that its political stability and economic policies have to be conducive for economic development".

There are several examples of successful diaspora networks in emerging economies (Box 2.8). The Indian diaspora, for instance, played a vital role in developing the IT and business process outsourcing industry in India. Chinese

Box 2.8. **Diaspora at work**

The Indian diaspora has undertaken a number of steps to help develop the IT industry in India:

- It established the International School of Business in India, to meet the needs of Indian IT companies, as well as those in other sectors, for project management and business expertise. Many Indian professors teaching in the United States, the United Kingdom and Canada take sabbaticals to teach there.
- Many Indians living in Canada, the United Kingdom and the United States returned to India to join large companies such as General Electric, Intel and IBM, or to start their own companies.
- The Indus Entrepreneur and the Silicon Valley Bank (both based in the United States) have taken delegations of venture capital companies to India to explore investment opportunities.
- With the rise of the Indian IT industry and the additional push by the diaspora, many venture capital companies in the United States now require their start-up companies to have a back office in India in order to save on R&D costs. As of March 2004, over 150 start-ups had some form of back office in India and a front office in the United States.
- Some venture capital companies in the United States, particularly those run by people of Indian origin, actively fund Indian companies that are likely to produce intellectual property and innovative products in wireless technology, semiconductor design and technology and new business models for conducting R&D (Pandey *et al.*, 2006).

Similarly, the Chinese Taipei diaspora has been crucial in the economy's industrial development:

- In the 1970s and 1980s, overseas Chinese engineers in Silicon Valley and in Chinese Taipei simultaneously formed local associations and advised senior Chinese Taipei ministers and policy makers. Engineers based in the United States provided insight into the changing organisation of IT production and the advantages of specialisation in a volatile environment, while policy makers in Chinese Taipei devoted public resources to designing policies and institutions to support industry decentralisation.
- A number of Chinese Taipei government agencies involved with science and technology policy opened offices in Silicon Valley and built ties with local industry associations in order to monitor industrial and technological trends for domestic producers. They recruited overseas engineers to return to Chinese Taipei, and provided information and contacts to overseas Chinese considering setting up technology businesses in Chinese Taipei.

Box 2.8. **Diaspora at work** *(cont.)*

- Chinese workers in the United States frequently consult and "moonlight" on product development, providing market intelligence as well as links to American customers and technology for firms in Chinese Taipei.
- Chinese Taipei producers benefited from their role as manufacturing partners for some of the world's leading computer and systems producers, with these relationships originating from contracts with Silicon Valley-based overseas Chinese companies, which provided production information and know-how as well as experience with volume manufacturing. As the partnerships deepened over time, firms in Chinese Taipei took on growing responsibilities for design (Saxenian, 2006, pp. 122-162).

Taipei has also benefited from its United States-educated engineers and entrepreneurs, who have linked the two economies and contributed to the development of the IT industry.

Skilled diaspora networks are also important for developing countries. While they may still be emerging and predominantly focused on remittances, developing country diaspora have the potential to act as vital networks to facilitate the flow of assets and knowledge. In recognition, some aid programmes now foster the development of a diaspora (Box 2.9).

Box 2.9. **Supporting the diaspora in developing countries**

International Organization for Migration: MIDA

The MIDA (Migration for Development in Africa) strategy was established in 2001 as a way to mobilise African migrants to strengthen the institutional capacities of African countries. MIDA programmes identify public and private institutional needs in terms of human and financial resources. At the same time, a registration mechanism is established in countries of residence. It registers interested members of the diaspora and is a way to match needs with the resources of overseas nationals.

The process has important advantages: strengthening the positive picture of the country among expatriates; exchanging best practices, research, working methods and management techniques; creation of lasting ties between national enterprises and institutions of higher education and scientific research in host countries and countries of origin; and the opening of paths for private sector co-operation and professional agreements in each country. Based on these rewarding experiences, the strategy has been extended to 2010.

Box 2.9. **Supporting the diaspora in developing countries** *(cont.)*

UNDP: TOKTEN

TOKTEN (Transfer of Knowledge through Expatriate Nationals) is a global mechanism, introduced by the United Nations Development Programme (UNDP) in 1977, for drawing on expatriate nationals who have migrated to other countries and achieved professional success abroad, and mobilising them to undertake short-term consultancies in their countries of origin.

For example, the UNDP, in partnership with Sudan's government of national unity, launched TOKTEN Sudan in January 2006. Volunteers are recruited on the basis of requests by Sudan's national institutions and organisations, and the focus is on priority development areas – rural development, education, health, agriculture and natural resources, good governance, rule of law, gender, among others – in line with the Millennium Development Goals. Candidates who meet the recruitment criteria are included in the TOKTEN Sudan Roster and are contacted if appropriate opportunities arise. Assignment of TOKTEN volunteers is directed mainly at capacity building through activities such as instructing, R&D, realisation of practical projects or advisory services, and are short-term (from one to eight weeks).

Source: IOM (2006); UNDP *(www.sd.undp.org/tokten.htm)*.

In summary, the evidence suggests that a diaspora may be a key factor in ensuring knowledge flows back to sending countries. Bhagwati (2003, p. 101) commented that a realistic response to increasing migration is to abandon the brain drain approach of trying to keep highly skilled people at home, and to move to a diaspora model "which integrates present and past citizens into a web of rights and obligations in the extended community defined with the home country as the center".

Highly skilled immigration and world welfare

Is the mobility of highly skilled people associated with overall global gains? Theory suggests that it is. Similar to movements of other factors of production, labour mobility is a part of globalisation and is reallocating labour to locations where it earns the highest return. In this way, human capital is put to its most productive use and valuable human capital is not wasted. The literature on economic geography associates the movement of labour to agglomerations with productivity gains and a larger effective global human capital stock. An international job market can improve the quality of job matches for both workers and employers; when employers need to access

scarce or unique skills, it is increasingly efficient to search across borders, while workers can scan a wider labour market to find the work most interesting to them (Regets, 2001). And better international flows of knowledge lead to more efficient knowledge production everywhere and thus to better solutions to problems and less duplication of R&D (Regets, 2001).

Using a model of migration that combines liquidity constraints and uncertain migration prospects, Docquier and Rapoport (2007) find that the optimal rate of migration displays an inverse U-shaped relationship with the sending country's level of development. They conclude that for a given developing country, the optimal migration rate of its highly educated population is likely to be positive; whether the current rate is above or below the optimum is then an empirical question. They argue that restricting the international mobility of educated people from developing countries may in fact decrease the long-run level of developing countries' human capital stock, and that rich countries should not necessarily see themselves as free riding on poor countries' educational efforts. The difficulty, as they see it, is to design quality-selective immigration policies that address the differentiated effects of the brain drain across countries of origin without overly distorting the immigration system. They suggest specific incentives for return migration to the worst affected countries; promotion of international co-operation to encourage brain circulation might be a starting point.

Moving from theory to the evidence, some authors have attempted to quantify various aspects of the migration and world welfare puzzle. For example, Lundborg and Segerstrom (2002) presented a dynamic general equilibrium North-South migration model to explore the effects of immigration from South to North, in which the North-South divide was designed to capture roughly the wage differences between the EU and eastern Europe, the United States and Mexico, and France and Algeria. The model embodies endogenous growth, with economic growth driven by the R&D decisions of firms in attempting to improve their products and climb the "quality ladder". Comparing the situation of a one-time migration of workers from South to North to a benchmark of no migration, the authors found that the growth rates of total world GNP and total world utility rise. However, the effects are not equally spread across countries, with Northern natives (both workers and capital owners) hurt by immigration, indicating that there are complex political economy issues associated with immigration policy.

A recent paper by Benhabib and Jovanovic (2007) asks what the optimal immigration policy for the world might be, if the welfare of both human-capital-rich and human-capital-poor countries is considered. In their two-country model, a policy that favours the welfare of the low-skill country would allow the least skilled to migrate, up to a threshold level, to the high-skill country. A simulation grouping the OECD countries (as the human-capital-rich

"country") and the rest of the world (as the human-capital-poor "country") showed that this would imply migration of up to 3.2 billion low-skilled people to the OECD. If, on the other hand, the welfare of the high-skill country is favoured or equal to the low-skill, then the optimal immigration policy may be no immigration at all, or one that allows only the highly skilled to migrate to the high-skill country.

Summary

The studies presented above support the idea that mobility of highly skilled people is associated with flows of knowledge and that mobility is not necessarily a zero-sum game in which sending countries lose and receiving countries gain. For the receiving country, while there may be some adjustment in relative factor returns, there is a positive dynamic effect owing to the contribution of knowledge and human capital to economic growth, and migrants themselves certainly gain from higher returns to their human capital. For sending countries, the literature now suggests that the brain drain may be associated with some positive effects on human capital accumulation, and that brain circulation and diaspora activities can make a vital contribution to knowledge flows and knowledge accumulation in the sending country. Overall world welfare is likely to increase as a result of improved allocations of highly skilled people.

Notes

1. It is interesting to see the different normative interpretations given to knowledge spillovers. Sorenson *et al.* (2006) note that, while economists and sociologists focus on the societal benefits of spillovers, management scholars view the "escape of knowledge" to competing firms as a clear reduction in the returns to innovation.
2. A new data collection launched November 2007 will add at least 20 countries to the analysis. Results should be available in late 2008 (see *www.oecd.org/sti/cdh*).
3. In China, changes in the political and economic environment may also play a role.
4. The fields studied were: biology/chemistry/medicine; computing and information technology; semiconductors, integrated circuits and superconductors; nanoscale science and technology; other sciences; and other engineering.
5. Sticky knowledge or information has been defined by von Hippel (1994) as information that requires high incremental expenditure in order to be transferred in a form usable by a given information seeker. The stickiness may arise from the nature of the information (in particular, its "tacitness"), the amount of information that must be transferred, and the attributes of the seekers and providers of the information (in particular, the seeker's absorptive capacity).
6. Feldman and Audretsch identify six industry clusters with common science bases in terms of critical academic departments: agro-business; chemical engineering; office machinery; industrial machinery; high-technology computing; and biomedical.

7. Although, McKenzie and Rapoport (2007) also point out that stronger migrant networks increase the likelihood that the poor will migrate; this can help reduce inequality in sending communities, as the benefits of migration spread to members at the lower end of the community's consumption and wealth distributions. With an increasing body of literature suggesting that inequality can retard growth, this finding has important consequences.

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