The Global Competition for Talent

MOBILITY OF THE HIGHLY SKILLED

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MOBILITY OF THE HIGHLY SKILLED

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Foreword

This publication draws on analytical literature, the most recent data available and the very valuable policy inventories and evaluations undertaken by some member and observer countries in order to discuss the dimensions, significance and policy implications of international flows of human resources in science and technology (HRST). It aims to extend OECD member countries' understanding of the dimensions of HRST mobility, particularly of scientists, engineers and researchers, and the range of policies available to manage and shape this mobility, by drawing together analysis on international mobility, knowledge transfer and innovation, and related government policy. The project commenced with a workshop, "The International Mobility of the Highly Skilled and Researchers", held in Paris in March 2007, and it involved a specific policy survey of 14 OECD countries and non-OECD economies as well as the European Commission.

The report is one of the key outputs on the international mobility of HRST of the Ad Hoc Working Group on the Steering and Funding of Research Institutions (SFRI) of the OECD Committee for Science and Technological Policy (CSTP) for the 2007-08 biennium. The OECD's Directorate for Science, Technology and Industry has a long-standing interest in the mobility of HRST. A seminar, "International Mobility of Highly Skilled Workers: From Statistical Analysis to the Formulation of Policies", held in Paris in June 2001, led to the publication of International Mobility of the Highly Skilled *(OECD, 2002). Research on national innovation systems has also included work on human resource mobility, summarised in* Innovative People: Mobility of Skilled Personnel in National Innovation Systems *(OECD, 2001). These analyses have been drawn on throughout the current project.*

This study also contributes to other work currently under way at the OECD, co-ordinated by the OECD's Directorate for Employment, Labour and Social Affairs (DELSA), on managing labour migration to support economic growth, which aims to present recommendations for the organisation of both low- and high-skill migration and for increasing the positive effects of return migration and use of the diaspora to contribute to the development of sending countries. This report is also likely to contribute to forthcoming work on human capital undertaken as part of the OECD Innovation Strategy and may help the OECD's efforts to facilitate a high-level dialogue between the G8 and Brazil, China, India, Mexico and South Africa on promoting and protecting innovation, as agreed at the G8's Heiligendamm meeting in June 2007.

The publication was prepared under the direction of Ester Basri. The authors were Sarah Box and Ester Basri of the OECD Directorate for Science, Technology and Industry. It benefited from input and comments by Dirk Pilat, head of the OECD Science and Technology Policy Division, and by delegates to the CSTP and SFRI. Details provided by member countries and observers have greatly enriched the analysis. The authors would particularly like to thank the delegates who contributed to the policy inventory. This new inventory of national policy initiatives to encourage the inward and outward mobility of HRST, is available at www.oecd.org/sti/stpolicy/talent.

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ISBN 978-92-64-04774-7
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Executive Summary

International mobility of human resources in science and technology is of growing importance...

The scale and complexity of the migration of human resources in science and technology (HRST) are increasing

Alongside sustained growth in foreign direct investment (FDI), in trade and in the internationalisation of research and development (R&D), mobility of human resources in science and technology (HRST) has become a central aspect of globalisation. Migration of talent now plays an important role in shaping skilled labour forces throughout the OECD area.

Mobile talent contribute to the creation and diffusion of knowledge

The importance of mobility stems from its contribution to the creation and diffusion of knowledge. Not only does it aid in the production and dissemination of codified knowledge, it is also an important means of transmitting tacit knowledge. In the broadest sense, tacit knowledge is any knowledge that cannot be codified and transmitted as information through documentation, academic papers, lectures, conferences or other communication channels. Such knowledge is more effectively transferred among individuals with a common social context and physical proximity.

Economic incentives but also access to quality research infrastructure and to leading researchers drive mobility

Various factors contribute to the flows of the highly skilled. In addition to economic incentives, such as opportunities for better pay and career advancement and access to better research funding, mobile talent also seek higher quality research infrastructure, the opportunity to work with "star"

scientists and more freedom to debate. Less amenable to potential government policy, but still important, are family or personal ties that draw talent to certain locations.

... and can have important impacts on knowledge creation and diffusion...

Mobile people diffuse knowledge directly and indirectly in their new location

Once in another country, people diffuse their knowledge. In the workplace, knowledge spreads to colleagues, especially those in close contact. Knowledge also spills over to geographically proximate individuals and organisations and can contribute to the emergence of local concentrations of activity. Mobile HRST also act as a vital complement to the transfer of knowledge through flows of goods and capital across borders.

... in both receiving and sending countries...

Countries receiving inflows benefit from a variety of positive effects related to knowledge flows and R&D

For receiving countries, the inflow of talent has positive effects relating to knowledge flows, including the possibility of increased R&D and economic activity owing to the availability of additional skilled workers, improved knowledge flows and collaboration with sending countries, increased enrolments in graduate programmes, and potential firm and job creation by immigrant entrepreneurs. Mobility can help to link domestic firms to foreign knowledge and to stimulate spillovers from foreign R&D to local R&D units and the economy at large. At the same time, receiving countries must ensure that inflows of scientists and researchers do not delay reforms to policies that may be limiting the domestic supply of HRST.

Much of the literature on highly skilled emigration focuses on remittances and brain drain

For sending countries, work on the effects of emigration has often focused on migrant remittances and brain drain, with particular emphasis on the impact on developing countries. Remittances are an important source of income for many low- and middle-income households in developing countries. The main concerns about brain drain centre on the loss of productive labour and its

associated output, the fiscal cost of educating workers who then move abroad, and the potential impact on much-needed institutional development and structural change. However, these concerns must be balanced against the question of whether these researchers and scientists could have found productive employment at home.

But emigration of skilled workers can also spur human capital accumulation in the sending country

Emigration of skilled workers, such as researchers and scientists, can also be beneficial for creation and diffusion of knowledge in their country of origin. In particular, emigration possibilities may encourage the development of skills. In addition, when skilled individuals move to larger and "denser" economies they can benefit the sending country by producing "better" knowledge than they could at home, accumulating human capital faster and improving their productivity, thereby increasing the potential return flows of knowledge. This can increase the global stock of knowledge.

… indicating that it is not necessarily a zero-sum game

Brain circulation stimulates knowledge flows and builds links between locations

"Brain circulation" can stimulate knowledge transfer to sending countries. This may mean the return of skilled migrants to their home country after a period abroad, or a pattern of temporary and circular migration between home and abroad. Professionals diffuse the knowledge they acquire to their home country and maintain networks, thereby facilitating continuing knowledge exchange. To make the most of brain circulation, the home country needs to have sufficient absorptive capacity, and returning talents need to be able to re-enter local labour markets at a level that is appropriate for their skills and knowledge.

A country's diaspora can also act as a conduit…

The existence of a diaspora further enhances the transfer of knowledge. A stock of skilled HRST abroad can act as a conduit for flows of knowledge and information back to the home country, and social and other links increase the probability that knowledge will continue to flow back even after individuals move back or move away. In some emerging economies, diaspora networks play a vital role in developing science and technology capacity.

… so that all countries can benefit

Taken together, these effects suggest that knowledge flows associated with the emigration of researchers and scientists can provide benefits to sending countries. The mobility of researchers therefore is not necessarily a zero-sum game in which receiving countries gain and sending countries lose.

International mobility patterns differ substantially across countries

Most OECD countries are net beneficiaries of highly skilled migration…

Data on international mobility of HRST show that most OECD countries are net beneficiaries, with inflows exceeding outflows. The United States, Canada, Australia and France, in particular, have experienced strongly positive net inflows of tertiary-educated migrants.

… but there are significant variations

However, a more detailed picture reveals that, in relative terms, New Zealand and Ireland have experienced large outflows. In absolute terms, the United Kingdom and Germany have the highest number of skilled expatriates, while Luxembourg, Norway and the Slovak Republic have the fewest. For some countries, intra-OECD flows add substantially to the stock of highly skilled individuals. For other OECD countries, non-OECD migrants play a more important role, and the main sources are Asian, led by China, India and the Philippines.

Students are increasingly mobile as well

The international mobility of students is a further aspect of the internationalisation of HRST. OECD countries benefit from the inflow of talented students and scholars, and many now actively seek to attract foreign students. Benefits also occur when domestic students study abroad and gain knowledge and experience in another country. Data show that the number of students enrolled outside their country of citizenship has risen sharply since 1995.

Return and circular migration is largely driven by family ties and employment opportunities

Return and circular flows of migrants add to the mobility picture. Data show a tendency for many "permanent" or long-term migrants to return to their country of origin. Return rates appear to be higher for skilled workers and for those from countries at a greater cultural, economic and geographic distance from the host country. This trend is consistent with the notion of a globalising labour market in which the mobility of skilled workers is affected by changes in relative labour market conditions. The decision to return is driven strongly by lifestyle and family considerations and the availability of attractive employment opportunities at home. For students, the considerations are similar.

There is room for improving the collection of data

While recent years have seen major efforts to improve data on international stocks and flows of the highly skilled, difficulties relating to international comparability, to differing and/or insufficient disaggregation and to timeliness remain. Further work is needed if countries are to better understand patterns and changes in stocks and flows of scientists, engineers and researchers and the broader category of the highly skilled.

The evidence on the impact of international mobility is limited…

Direct evidence of the impact of mobility on innovation outcomes is hard to find

Quantitative evidence on the impact of mobility patterns is not readily available. Many variables and factors influence science and technology outcomes and are hard to disentangle. Nevertheless, data and information can be used to build a picture and to see some links between mobility and broader science and innovation outcomes.

Mobility is clearly leading to greater internationalisation of the labour market

A clear effect of the mobility of highly skilled workers is the increasing internationalisation of the labour market for the highly skilled. Both in private industry and academia, foreign staff are sought for their specific knowledge or abilities, their language skills and their knowledge of foreign markets.

... but points to a range of positive impacts on knowledge creation and diffusion

Some evidence suggests that immigrant HRST contribute strongly to innovation

The links between mobility and innovation are less clear, although some evidence suggests that immigrants contribute strongly to patent applications and creation of technology firms. Studies from several countries highlight a trend towards more international co-authorship of academic articles. Some work suggests that the impact of collaborative work, as measured by citations, is higher than the average impact of national work.

Mobility opportunities are growing

In the broader context of R&D and innovation activity, many countries have greatly improved their ability to exploit and perform research and innovation over the past decade. This is changing the geographical spread and intensity of research and scientific activity. The growing sums spent on R&D in non-OECD countries and their human capital resources, coupled with the increasingly internationalised activities of technology firms, all suggest that the opportunities for talent mobility will continue to grow.

A wide range of policies aim at attracting and retaining HRST...

Most countries offer a range of policies

OECD policies reveal a wide range of "intensity" in countries' approach to the mobility of HRST. Most countries see it as important in a context of retaining and attracting talent and have policies to encourage and assist mobility. These range from economic incentives to encourage inflows, immigration-oriented assistance, procedures for recognising foreign qualifications, social and cultural support, and support for research abroad. Some countries focus on just a few policy mechanisms, while others offer "something for everyone".

However, few have a specific mobility strategy

Only a few countries' policy approaches are part of an explicit mobility strategy. For those in which policies are not part of such a strategy, there is a greater risk of incoherence among policies on inflows, outflows and the diaspora. Ideally,

mobility policies should be part of a wider mobility strategy that contributes to the country's economic and social objectives and sets out the rationale for intervention. There is generally more support for inflows of researchers and other HRST than for outflows, perhaps because countries judge outward mobility to be adequate or because they are reluctant to encourage outward mobility, despite arguments about the benefits of brain circulation.

National policies generally target the same HRST…

National policies appear generally to target the same population, with little orientation towards national scientific and technological interests. Since many countries offer support for mobility, as opposed to permanent migration, researchers may use these policies to work in a number of countries. It is difficult to know if the similarity of mobility policies represents a move towards best practice, as few policies have been evaluated.

… and most do not impose geographical restrictions

In most cases, national policies do not place restrictions on the country of origin (inward mobility) or of destination (outward mobility). In theory, then, mobility policies often have a global focus.

Policy for the future

What should future mobility policy look like?

OECD countries already have a wide selection of policy tools at their disposal, which they use more or less intensively to promote HRST mobility. The question then is, what is the role for international mobility policy in the future, given what is known about mobility and knowledge flows and about current mobility, R&D and innovation patterns?

Identifying a clear rationale for intervention is the first step

In designing future mobility policies, a key first step is to identify a rationale for intervention and clear objectives. For mobility, the main rationale may be the potential positive externalities from knowledge spillovers and information asymmetry issues. The obstacles to mobility commonly cited include legal and administrative barriers, lack of funding, personal issues and language.

As many mobility policies have not been evaluated, best practice has yet to emerge

Few policies have been evaluated, so it is difficult to point to best practices. However, some lessons can be drawn from evaluation material provided by countries in response to the OECD questionnaire, including the importance of setting appropriate funding levels and programme durations for the target population. More work on evaluation would be valuable.

Removing barriers to circular mobility and fostering the diaspora may prove fruitful

Given differences among countries, it is not possible to identify a "recipe" for what governments should do more of, what they should do less of, and what should stay the same. One promising avenue, however, is removal of barriers to short-term and circular mobility. Shorter (and potentially repeated) periods abroad may avoid some of the obstacles that currently hinder mobility, and would support knowledge flows associated with brain circulation and the diaspora.

Countries must ensure that the broad environment for science and innovation is sound

Moreover, policy coherence is important not only for mobility policies but also to ensure that the broader environment for innovation and scientific endeavour is sound. In particular, to improve innovation outcomes, it is not sufficient simply to increase the number of HRST; these people must operate in a system that enables them to use, create and disseminate knowledge.

Countries should also remove obstacles to the domestic supply of HRST

Finally, an important message from this study is that the global competition for talent is growing. Many OECD countries and a growing range of non-member economies aim to attract the same pool of highly skilled researchers and scientists. Relying extensively on international flows and mobility policies to fill existing or future gaps in supply may therefore entail risks. Policy will also need to focus on addressing shortcomings in national policies that may limit the supply of HRST.

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The Global Competition for Talent
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Chapter 1

Introduction

This chapter sets the scene for the discussion of the mobility of the highly skilled workforce and for the policy issues arising from an increasing trend in this area.

Human resources play a central role in knowledge production and thus in technological and economic development. A knowledge-based society relies on a highly qualified labour force, not only for high-technology sectors and research, but increasingly in all sectors of the economy and society. The growing intensity of knowledge means that all countries have a greater need for highly skilled specialists who are able to access, understand and use knowledge.

Movements of highly skilled people, including human resources in science and technology (HRST), make up a small but important part of international flows of migrants. From 1990 to 2000, in net terms, 5 million tertiary-educated adults moved from less developed to more developed countries, while 2 million moved between more developed countries (OECD, 2007b). The numbers are not large in absolute terms, as the United Nations estimates the stock of international migrants at some 190 million. However, if the movement of the highly skilled is concentrated in particular fields, or accounts for a large portion of the skilled population in a source or recipient country, there may be significant implications for a country's economic performance. In particular, the movement of HRST may strongly affect innovation systems.

The international mobility of labour is not a new phenomenon – people have always moved to other countries in search of better economic prospects, to escape conflict or persecution, or simply to be with family members. Historically, the diffusion of technologies has owed much to human mobility. More recently, the movement of people has intensified as economic activity has become more globalised and the introduction and reinforcement of market and semi-market economies has increased commercial activity and economic opportunity (OECD, 2006). Along with sustained growth in foreign direct investment (FDI), in trade, and in the internationalisation of research and development (R&D), mobility of HRST appears to have become a central aspect of globalisation. The total stock of immigrants grew by 23% from 1995 to 2005 in developed countries, which are now home to 60% of all international migrants (OECD, 2007b). Given ageing populations, falling interest in certain occupations in OECD countries and related concerns about potential labour shortages, international migration of the highly skilled has moved up the policy agenda in most OECD countries.

Against this background, the factors that attract skilled people to other countries are strengthening. First, there are more opportunities for people

with scientific and technical talent to study and work in a foreign country. In both OECD and non-OECD economies demand for researchers continues to rise, and governments are rapidly developing policies to attract foreign and expatriate HRST. Indeed, employment in HRST occupations grew faster than total employment between 1996 and 2006 in all OECD countries. At the firm level, intellectual assets, including those embodied in skilled people, have become strategic factors for value creation as firms shift towards more innovation-based activities, which rely largely on R&D, patents, software, human resources and new organisational structures (OECD, 2007a).

The range of possibilities for continued mobility of HRST is also expanding. With the geographical fragmentation of value chains in response to the changing business environment and the increased presence of scientific and technological skills in many more countries, multinational enterprises (MNEs) increasingly establish R&D facilities throughout the world (OECD 2008, forthcoming). While most internationalisation of R&D still takes place within the OECD area, developing countries increasingly attract R&D centres. China and India, in particular, have attracted much attention in recent years. As the demand for HRST extends across a wider range of countries, the distinction between "sending" and "receiving" countries blurs. The time scale of mobility is also changing, ranging from traditional notions of permanent migration to temporary, circular and even commuting arrangements. These trends make analysis more challenging.

For OECD countries, these developments are important. Skilled HRST embody knowledge and contribute to innovative activity and play a vital role in economic growth and prosperity (or, at a firm level, in profits and success). Attracting more HRST, at both the country and firm levels, can hasten the accumulation of knowledge, stimulate innovation and lead to higher levels of economic activity and prosperity. However, the loss of skilled people engenders concerns about shortages and brain drain, particularly in developing countries.

A number of policy questions related to the international mobility of skilled HRST are therefore high on the policy agenda of OECD governments. How much mobility is desirable? What is the best way to attract talent? How does the loss of locally trained workers affect innovation? What is the best way to ensure policy coherence among domestic policies and policies relating to developing countries? Countries want to make the most of the opportunities presented by this aspect of globalisation, but they also want to better understand the effects on their economies and learn how to manage them. The demand for HRST is strong and increasing, and international flows have significantly affected stocks in many countries, yet the appropriate conceptual frameworks for policy, and the right mix of measures and instruments, are not yet clear.

This study draws on analytical literature, the most recent available data and the very valuable policy inventories and evaluations undertaken by some member and observer countries to discuss the dimensions, significance and policy implications of international flows of HRST at the present time. Chapter 2 reviews recent analyses of the significance of HRST mobility in knowledge formation and use, the motives for HRST migration, and the impacts of mobility on both sending and receiving countries. Chapter 3 reviews current data on HRST migration and explores the evidence on the impacts of OECD and non-OECD mobility patterns. Chapters 4 and and 5 focus on policy: Chapter 4 provides the most recent information on current mobility policies in selected member countries, gathered via a questionnaire sent to members of the OECD's Ad Hoc Working Group on Steering and Funding of Research Institutions; and Chapter 5 looks ahead to discuss future policy options for the mobility of HRST.

References

OECD (2006), *International Migration Outlook: SOPEMI 2006 Edition*, OECD, Paris.

OECD (2007a), "Creating Value from Intellectual Assets", *OECD Policy Brief*, February, OECD, Paris.

OECD (2007b), "Trends in International Migration Flows and Stocks 1975-2005", OECD internal working document, 31 May, Paris.

OECD (2008, forthcoming), *Open Innovation in Global Networks*, OECD, Paris.

ISBN 978-92-64-04774-7
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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.

References

Abramovitz, M. and P. David (1996), "Technological change and the rise of intangible investments: the US economy's growth-path in the twentieth century", in OECD (1996), *Employment and Growth in the Knowledge-Based Economy*, OECD, Paris, pp. 34-65.

Ackers, L. (2005), "Moving People and Knowledge: Scientific mobility in the European Union", *International Migration*, Vol. 43(5), pp. 99-131.

Agrawal, A., D. Kapur and J. McHale (2007), "Birds of a Feather – Better Together? Exploring the Optimal Spatial Distribution of Ethnic Inventors", *NBER Working Paper Series*, Working Paper 12823, Cambridge, MA.

Agrawal, A., I. Cockburn and J. McHale (2006), "Gone but not forgotten: knowledge flows, labor mobility and enduring social relationships", *Journal of Economic Geography*, Vol. 6, pp. 571-591.

Aho Report (2006), "Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit", European Commission EUR 22005, January, Luxembourg: Office for Official Publications of the European Communities.

Audretsch, D. (2003), "Innovation and Spatial Externalities", *International Regional Science Review*, Vol. 26(2), pp. 167-174, April.

Audretsch, D. and P. Stephan (1998), "How and why does knowledge spill over? The case of biotechnology", *CEPR Discussion Paper*, #1991, Centre for Economic Policy Research.

Auriol, L. (2007), "Labour Market Characteristics and International Mobility of Doctorate Holders: Results for seven countries", *STI Working Paper*, 2007/2, OECD, Paris.

Beine, M., F. Docquier and H. Rapoport (2001), "Brain drain and economic growth: theory and evidence", *Journal of Development Economics*, Vol. 64, pp. 275-289.

Beine, M., F. Docquier and H. Rapoport (2006), "Brain drain and human capital formation in developing countries: winners and losers", Discussion Paper 2006-23, Département des Sciences Économiques de l'Université Catholique de Louvain, Belgium. [Forthcoming in *Economic Journal*]

Benhabib, J. and B. Jovanovic (2007), "Optimal Migration: A World Perspective", *NBER Working Paper Series*, Working Paper 12871, Cambridge. MA.

Bhagwati, J. (2003), "Borders beyond control", *Foreign Affairs*, Vol. 82(1), January/February 2003.

Borjas, G. (2005), "Foreign-Born Domestic Supply of Science and Engineering Workforce: The Lobot-Market Impact of High-Skill Immigration", *AEA Papers and Proceedings*, Vol. 95(2), May, pp. 56-60.

Branstetter, L. (2006), "Is foreign direct investment a channel of knowledge spillovers? Evidence from Japan's FDI in the United States", *Journal of International Economics*, Vol. 68, pp. 325-344.

Ciccone, A. and R. Hall (1996), "Productivity and the Density of Economic Activity", *American Economic Review*, Vol. 86(1), March, pp. 54-70.

Coe, D. and E. Helpman (1995), "International R&D spillovers", *European Economic Review*, Vol. 39, pp. 859-887.

Commander, S., M. Kangasniemi and L.A. Winters (2004), "The Brain Drain: A review of theory and facts", *Brussels Economic Review*, Vol. 47(1) Spring, pp. 29-44.

Cowan, R. and D. Foray (1997), "The Economics of Codification and the Diffusion of Knowledge", *Industrial and Corporate Change*, Vol. 6(3), pp. 595-622.

Crespi, G., A. Geuna and L. Nesta (2006), "Labour Mobility of Academic Inventors: Career decision and knowledge transfer", *EUI Working Papers*, RSCAS No. 2006/06, Robert Schuman Centre for Advanced Studies, European University Institute, Florence.

Cruz-Castro, L. and L. Sanz-Menéndez (2005), "Bringing science and technology human resources back in: the Spanish Ramón y Cajal programme", *Science and Public Policy*, 32(1), pp. 39-53.

Docquier, F. and H. Rapoport (2007), "Skilled migration: the perspective of developing countries", Discussion Paper 2007-17, Département des Sciences Économiques de l'Université Catholique de Louvain, Belgium.

Dolman, B. (2008), "Migration, trade and investment", *Australian Government Productivity Commission Staff Working Paper*, Canberra, February.

Duranton, G. and D. Puga (2001), "Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products", *American Economic Review*, Vol. 91(5), December, pp. 1454-1477.

Ejermo, O. (2005), "Technological Diversity and Jacobs' Externality Hypothesis Revisited", *Growth and Change*, Vol. 36(2), Spring, pp. 167-195.

Ellerman, D. (2006), "The Dynamics of Migration of the Highly Skilled: A survey of the literature", in Y. Kuznetsov (ed.) (2006), *Diaspora Networks and the International Migration of Skills: How countries can draw on their talent abroad*, WBI Development Studies, The World Bank, Washington, DC.

Feldman, M. and D. Audretsch (1999), "Innovation in cities: Science-based diversity, specialization and localized competition", *European Economic Review*, 43, pp. 409-429.

Freeman, R. (2006), "People flows in globalization", *Journal of Economic Perspectives*, Vol. 20(2), Spring, pp. 145-170.

Gallié, E-P. and R. Guichard (2005), "Do collaboratories mean the end of face-to-face interactions? An evidence from the ISEE project", *Economics of Innovation and New Technology*, Vol. 14(6), September, pp. 517-532.

Gertler, M. (2003), "Tacit knowledge and the economic geography of context, or The undefinable tacitness of being (there)", *Journal of Economic Geography*, 2003(3), pp. 75-99.

Glaeser, E. and D. Maré (2001), "Cities and Skills", *Journal of Labor Economics*, Vol. 19(2), pp. 316-342.

Guellec, D. and M. Cervantes (2002), "International Mobility of Highly Skilled Workers: From statistical analysis to policy formulation", in OECD (2002), *International Mobility of the Highly Skilled*, OECD, Paris.

Guellec, D. and B. van Pottelsberghe de la Potterie (2001), "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries", *OECD Economic Studies*, No. 33, 2001/II, p. 103-126.

Harris, M.N., Kam Ki Tang and Yi-Ping Tseng (2003), "Employee Turnover: Less is not necessarily more? ", Paper presented at the international conference of Comparative Analysis of Enterprise (micro) Data, 15-16 September 2003, London.

Hart, D. (2007), "Understanding immigration in a national systems of innovation framework", *Science and Public Policy*, Vol. 34(1), pp. 45-53, February.

Hippel, E. von (1994), "Sticky Information and the Locus of Problem Solving: Implications for Innovation", *Management Science*, Vol. 40(4), April, pp. 429-439.

Hugo, G. (2005), "Demographic trends in Australia's academic workforce", *Journal of Higher Education Policy and Management*, 27(3), pp. 327-343.

IMD (2006), *IMD World Competitiveness Yearbook 2006*, Switzerland.

IOM (International Organization for Migration) 2006, *A Global Strategy of Migration for Development: Beyond the MIDA approach to mobilizing and sharing of human and financial resources of the overseas African community: 2006-2010*, June, Geneva.

Jaffe, A., M. Trajtenberg, and R. Henderson (1993), "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations", *Quarterly Journal of Economics*, Vol. 108(3), August, pp. 577-598.

Jean, S., O. Causa, M. Jiménez and I. Wanner (2007), "Migration in OECD Countries: Labour Market Impact and Integration Issues", *OECD Economics Department Working Papers*, No. 562, OECD, Paris.

Jean, S. and M. Jiménez (2007), "The Unemployment Impact of Immigration in OECD Countries", *OECD Economics Department Working Papers*, No. 563, OECD, Paris.

Kapur, D. (2001), "Diaspora and Technology Transfer", *Journal of Human Development*, Vol. 2(2), pp. 265-286.

Kerr, W. (2008 forthcoming), "Ethnic Scientific Communities and International Technology Diffusion", *Review of Economics and Statistics, Vol. 90(2)*.

Khadria, B. (2004), "Migration of Highly Skilled Indians: Case studies of IT and health professionals", *OECD STI Working Paper* 2004/6, DSTI/DOC(2004)6, OECD, Paris.

Kuhn, P. and C. McAusland (2006), "The International Migration of Knowledge Workers: When is brain drain beneficial? ", *NBER Working Paper Series*, WP 12761, Cambridge MA.

Kuznetsov, Y. (2006), "Leveraging Diasporas of Talent: Towards a New Policy Agenda", in Y. Kuznetsov (ed.) (2006), *Diaspora Networks and the International Migration of Skills: How countries can draw on their talent abroad*, WBI Development Studies, The World Bank, Washington, DC.

Kuznetsov, Y., A. Nemirovsky and G. Yoguel (2006), "Argentina: Burgeoning networks of talent abroad, weak institutions at home", in Y. Kuznetsov (ed.) (2006), *Diaspora Networks and the International Migration of Skills: How countries can draw on their talent abroad*, WBI Development Studies, The World Bank, Washington, DC.

Lazonick, W. (2007), "Foreign Direct Investment, Transnational Migration, and Indigenous Innovation in the Globalization of High-Tech Labor", Revised version of paper presented at the International Forum of Comparative Political Economy of Globalization, September 1-3 2006, Renmin University of China, Beijing (see *http://faculty.insead.edu/Lazonick/Recent Publications.htm*).

Lundborg, P. and P, Segerstrom (2002), "The growth and welfare effects of international mass migration", *Journal of International Economics*, Vol. 56, pp. 177-204.

Mahroum, S. (2001), "Europe and the immigration of highly skilled labour", *International Migration*, 39(5), pp. 27-43.

McKenzie, D. and H. Rapoport (2007), "Network effects and the dynamics of migration and inequality: Theory and evidence from Mexico", *Journal of Development Economics*, Vol. 84, pp. 1-24.

Mishra, P. (2007), "Emigration and wages in source countries: Evidence from Mexico", *Journal of Development Economics*, Vol. 82, pp. 180-199.

Nanda, R. and T. Khanna (2006), "Diaspora and Domestic Entrepreneurs: Evidence from the Indian Software Industry", Working Paper, MIT Sloan School of Management, Cambridge, MA.

Nås, S., A. Ekeland, C. Svanfeldt and M. Åkerblom (2001), "Knowledge Transfer through Labour Mobility in the Nordic Countries: Structure and Dynamics", in OECD (2001), *Innovative People: Mobility of Skilled Personnel in National Innovation Systems*, OECD, Paris.

Nerdrum, L. and B.Sarpebakken (2006), "Mobility of Foreign Researchers in Norway", *Science and Public Policy*, 33(3), p. 217-229.

NSF (National Science Foundation) (2006), *Science and Engineering Indicators 2006*.

OECD (2006*a*), *International Migration Outlook: SOPEMI 2006 Edition*, OECD, Paris.

OECD (2006*b*), *OECD Science, Technology and Industry Outlook 2006*, OECD, Paris.

OECD (2007*a*), *R&D and Innovation in Spain: Improving the Policy Mix*, OECD and Spanish Foundation for Science and Technology, Paris.

OECD (2007*b*), *International Migration Outlook: Annual Report 2007 Edition*, OECD, Paris.

OECD (2007*c*), *Policy Coherence for Development: Migration and Developing Countries*, OECD, Paris.

OECD (2008 forthcoming), *Open Innovation in Global Networks*, OECD, Paris.

Özden, Ç. and Schiff, M. (eds.) (2007), *International Migration, Economic Development and Policy*, The World Bank, Washington, DC.

Pandey, A., A. Aggarwal, R. Devane and Y. Kuznetsov, (2006), "The Indian Diaspora: A unique case? ", in Y. Kuznetsov, (ed.) (2006), *Diaspora Networks and the International Migration of Skills: How countries can draw on their talent abroad*, WBI Development Studies, The World Bank, Washington, DC.

Power, D. and M. Lundmark (2004), "Working through Knowledge Pools: Labour market dynamics, the transference of knowledge and ideas, and industrial clusters", *Urban Studies*, Vol. 41, No. 5/6, pp. 1025-1044, May.

Rapoport, H. (2004), "Who is afraid of the brain drain? Human capital flight and growth in developing countries", *Brussels Economic Review*, Vol. 47(1), pp. 89-101, Spring.

Regets, M. (2001), "Research and Policy Issues in High-skilled International Migration: A perspective with data from the United States", in OECD (2001), *Innovative People: Mobility of Skilled Personnel in National Innovation Systems*, OECD, Paris.

Rindoks, A., R. Penninx and J. Rath (2006), "Gaining from Migration: What works in networks? Examining economically related benefits accrued from greater economic linkages, migration processes, and diaspora", Report prepared for the

OECD Development Centre, February, Institute for Migration and Ethnic Studies, Amsterdam.

Saxenian, A. (2002), "Brain Circulation: How high-skill immigration makes everyone better off", *The Brookings Review*, Vol. 20(1), Winter, pp. 28-31.

Saxenian, A. (2006), *The New Argonauts: Regional Advantage in a Global Economy*, Harvard University Press, Cambridge, MA.

Saxenian, A. and J.-Y. Hsu (2001), "The Silicon Valley-Hsinchu Connection: Technical Communities and Industrial Upgrading", *Industrial and Corporate Change*, Vol. 10(4), pp. 893-920.

Schiff, M. (2006), "Brain Gain: Claims about its size and impact on welfare and growth are greatly exaggerated", in Özden, Ç. and Schiff, M. (eds.) (2006), *International Migration, Remittances and the Brain Drain*, International Bank for Reconstruction and Development/The World Bank, Washington, DC.

Sorenson, O., J. Rivkin and L. Fleming (2006), "Complexity, networks and knowledge flow", *Research Policy*, Vol. 35, pp. 994-1017.

The Economist (2006), *The Battle for Brainpower: A survey of talent*, 7 October, London.

Thompson, P. and M. Fox-Kean (2005), "Patent Citations and the Geography of Knowledge Spillovers: A reassessment", *American Economic Review*, Vol. 95(1), March, pp. 450-460.

Tremblay, K. (2002), "Student mobility between and towards OECD countries: A comparative analysis", in OECD (2002), *International Mobility of the Highly Skilled*, OECD, Paris.

UNCTAD (United Nations Conference on Trade and Development) (2005), *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*, United Nations, New York and Geneva.

Walters, L. (2004), "Human embryonic stem cell research: An intercultural perspective", *Kennedy Institute of Ethics Journal*, 14(1), pp. 3-38.

World Bank (2006), *Global Economic Prospects 2006: Economic Implications of Remittances and Migration*, Washington DC.

World Economic Forum (2006), *The Global Competitiveness Report 2006-2007*, Geneva, Switzerland.

Zhang, G. and W. Li (2002), "International Mobility of China's Resources in Science and Technology and its impact", in OECD (2002), *International Mobility of the Highly Skilled*, OECD, Paris.

Zucker, L. and M. Darby (2006), "Movement of Star Scientists and Engineers and High-Tech Firm Entry", *NBER Working Paper Series*, Working Paper 12172, Cambridge, MA.

Zucker, L., M. Darby and M. Brewer (1998), "Intellectual Human Capital and the Birth of US Biotechnology Enterprises", *American Economic Review*, Vol. 88(1), March, pp. 290-306.

ISBN 978-92-64-04774-7
The Global Competition for Talent
Mobility of the Highly Skilled
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Chapter 3

Mobility and Its Impact: Data and Evidence

This chapter presents the available data on international mobility as a basis for exploring issues relating to the patterns of mobility and innovation, the importance of mobility of scientific and technological workers in the innovation process, and the impacts of OECD and non-OECD mobility.

Human resources in science and technology (HRST) are a crucial component of modern economies. Over the decade from 1996 to 2006, employment in HRST occupations grew faster than total employment in all OECD countries. As a percentage of total employment in 2006, workers in professional and technical occupations represented more than 30% of total employment in the United States and in the EU25 (OECD 2007a, p. 50). Northern European countries tend to have the largest share of HRST occupations in total employment, although other countries with low initial shares of professionals and technicians, such as Spain, Hungary and Greece, are experiencing strong growth rates and are catching up to other OECD countries.

This chapter explores the available data and evidence on the international mobility of HRST. While the main focus is the mobility of highly skilled professionals, particularly scientists, engineers and researchers, direct data on their movement and flows are limited, so proxy measures are used (Box 3.1). Patterns of mobility are described: the stocks and flows of migrants to and from OECD countries, as well as the perspective of non-OECD economies; international mobility of students; and repatriation of mobile HRST. The chapter then presents some evidence on the impact of mobility and the outlook for the future. Owing to data constraints, patterns of mobility for researchers at the sectoral level or within the private sector are not studied. These areas would benefit from further study.

Box 3.1. **Data availability and limitations**

Recent years have seen major efforts to improve data on international stocks and flows of highly skilled people. This chapter draws on the most recent data. However, statistical data on intersectoral and cross-border flows of the highly skilled, and more generally on HRST and researchers, remain problematic. First, internationally comparable data are difficult to collect because of the heterogeneity of immigration data. Countries have different migration systems, legislation and policies, and definitions of the immigrant population and counting methodologies vary markedly across countries. In some an immigrant is defined according to the place of birth whereas in others citizenship/nationality is used. A complication is the fact that in many countries it is possible to have dual nationality.

Box 3.1. **Data availability and limitations** *(cont.)*

A second problem associated with collecting data on the international mobility of *researchers* stems from the statistical definition of researchers in relation to the standard occupational classifications. It is important to clarify the differences between the highly skilled, HRST, R&D personnel and researchers. Highly skilled refers to persons possessing tertiary-level qualifications (*i.e.* International Standard Classification of Education [ISCED] level 5A, 5B and 6). HRST are defined in the *Canberra Manual* (OECD and Eurostat, 1995) as people who fulfil one of the following conditions: they *i)* have successfully completed *education* at the tertiary level in an S&T field of study (*i.e.* HRSTE); or *ii)* are not formally qualified as above, but are *employed* in an S&T occupation where the above qualifications are normally required (*i.e.* HRSTO).

The HRST definition is broad and covers "people actually or potentially employed in occupations requiring at least a first university degree". Therefore, HRST and highly skilled are similar terms when HRST are defined according to level of education. Doctorate holders are persons who have followed a tertiary programme and have been awarded an advanced research qualification at ISCED level 6. R&D personnel, as defined by the *Frascati Manual* (OECD 2002, pp. 92-93) are "all persons employed directly on R&D", which includes those providing direct services such as R&D managers, technicians and clerical staff. Researchers are defined as "professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and in the management of the projects concerned". However, the International Standard Classification of Occupations does not currently have a code to define "researchers": it only defines research managers. This means that when statistical data sets are merged, such as labour force surveys and census data, R&D personnel and researchers cannot be identified.

It is beyond the scope of this chapter to discuss fully the limitations associated with collecting data on the international mobility of the highly skilled and researchers, but the main issues include inconsistent methodological frameworks, differing occupational and statistical classifications, different sample sizes, and differing survey questions. As a result, regular and comparable data that can be used to map the international mobility of HRST and researchers are lacking. Developing internationally comparable indicators is clearly an area that statisticians and policy makers need to address.

Patterns of mobility

As Chapter 2 shows, mobility patterns are becoming more complex, and the expanding geographical range of possibilities also increasingly blurs distinctions between "sending" and "receiving" countries. The extension of

traditional notions of permanent migration to include temporary or circular mobility increases the difficulty of collecting and analysing relevant data.

The data presented here are taken from various sources, including the OECD Database on Immigrants and Expatriates. This internationally comparable data set, with detailed information on the foreign-born population for almost all OECD member countries, allows for the calculation of emigration rates[1] (by level of qualification) to the OECD area for approximately 100 countries. Although the data are largely based on national censuses conducted in 2000 and 2001, and are thus becoming dated, they provide the best internationally comparable data on foreign-born populations and educational attainment. More up-to-date data will be available when countries undertake their next round of censuses (usually on a ten-year cycle). The database has recently been extended to include information on further demographic and labour market characteristics of immigrants living in OECD countries in 2001 (OECD Database on Immigrants in OECD Countries). In general, the data on international stocks and flows of highly skilled people have improved in recent years, although data on intersectoral and cross-border flows of HRST remain problematic owing to differences in national systems and definitions (see Box 3.1). As a result, there are gaps in the empirical picture.

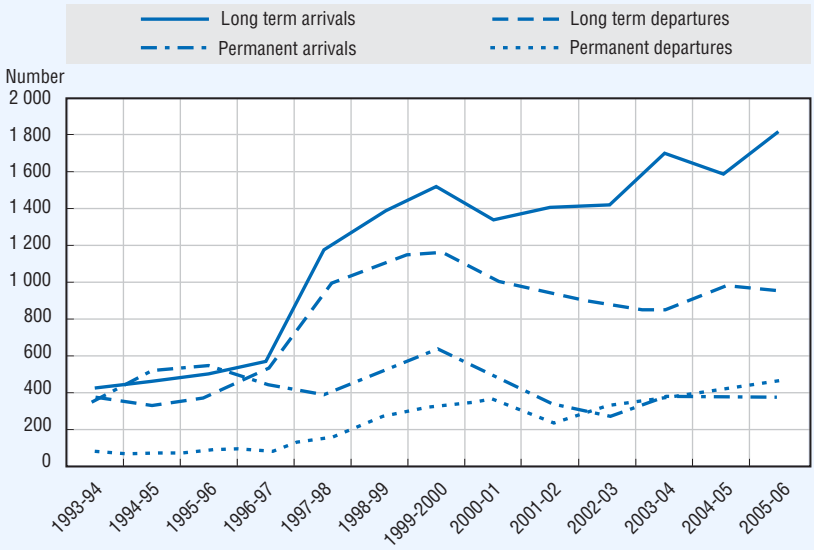
It is important to note that the international mobility of HRST may have increased in recent years because of the globalised market for HRST and changes in science and innovation systems. For example, recent data from Australia show rapid growth in the movement of scientists and academics (Box 3.2). Moreover, intra-EU mobility and migration have changed following the last round of accessions to the EU (OECD, 2007c, p. 43) although the extent of the movement of HRST is not yet known.

Box 3.2. **The migration of academics and scientists: recent evidence from Australia**

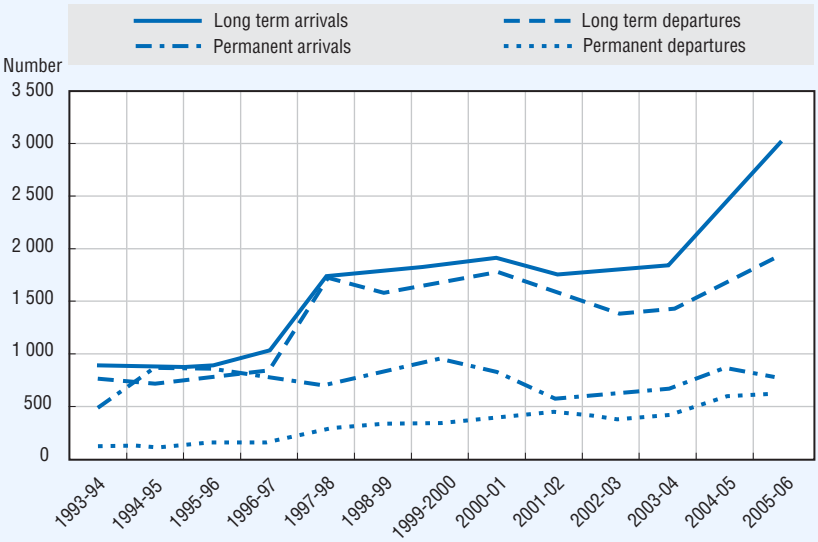
Australia collects detailed data on both stocks and flows of international migration. It is one of the few countries to collect information on persons leaving as well as arriving. Looking at the movement of academics and scientists over the period 1993-94 to 2005-06 shows substantial increases in long-term arrivals and departures. The number of academics and scientists entering Australia on a long-term basis rose from 1 283 in 1995-96 to 4 823 a decade later. The outflow of Australian academics and scientists also increased over the period, although in smaller numbers.

Box 3.2. **The migration of academics and scientists: recent evidence from Australia** *(cont.)*

Academics



Scientists



Source: Hugo (2007), p. 11.

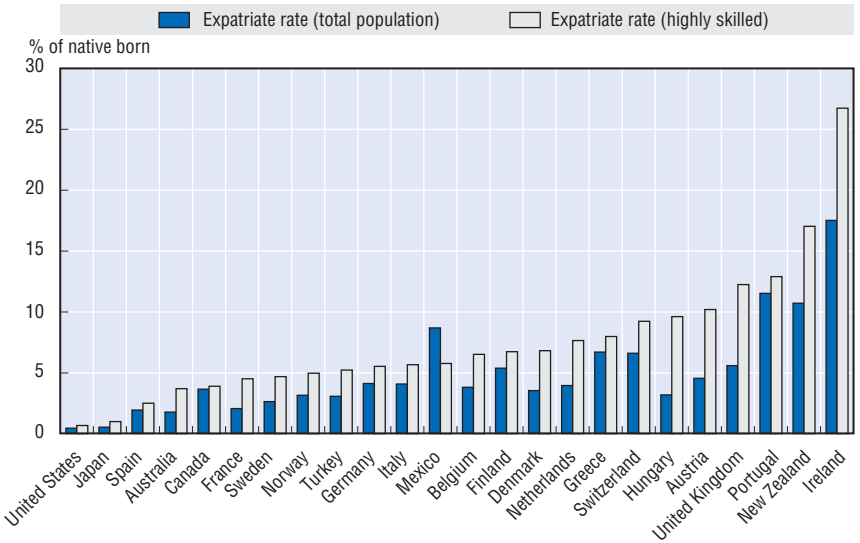
Departures

Figure 3.1 shows that for most OECD countries, the stock of highly skilled (*i.e.* tertiary-educated) expatriates in other OECD countries represents less than 10% of the stock of the highly skilled native-born. For instance, the United States, Japan and Spain all have highly skilled expatriation of well below 5% of stocks, suggesting low mobility rates. However, New Zealand and Ireland have more than 15% of their highly skilled population living in another OECD country. As for Mexico, it is the only OECD country for which general expatriation is greater than highly skilled expatriation as a percentage of the native-born. Table 3.1 gives absolute numbers of highly skilled expatriates from OECD countries living in other OECD countries in 2001. Luxembourg, Norway and the Slovak Republic had the smallest absolute numbers of expatriates, while Germany and the United Kingdom had the largest. In terms of gender, a profile of immigrants in OECD countries showed that, in most, there is little difference in emigration rates for men and women (OECD, 2008a, p. 79).

In terms of educational attainment of expatriates from OECD countries, Figure 3.2 shows that the highly skilled make up more than 25% of migrants for most countries. However, there is again a wide spread, which reflects the

Figure 3.1. **Expatriates in OECD countries, as a percentage of all native-born, by OECD country of birth, 2001**[1]

Total population and highly skilled



1. 2001, or nearest available year, for available countries.

Source: OECD Database on Immigrants and Expatriates.

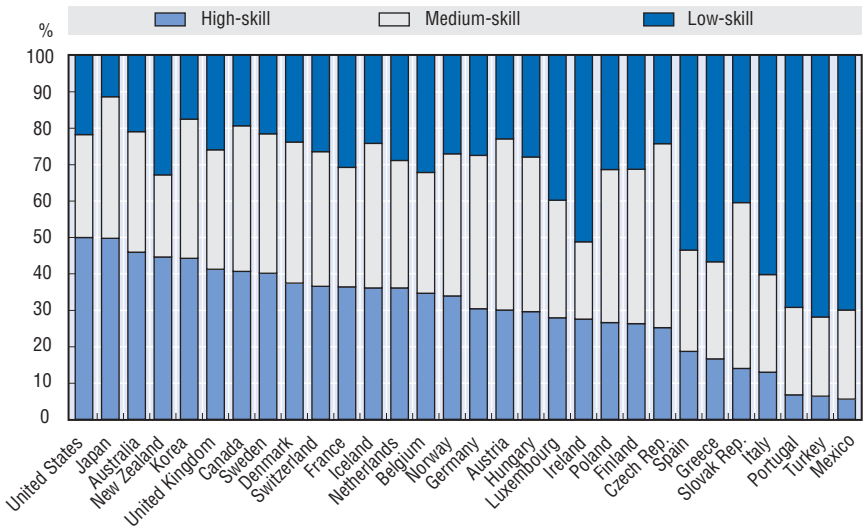
Table 3.1. **Expatriates in OECD countries, highly skilled, by OECD country of birth, 2001**[1]

	Highly skilled expatriates		Highly skilled expatriates
Australia	122 580	Luxembourg	7514
Austria	101 013	Mexico	474 565
Belgium	112 550	Netherlands	209 898
Canada	426 291	New Zealand	168 374
Czech Republic	54 273	Norway	39 433
Denmark	59 874	Poland	327 110
Finland	67 171	Portugal	82 796
France	361 615	Slovak Republic	52 251
Germany	883 624	Spain	59 874
Greece	118 833	Sweden	78 643
Hungary	90 232	Switzerland	107 458
Ireland	186 312	Turkey	130 753
Italy	294 767	United Kingdom	1 276 929
Japan	284 587	United States	412 618
Korea	134 909	Total	6 726 847

1. 2001, or nearest available year.

Source: OECD Database on Immigrants and Expatriates.

Figure 3.2. **Distribution of expatriates by skill level and country of origin, 2001**[1]



1. 2001, or nearest available year

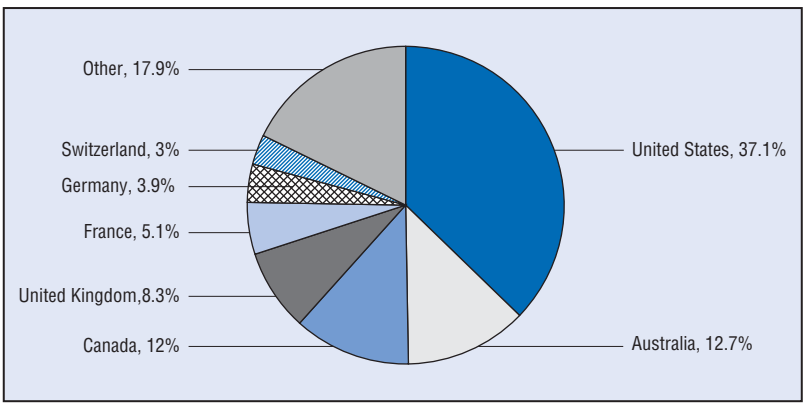
Source: OECD Database on Immigrants and Expatriates; Dumont and Lemaître (2005).

diversity of OECD countries. Almost 50% of expatriates from Japan and the United States are highly skilled, compared with less than 10% in Mexico, Portugal and Turkey.

Where do highly skilled expatriates go? Figure 3.3 shows that as at 2001 the United States, Canada, Australia and the United Kingdom had attracted the largest absolute numbers of OECD-born highly skilled expatriates, followed by France and Germany. Expatriate numbers are not necessarily related to a country's economic size. Japan, for example, had over 12% of the OECD's GDP in 2000 (at current market prices using current PPPs), but attracted only 0.7% of the OECD's highly skilled expatriates in 2001. In contrast, Australia's share of the OECD's GDP in 2000 was around 2%, yet it attracted 12.7% of OECD-born highly skilled expatriates. This reflects the complex range of factors that influence mobility choices, discussed in Chapter 2.

Figure 3.3. **Main OECD destinations of OECD-born highly skilled expatriates, 2001**[1]

Percentage shares



1. 2001, or nearest available year

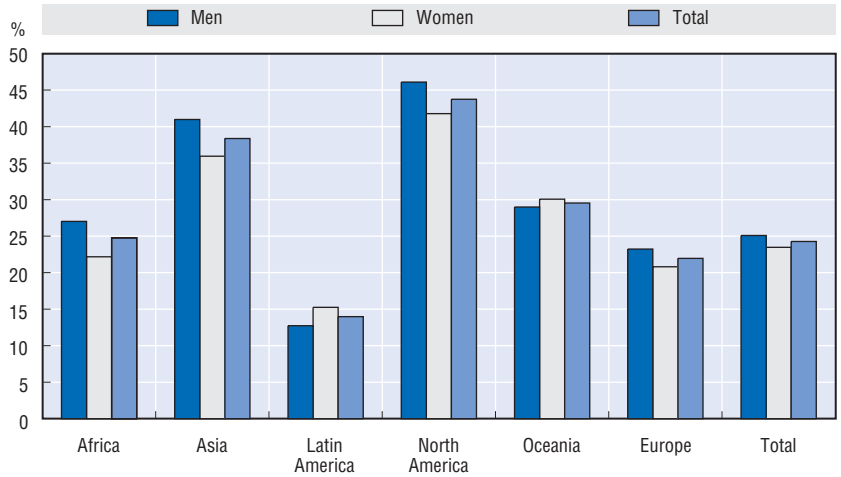
Source: OECD Database on Immigrants and Expatriates.

Arrivals

A snapshot of the characteristics of all immigrants living in OECD countries in 2001 shows that 24.3% of the foreign-born were tertiary-educated. This can be broken down by region of origin and by gender (Figure 3.4). For instance, 38.4% of immigrants born in Asia were tertiary-qualified, compared to 22% of European-born migrants. This differential may be due to several factors, including the tendency for Asian migrants to move to countries with selective immigration policies (*i.e.* the highly skilled tend to move), and the

Figure 3.4. **Percentage of immigrants in OECD countries with tertiary education**

By region of origin and gender



Source: Database on Immigrants in OECD Countries; OECD (2008a), p. 17.

large number of Asian students studying abroad. More broadly, recent migration waves tend to be better educated than earlier ones. Therefore, if immigrants from a certain region are predominantly recent migrants, the average educational level is likely to be higher. For example, 90% of Italian, Greek and Portuguese immigrants in the OECD area migrated before 1990 and were less likely to be tertiary-educated (OECD, 2008a, p. 79). Figure 3.4 also shows that, on average, slightly fewer female migrants are tertiary-educated, compared to male migrants, but this also differs by region of origin. For instance, 15.2% of female migrants born in Latin America were tertiary-qualified, compared to 12.7% of male migrants.

For a number of OECD countries, intra-OECD flows of highly skilled (tertiary-educated) migrants add substantially to the stock of the highly skilled. In Luxembourg, Switzerland, Australia, New Zealand and Ireland, highly skilled migrants from other OECD countries were equivalent to more than 15% of the native-born highly skilled in the country in 2001. In Switzerland, for example, there is a long tradition of employing highly qualified staff from the European countries in which the Swiss national languages (German, French and Italian) are spoken, and inward mobility of human capital has been a major source of personnel in science and technology since the Second World War (Arvanitis and Wörter, 2005, p. 59). For 16 of the OECD countries covered by the data, highly skilled migrants from

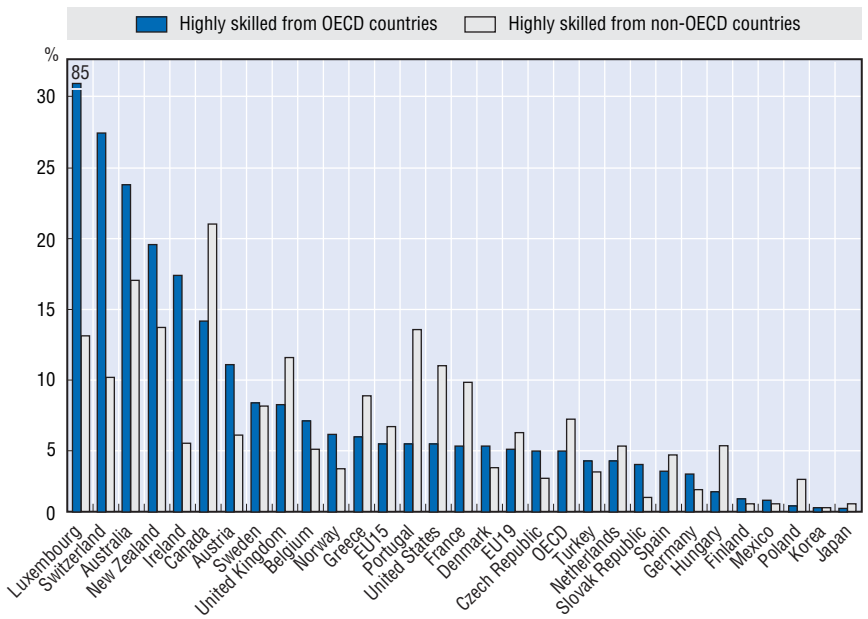
OECD countries were more numerous than those from non-OECD countries (Figure 3.5).

Nevertheless, while intra-OECD migration flows are significant, a number of OECD countries attract a larger number of highly skilled migrants from non-OECD economies. For example, Figure 3.5 shows that in Canada in 2001 these highly skilled migrants were equal to more than 20% of the highly skilled native population. This compares to less than 15% for OECD-sourced skilled migrants. Other countries with significantly higher non-OECD skilled migration relative to intra-OECD migration include Portugal, the United States and France.

Recent figures from the European Union also highlight differences in the significance of foreign skills across countries. Using a set of new indicators on HRST populations by nationality and country of birth, Eurostat found that in 2006, only 6% of HRST aged 25-64 in the European Union were non-nationals (*i.e.* citizens of a country other than their country of residence) (Eurostat, 2007). These non-national HRST were equally divided between

Figure 3.5. **Highly skilled migrants from OECD and non-OECD countries, by OECD country of residence, 2001**[1]

As a percentage of highly skilled natives in the country of residence

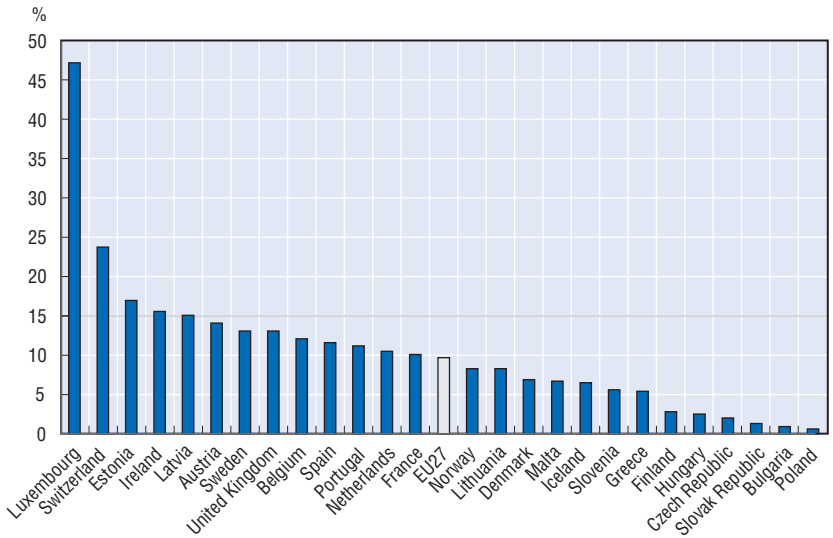


1. 2001, or nearest available year.

Source: OECD Database on Immigrants and Expatriates.

citizens of other EU countries and citizens of countries outside the European Union. At the country level, non-nationals ranged from 46% in Luxembourg, to 0.3% in Slovenia. The shares of foreign-born were a little higher, as some foreign-born immigrants obtain citizenship in their country of residence (Figure 3.6).

Figure 3.6. **Share of foreign-born in HRST aged 25-64, in EU27 and selected countries, 2006**[1]



1. Iceland, Ireland, Luxembourg, Switzerland and Latvia, data from 2005; Lithuania, data from 2003. EU aggregate does not include Bulgaria, Estonia, Germany, Italy, Malta, Romania and the Slovak Republic.

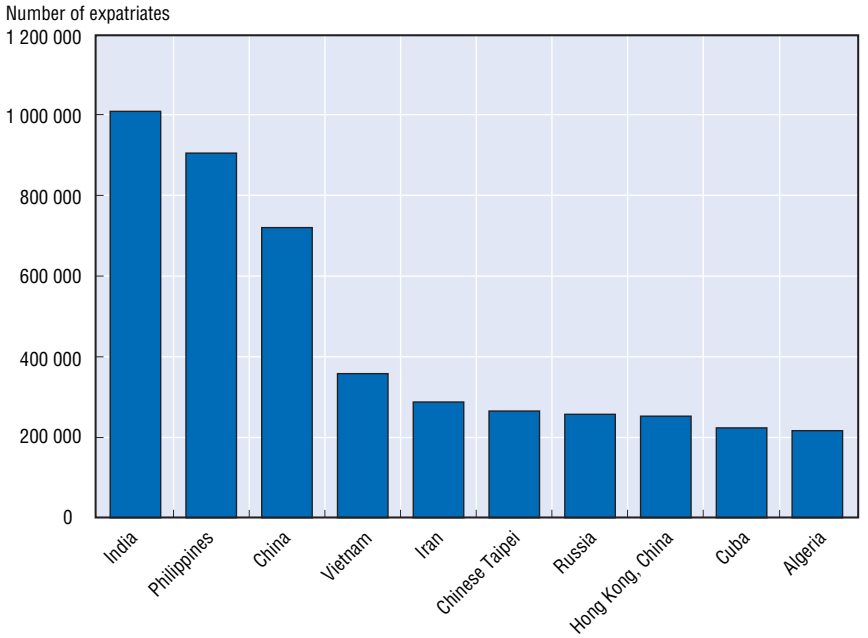
Source: Eurostat (2007).

Foreign-born residents in OECD countries come from many countries. In 2001, the top ten source economies for highly skilled non-OECD expatriates were predominantly Asian, led by India, the Philippines and China (Figure 3.7).

Overall, most OECD countries are net beneficiaries of highly skilled migration, with highly skilled immigration towards OECD countries from other OECD countries and the rest of the world systematically exceeding highly skilled emigration from OECD countries to other OECD countries. Figure 3.8 shows that Mexico, Korea, Ireland, Italy, Finland and some central and eastern European countries experienced a net loss of individuals with a tertiary education, while the other OECD countries experienced a net inflow. These figures do not include expatriation of the highly skilled to non-OECD

Figure 3.7. **Foreign born highly skilled expatriates in OECD countries, by country of origin, 2001**[1]

Top ten non-OECD economies



1. 2001, or nearest available year.

Source: OECD Database on Immigrants and Expatriates.

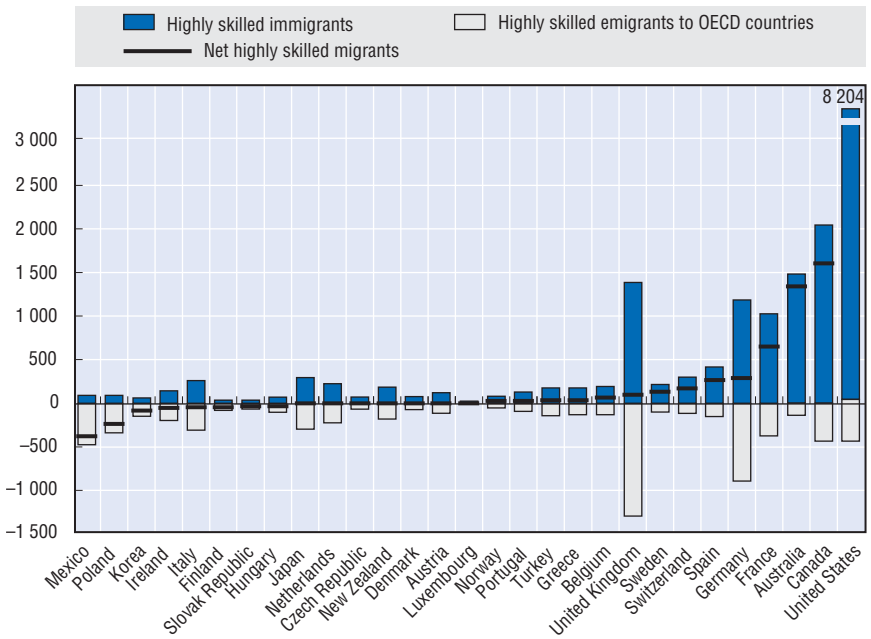
countries which is assumed to be relatively uncommon (see Dumont and Lemaître, 2005); however, as these countries develop, they will likely exert a greater "pull", perhaps especially for descendants of earlier migrants from these countries.

While these data show the net balance of the highly skilled, they do not reveal whether the skill levels and technical specialisations of immigrants and expatriates are similar. It is therefore not possible to analyse skill mismatches and know whether movements are concentrated in particular occupational fields. The difference between incoming and outgoing flows in terms of the level of expertise may also be significant. For example, a country may lose a Nobel prize-winning researcher and gain a person who has recently completed a tertiary-level qualification.

The significance of these highly skilled flows into OECD countries becomes even more apparent when considering researchers and doctorate

Figure 3.8. **Immigrant and emigrant population 15 years and over with a tertiary education in OECD countries, 2001**[1]

Thousands



1. 2001, or nearest available year.

Source: OECD Database on Immigrants and Expatriates.

holders. Figure 3.9 shows that the stocks of doctorate holders are affected by mobility in a number of countries, although countries differ considerably in this respect. For example, in New Zealand, more than 40% of doctorate holders were foreign-born and in Ireland they were over 35%.

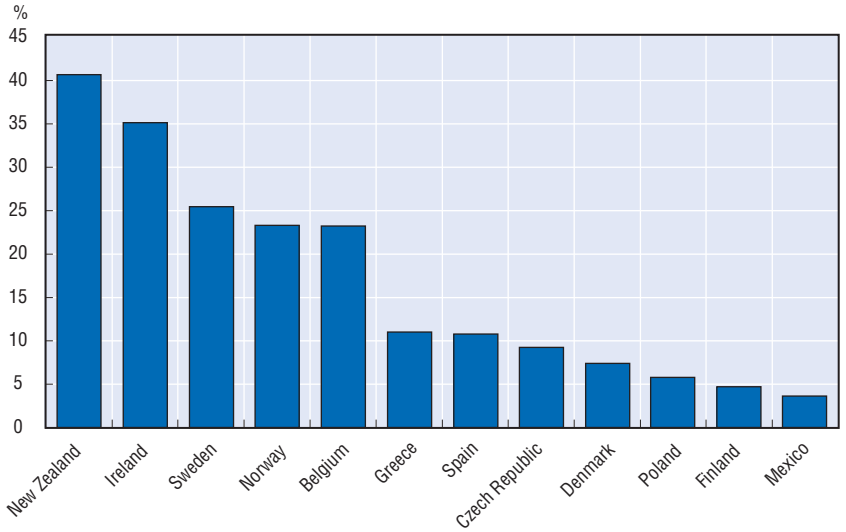
It is also clear that migrants make a significant contribution to the science workforce in many countries. Table 3.2 shows that the share of science professionals in the tertiary-educated workforce is frequently higher for migrants, especially those of Asian origin, than for the native population. For instance, in the United States, over 20% of tertiary-educated migrants from Asia are science professionals, compared with 10.3% of other migrant groups, and 7.7% of tertiary-educated natives.

The perspective of non-OECD economies

The OECD Database on Immigrants and Expatriates allows for the calculation of emigration or expatriation rates to the OECD area for highly skilled people from all OECD countries as well as many non-OECD economies. The emigration rate is calculated by dividing the highly skilled (those with

Figure 3.9. **Foreign-born doctorate holders as a percentage of total doctorate holders, 2001**[1]

By OECD country of residence



1. 2001, or nearest available year.

Source: OECD Database on Immigrants and Expatriates (excluding countries that have provided data for the Careers of Doctorate Holders project).

Table 3.2. **Share of science professionals in tertiary-educated workers, circa 2000**

Percentages

	Canada	United States	United Kingdom	Australia	France	Sweden
Among Asian migrants	12.8	20.1	10.9	12.4	14.5	8.2
Among other migrants	9.5	10.3	8.6	8.7	10.6	7.1
Among natives	5.8	7.7	9.6	6.7	8.9	8.5

Note: Science professionals defined as ISCO Group 21 (Physical, mathematical and engineering science professionals).

Source: Database on Immigrants in OECD Countries; OECD (2008a), p. 23.

tertiary education) expatriate population from the country of origin by the total native-born population of the same country and level of education. Figure 3.10 presents three groups of countries: those with expatriation rates of the highly skilled of less than 10%; those with expatriation rates of 10 to 20%; and those with expatriation rates of 20% or more. Most OECD countries' expatriation rates of the highly skilled are below 10%, although some have higher rates, especially New Zealand (17%) and Ireland (27%).

Among the non-OECD economies with low expatriation rates to OECD countries are most of the large ones, such as Indonesia, Bangladesh, Brazil, India and China. Smaller countries, particularly islands, such as Jamaica, Haiti, Trinidad and Tobago, and Fiji, tend to have much higher expatriation rates, of more than 60% and in some cases more than 80%. African countries also have particularly high expatriation rates of the highly skilled to OECD countries.

Figure 3.10. **Expatriation rates of the highly skilled to the OECD, 2001**[1]

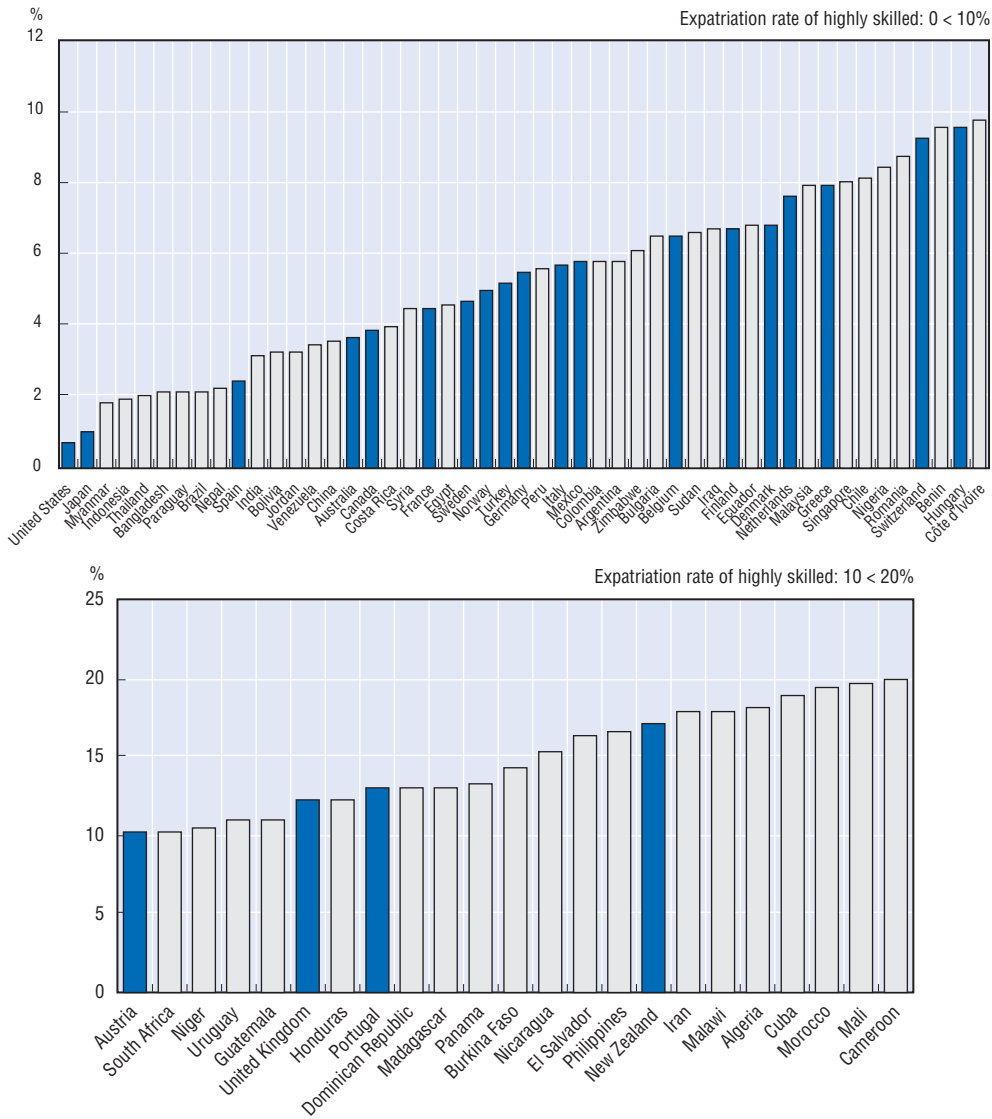
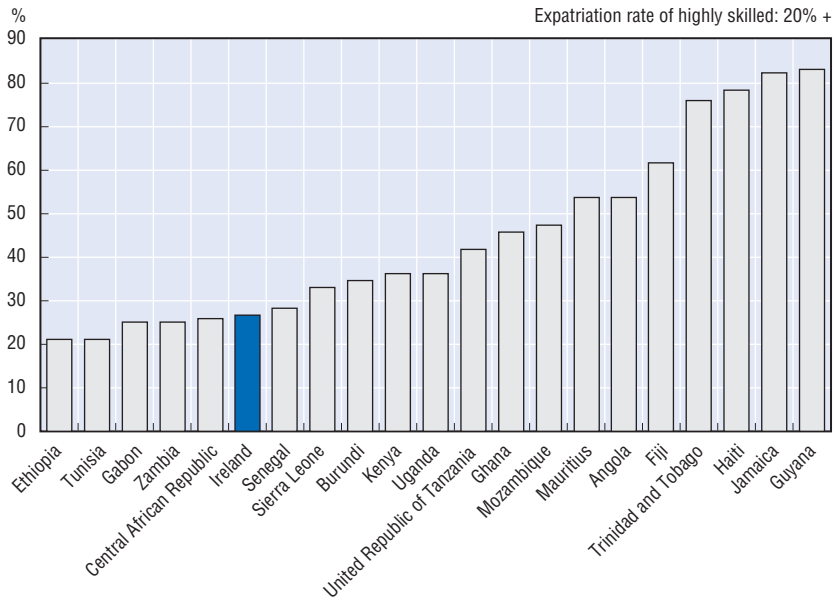


Figure 3.10. **Expatriation rates of the highly skilled to the OECD, 2001**[1] *(cont.)*



1. 2001, or nearest available year

Source: OECD Database on Immigrants and Expatriates (series ERCSHS15).

Nevertheless, as noted above, flows of migrants now seldom go in only one direction. Data from the International Organization for Migration show that, of the top ten migrant-hosting countries in 2000, five were non-OECD economies: the Russian Federation, Ukraine, India, Saudi Arabia and Pakistan, which together hosted more than 20% of the world's international migrants (IOM, 2005, p. 397). However, when the former Soviet Union was broken up into independent states, the number of international migrants increased as people previously classified as internal migrants were reclassified as international migrants. A database constructed by the World Bank, which excludes the Russian Federation, Ukraine and Kazakhstan on the basis that they are not representative of "normal" migration patterns, shows four non-OECD members in the top ten for receiving migrants: India, Saudi Arabia, Pakistan and Hong Kong, China (Parsons *et al.*, 2007).[2] Together, these economies accounted for 10.5% of international migrants. Four of the following five next biggest migrant recipients were also non-OECD members: Côte d'Ivoire, Iran, Israel and Jordan. Overall, the World Bank database showed that South-South migration accounted for 24% of total emigration (South-North was 37% and North-North 16%).

Skilled workers form part of this circulation between non-OECD members. For example, Adepoju (2004) noted that skilled Africans, pressured by uncertain economic conditions at home, had found the economies of Gabon, Botswana, Namibia and South Africa to be convenient alternatives to Europe, the United States and the Gulf States. Unfortunately, there are few data available to quantify the "South-South" flows of skilled migrants. Some data from South Africa suggest that between 1994 and 2001, South Africa gained around 500 researchers a year, a significant number of whom were mid- to late-career professionals from African countries. At the same time, South Africa was losing an estimated 2 500 researchers a year, thus contributing to the low number of researchers in total employment (National Advisory Council on Innovation, 2006, p. 58).

Interestingly, among non-OECD countries, tertiary-educated emigration rates are higher for women than for men, at 13.9 and 9.7%, respectively (OECD, 2008a, p. 79). At the continental level, the average emigration rate of the tertiary educated is higher for women than for men in Africa (27.7% for women, 17.1% for men), and in Latin America (21.1% for women, 17.9% for men). A smaller difference is found in Asia and Oceania, and there is no gap in Europe and North America.

Gender differences in emigration were also found in research by Docquier *et al*. (2007). The study, based on data for 170 countries, found that the emigration rate of skilled females (defined as those having at least one year of post-secondary education) in low-income countries was 10.2% in 2000, compared to 6.3% for skilled males. For high-income countries, the figures were more balanced, with an emigration rate for women of 4% and for men of 3.7%. Large gender differences in emigration rates were also found between regions in Africa (northern and southern Africa had similar rates across genders while middle and western Africa had much higher female rates) and between regions in Asia. The authors found a strong correlation between the gender gap in emigration rates and the gender gap in educational attainment in source countries. It may be that gender gaps in education reflect broader societal gender differences that encourage skilled women to seek opportunities abroad, thus leading to higher female emigration rates. Overall, the study found that the share of females in skilled emigration increased from 46.7 to 49.3% over the period 1990-2000. This result was mainly due to an increase in the supply of skilled women as they gained increased access to schooling in less developed countries.

Student mobility

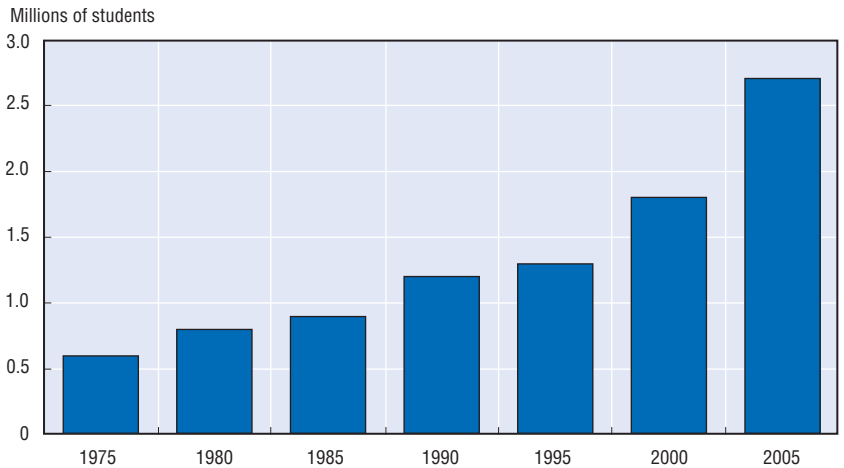
The internationalisation of HRST is also observed in the international mobility of students. OECD countries benefit from the inflow of talented students and scholars. Students, especially from developing countries, often

stay on in OECD countries for further research or employment and contribute to innovation in these countries. Students may also return later for employment. A study of German university graduates, for example, found that studying abroad increases a person's probability of working abroad by 15-20 percentage points (Parey and Waldinger, 2007). Attracting foreign students can provide a highly qualified reserve of labour that is familiar with the prevailing rules and conditions in the host country and is able to foster international networks and co-operation. Foreign students may also contribute to the viability of some programmes that would otherwise not attract a sufficient number of enrolments. Many countries now work actively to attract foreign students, with courses taught in widely spoken foreign languages (*e.g.* English, French, German), attractive fee structures, joint degree programmes with foreign universities, and favourable visa processes, for example.

Countries also benefit from their students studying abroad. Luxembourg, for example, relies on international co-operation and mobility of students and researchers for its research system, as its small size means it can only cover a few fields in higher education and research (Ohler, 2005, p. 42). Indeed, until the establishment in 2003 of the University of Luxembourg, students in all fields had to seek their university education abroad.

Data from the OECD and the UNESCO Institute for Statistics show that the number of students enrolled outside their country of citizenship has risen steadily since 1975, with a particularly sharp increase from 1995 to 2005 (Figure 3.11). Most were enrolled in the OECD area (84%), with the United

Figure 3.11. **Number of students enrolled outside their country of citizenship, 1975-2005**



Source: OECD (2007b), p. 303.

States, the United Kingdom, Germany, France and Australia the top five destinations for foreign tertiary students (OECD, 2007b, pp. 303-304).

Other, non-traditional OECD destination countries are also seeking to increase foreign student numbers. For example, the total number of foreign students in Korea reached over 30 000 in 2006 (Table 3.3). International students in science and technology fields are mainly from Southeast Asia. The evidence suggests that most return to their home countries or a third country after graduation, rather than stay in Korea as researchers. Japan has also increased foreign student numbers, with approximately 100 000 foreign undergraduate and graduate students in 2006 (Table 3.4). Here, too, most science and engineering students are from Asian countries. D'Costa (2007) notes that, based on data on visa conversions from student status to worker status, few students remain to work in Japan after completing their studies.

Table 3.3. **International students in Korea, 2006**

Origin	Total	*Of which:* Degree courses		Language courses
		Science and engineering	Human and social sciences	
Asia	29 227	6 158	13 509	6 945
Africa	211	45	137	28
Oceania	125	15	61	23
North America	1 717	114	763	548
South America	200	29	117	36
Europe	1 077	105	342	358
Total	32 557	6 466	14 929	7 938

Source: Korean Ministry of Science and Technology (2007), p. 159.

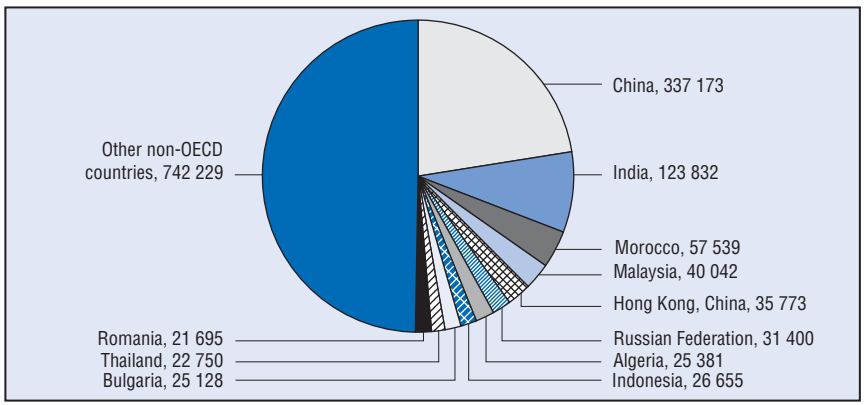
In total, two-thirds of foreign/international students in OECD countries in 2005 were from non-OECD economies (OECD, 2007b, p. 310). Asian students formed the largest group, accounting for nearly half of the overall total and making up more than three-quarters of foreign students in Australia, Greece, Japan, Korea and New Zealand. Figure 3.12 shows the main countries of origin of international students from non-OECD countries, with China and India followed by Morocco and Malaysia. The large number of Chinese students studying overseas is due in part to measures taken by the Chinese government in the wake of system reforms to encourage Chinese students to study abroad. The number of Chinese students studying overseas at their own expense is also increasing rapidly as a result of higher standards of living in China.

Table 3.4. **Foreign students in Japan, 1985-2006**

	1985			2006		
	Total	% of total foreign students	% in social sciences, science and engineering	Total	% of total foreign students	% in social sciences, science and engineering
Foreign undergraduate students						
Total	**14 264**			**68 889**		
China	4 275	30	46.1	46 196	67.1	64.2
N-S Korea	7 351	51.5	51.6	13 081	20.3	51.8
Malaysia	446	3.1	82.5	1 335	1.9	87.8
Thailand	233	1.6	50.2	639	0.1	55.1
Indonesia	94	0.7	46.8	462	0.7	53.2
Vietnam	20	0.1	0.5	777	1.2	68.2
India	41	0.3	9.8	109	0.2	52.3
United Kingdom	83	0.6	43.4	291	0.5	20.3
United States	733	5.1	8.9	1 555	2.2	8.6
Foreign graduate students						
Total	**5 477**			**31 915**		
China	2 087	38.1	49.9	17 566	55	52.1
N-S Korea	1 644	30	39.6	4 322	13.5	44.6
Malaysia	55	1	47.3	433	1.4	70.7
Thailand	260	4.7	52.3	866	2.7	46
Indonesia	128	2.3	42.2	908	2.8	58.4
Vietnam	11	0.2	45.5	778	2.4	63.4
India	58	1.1	46.6	268	0.8	52.2
United Kingdom	30	0.5	26.7	0	0	0
United States	171	3.1	22.8	286	0.9	44.1

Source: D'Costa (2007).

Figure 3.12. **Students from non-OECD economies enrolled in tertiary education in OECD countries, 2004**

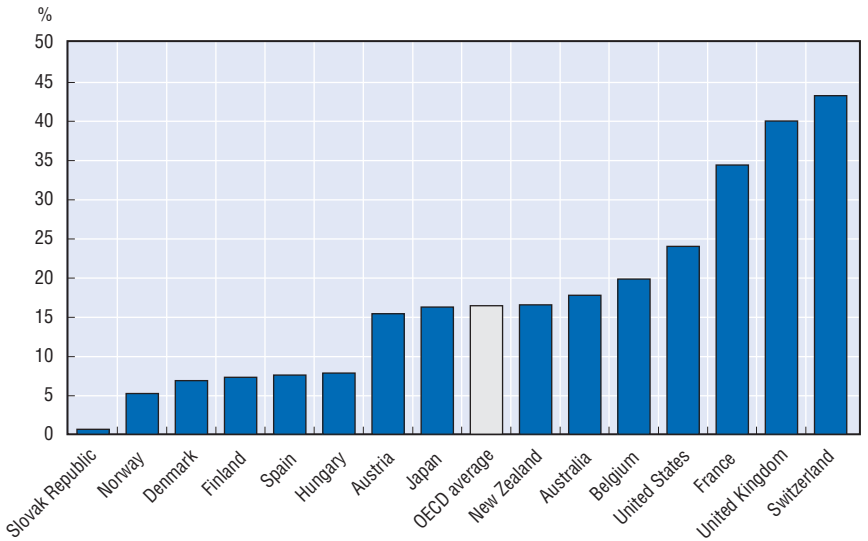


Source: OECD (2007a), p. 61.

International students are a large proportion of total enrolments in advanced research programmes in some OECD countries. Switzerland, the United Kingdom, France and the United States, in particular, have a large number of international students in their advanced programmes – over 40% in Switzerland (Figure 3.13).

Figure 3.13. **International students in advanced research programmes, 2005**[1]

% of total enrolments in advanced research programmes



Note: Advanced research programmes are second-stage tertiary studies that lead to the award of an advanced research qualification. The programmes are devoted to advanced study and original research and are not based on course work alone. The programmes equate to Level 6 of the International Standard Classification of Education (ISCED).

1. For all countries except Finland and Switzerland, international students are defined on the basis of their country of residence. For Finland and Switzerland, international students are defined on the basis of their country of prior education.

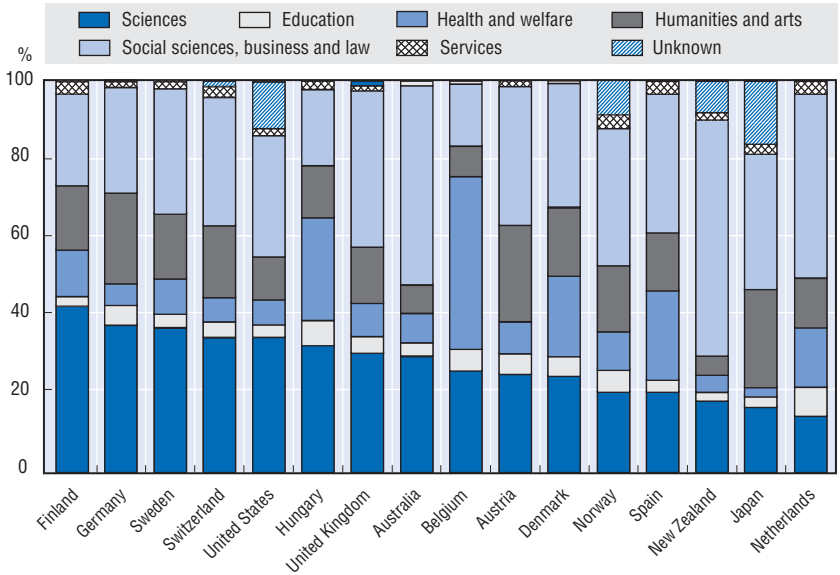
Source: OECD (2007b), p. 317.

Scientific disciplines in a broad sense (that is, including agriculture, engineering, manufacturing and construction programmes) attract large numbers of international students in some OECD countries. Finland receives the largest proportion of its international students in these fields (42%), and the share is also high in Germany, Sweden and Switzerland (Figure 3.14).

The number of students studying abroad in non-OECD economies is also increasing. For instance, Chinese higher education institutions have begun to attract foreign students in recent years. In mainland China in 2005, 44 337 foreign students graduated, 60 904 foreign students entered and 78 323 foreign students enrolled (Table 3.5). While most students were

Figure 3.14. **International students by field of education, 2005**

Percentage of all international tertiary students enrolled in different fields of education



Note: Sciences includes science, agriculture, engineering, manufacturing and construction. Figures for Finland, Germany, Switzerland, Austria and Spain exclude tertiary-type B programmes (ISCED Level 5B – a more practically oriented and occupationally specific programme, which does not give direct access to advanced research programmes). Figures for Germany, Spain, New Zealand and the Netherlands exclude advanced research programmes (ISCED Level 6).

Source: OECD (2007b), p. 311.

Table 3.5. **Foreign students in China, 2005**

By level of training

	Graduates		Degree awarded		Entrants		Enrolments	
	Number	%	Number	%	Number	%	Number	%
Doctoral degree	355	0.8	323	8.5	655	1.1	1 977	2.5
Master's degree	943	2.1	887	23.4	1 596	2.6	3 938	5.0
Normal courses	3 327	7.5	2 581	68.1	12 001	19.7	29 584	37.8
Short-cycle courses	319	0.7	-	-	640	1.1	867	1.1
In-service training	39 393	88.8	-	-	46 012	75.5	41937	53.5
Total	**44 337**	**100**	**3 791**	**100**	**60 904**	**100**	**78 323**	**100**

Source: Ministry of Education, *Educational Statistics Yearbook of China 2005*.

engaged in "in-service training" (which includes on-the-job training programmes for personnel and orientation programmes) rather than degree courses, the Chinese government has introduced various programmes to encourage and attract foreign students to China for higher-level study and research, such as the Great Wall Scholarship, the Scholarship for Chinese Cultural Studies and the Outstanding Student Scholarship. Furthermore, restrictions limiting foreign students from working part-time have been removed in some areas. For example, the Beijing Municipal Commission of Education does not restrict international students to teaching in the tertiary education institution in which they study (OECD, 2006).

In South Africa, higher education institutions play an important role in training international students from the rest of Africa. Most foreign students studying in South Africa (66%) are from countries of the Southern African Development Community (SADC) – Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Swaziland, Tanzania, Zambia and Zimbabwe. Almost 22% of foreign enrolments in 2001 were at the postgraduate level and 3% were at the doctoral level (National Advisory Council on Innovation, 2006, p. 66). Foreign students accounted for around 9% of total enrolments at South African universities in 2001; it is considered that these numbers could be increased and that South Africa could play a much more significant role in building the human resource base of other sub-Saharan African countries.

Geographic context

While mobility is often measured and discussed at the national level, it is at the regional and local levels that its effects may be felt most strongly. Through their choice of locations, highly skilled migrants can help create, strengthen or weaken existing "centres" and "peripheries" of economic activity. Mahroum (2000) comments that the inflow of scientists to a certain scientific site increases the site's credibility among its peers, and the greater this credibility becomes, the more scientists it attracts.

There is some evidence that the mobility of highly skilled individuals can strengthen existing clusters of scientific activity. Guellec and Cervantes (2002) found that much international migration of scientists and engineers was concentrated around knowledge-intensive clusters and specific research areas (for example, biosciences). The universities of Cambridge and Oxford, in the United Kingdom, received some 15% of all foreign academics employed in the country between 1994 and 1997, for example. A study of German scholars in the United States found that one-third were employed on the west coast, in the academic centres of California, while another third were concentrated in Boston, New York and Washington, DC, on the east coast.

Further confirmation comes from recent research by Wadhwa *et al.* (2007b) on the role of regional technology centres in the United States. In an analysis of immigrant-founded companies in Silicon Valley in California and the Research Triangle Park in North Carolina, the authors found that over half of Silicon Valley start-ups had one or more immigrants as a key founder, compared with the California average of just under 40%. The Research Triangle Park also had a higher percentage of immigrant-founded firms than the state average (18.7 and 13.9%, respectively).

The same study also found a high level of geographical ethnic clustering in immigrant-founded engineering and technology companies, with 40% of Indian founders preferring California and New Jersey, while Chinese founders were heavily concentrated in California, with 49% of those from mainland China and 81% from Chinese Taipei. The authors suggested that the clustering reflected the self-reinforcing nature of social and technical networks.

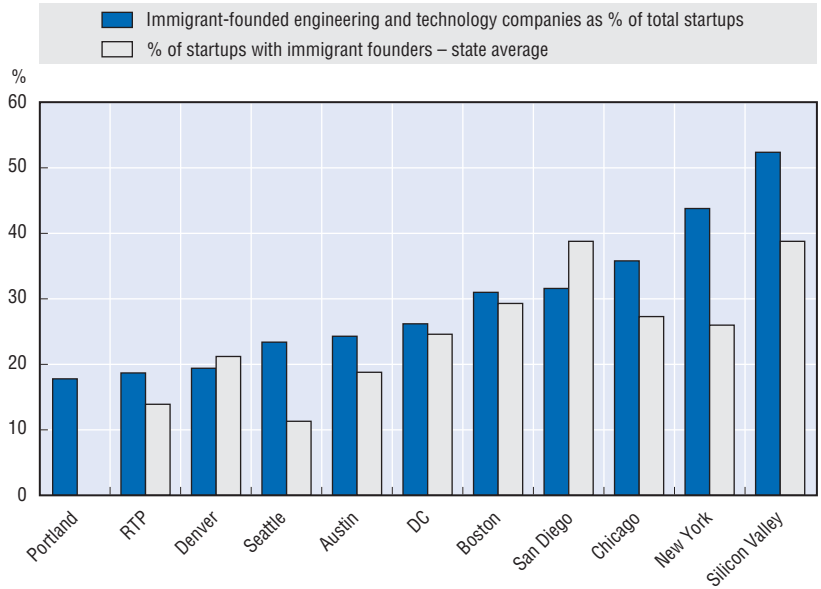
Extending the analysis of the geographical concentration of immigrant-founded companies, Wadhwa *et al.* (2007c) surveyed more than 1 500 start-ups in 11 of the leading centres of technology in the United States for the 1995-2005 period. The study supported earlier findings that immigrant-founded companies cluster in technology centres and thus reinforce centres of scientific and engineering activity. Start-ups in and around major technology centres usually had a higher concentration of immigrant founders than the state average (Figure 3.15). The exceptions were Denver and San Diego, both of which have a significant proportion of military technology and engineering activity, from which immigrants are often excluded.

Return and circular migration

Many migrants choose at some stage to return to their country of origin or to move from their first country of residence to another. The literature reviewed in Chapter 2 also suggested that temporary and circular migration is beginning to play a greater role in mobility, particularly in Europe. As argued by Aydemir and Robinson (2006), information about return or onward migration is essential for understanding the impact of migration on host countries, as "who stays" and "for how long" influences the contribution immigrants make to a host country's human capital stock and population profile, as well as the payoff to settlement and assimilation policies. It is also important for understanding the potential impact on source countries. The evidence suggests that return and onward migration form an important part of mobility and are thus an important consideration for mobility policies.

The OECD Database on Immigrants in OECD countries shows that, of the stock of tertiary-educated immigrants in OECD countries in 2001, almost 65% had been in their country of residence for ten or more years, 15% had been resident

Figure 3.15. **Immigrant-founded start-ups in US technology centres, 1995-2005**



Note: Figures for the percentage of start-ups with immigrant founders at the state level not available for Portland. RTP is the Research Triangle Park in North Carolina. DC is Washington, DC.
Source: Wadhwa *et al.* (2007c).

for five to ten years, and 20% for less than five years. However, the percentage of the tertiary educated who stay for ten or more years is less than that for primary- and secondary-educated migrants (67% and 70%, respectively). This may reflect the fact that more recent cohorts of immigrants are more educated, but may also suggest that tertiary-educated migrants tend to stay for shorter periods. Indeed, among countries that operate a selective system of migration that favours the highly skilled, such as Australia, Canada and New Zealand, the percentage of tertiary-educated migrants who stay ten or more years is significantly lower than that of primary- and secondary-educated migrants (Table 3.6).

Table 3.6. **Percentage of the foreign-born population with a duration of stay of ten or more years**
By country of residence and level of education

	Primary-educated	Secondary-educated	Tertiary-educated
Australia	84.1	76.6	67.8
Canada	74.7	71.3	65.1
New Zealand	79	61.2	57.4
OECD (weighted)	67.4	69.4	64.7

Source: OECD (2008a), p. 99.

Recent data from Australia show that, among the permanent departures of overseas-born residents in 2005-06, more than 60% indicated that they were returning to their country of birth (DIAC, 2007). Many had resided in Australia for some time, almost 70% for five years or more and only 14% for less than two years. A very large proportion of overseas-born residents from Hong Kong, China (85%) and Vietnam (80%) who were permanently leaving had resided in Australia for more than five years. In aggregate, 48% of the total permanent departures were in skilled occupations and 45% of these were born abroad.

The data also show that most skilled Australian emigrants return to Australia. The overall rate of return of skilled Australian residents who indicated that they were leaving permanently or on a long-term basis was around 75% (when returns two years after departure were compared[3]). For those moving to the United Kingdom, the return rate was around 85% (Birrell *et al.*, 2004, pp. 22-23).

Register data from the Nordic countries also reveal a tendency to return to one's home country. Among Danish and Finnish citizens who emigrated to other Nordic countries from 1988 to 1996, 50% had returned home after four to five years, and 60% had returned after nine to ten years (Graversen *et al.*, 2001). The return rate was stable over time, with each cohort displaying similar behaviour. The return rate of non-Danish and Finnish citizens to Denmark and Finland after emigrating to another Nordic country was much lower: after nine to ten years, only 10 to 20% had returned.

Analysis of individual longitudinal migration records of foreign-born persons migrating to and from Norway over the period 1967-2003 also found substantial return migration, although patterns varied significantly by country of origin (Bratsberg *et al.*, 2007). During the period, more than 500 000 migrants arrived in Norway, and around half were still there at the beginning of 2004. Immigrants from the OECD area tended to stay for short periods (only 20% remained in Norway after ten years); out-migration was much lower for immigrants from eastern Europe (around 50%) and lower again for immigrants from non-western source countries (around 30%). After 10 years only 15% of immigrants admitted on the grounds of family reunification had left. Primary refugees are slightly more inclined to leave – after ten years, more than 30% had moved on. Immigrants with work visas are the most likely to out-migrate; about 50% had left within ten years of arrival. Around 14% of out-migrants chose to move to a third country, rather than their home country; this was especially true for immigrants from less developed countries. Sweden, the United Kingdom and the United States were the most popular destinations for these out-migrants.

However, the Norwegian picture on out-migration changes slightly when the focus is on scientific researchers. A study by Nerdrum and

Sarpebakken (2006) found that the greater the cultural, economic and geographic distance separating researchers' home countries from Norway, the higher the likelihood that they will leave the Norwegian public research system more quickly than foreigners from more similar and closer countries. The average yearly outgoing mobility rate for OECD-origin academic research staff over the period 1991-2001 was 4.6%, compared to 12.8% for "rest of the world", 4% for other Nordic researchers, and 3.3% for Norwegian researchers.

A study of return and onward migration among working-age men in Canada found that a substantial part of "permanent" migration is in fact temporary, especially for skilled workers (Aydemir and Robinson, 2006). Using a combination of landings records, census data and longitudinal tax filing information, the study found that out-migration 20 years after arrival was around 35% among young working-age male immigrants. About six out of ten of those who leave do so within the first year of arrival, suggesting that many immigrants make a decision relatively quickly. Migrants' characteristics strongly affect the tendency to leave; out-migration rates were higher among immigrants admitted under the skilled worker or business class visa, with around four in ten leaving within ten years of arrival, compared to two or three in ten for those arriving under assisted relative or refugee visa classes. The authors suggested this finding was consistent with the notion of a global labour market, since skilled worker and business groups are more likely to move on the basis of changing relative labour market conditions in various countries. There was also strong evidence of business cycle effects, with cohorts arriving in recessionary periods around 50% more likely to leave than those arriving at other times.

Information on migrant intentions to stay can also reveal something about the likelihood of return and circular migration. Data from the United Kingdom, covering the period 1996 to 2005, show that the intended length of stay for immigrants is falling (Office for National Statistics, 2007). Approximately 45% of migrants who specified the duration at their time of entry in 2005 stated their intention to stay in the United Kingdom for one to two years, while 30% intended to stay more than four years. In 1996, only 35% of migrants intended to stay one to two years and 40% intended to stay more than four years.

Reasons for return

Anecdotal evidence on reasons for return migration is provided by Khadria (2004), drawing on a small survey of returned IT workers in India. The three primary motivating factors behind the return to India of the sampled IT workers were family/personal reasons, recognition of India as a major

emerging IT power, and increasing employment opportunities in India. Higher real earnings in India were also a motivating factor for many workers. Although nominal wages were higher abroad, the cost of living was also much higher. Important motivating factors for settling in Bangalore in particular were abundant employment opportunities, better infrastructure than in other Indian cities, better remuneration packages and availability of experts in the IT sector.

Khadria found that the returning workers had generally moved overseas for less than six years and had mainly gone to work on project assignments for their employers or to gain professional experience. None had gone with the intention of settling permanently abroad, and the majority felt that the knowledge and skills they had gained overseas were very useful for their current jobs in India. Many said their experience helped in interacting with clients (many of whom were from the United States or European countries), acquiring technological innovations and coping with technical change, improving management practices, and confidence building.

A study of Australia's diaspora found similar motivating factors behind the return of migrants (Hugo *et al.*, 2003). Lifestyle and family were the overwhelming reasons for returning to Australia for many migrants, while those not intending to return indicated that a better job or higher salary than the one they currently had would attract them back. Nearly 80% of the expatriates surveyed believed that their overseas residency had benefits for Australia in terms of "creating goodwill towards Australia" and "skills transferable back to Australia".

Research on Portuguese scientists' views on return migration highlights the importance of adequate employment opportunities at home. Fontes (2007) built a sample of 55 Portuguese expatriate scientists who were inventors of biotechnology patents and collected information on their careers and their perspectives on return. Most were still abroad and intended to stay there; however, for most of them, "this decision is based less on the unwillingness to return, than on the awareness of the difficulties to be expected at home" (2007, p. 295). Around 38% of the scientists strongly wished to return and regretted the absence of employment compatible with their qualifications, while 34.5% would only be willing to return if a particularly good opportunity arose. Fontes pointed to the importance of a coherent and sustained strategy that combines incentives to return with the creation of attractive conditions and the strengthening of scientific diaspora networks.

Expectations regarding labour market/employment conditions also play a role in the decision to return. Data on French PhDs, for example, showed that only a small percentage lived outside of France after three years of work

(Martinelli, 2001). In 1999, only 7% of the 1996 PhD cohort was abroad and nearly 60% wanted to return as soon as possible or in a year's time, with only 21% wishing to stay abroad. Martinelli stated that the circumstances of PhDs living abroad explained their desire to return home; in particular, while most young PhDs in France held indefinite-term jobs in 1999, 79% of those abroad were employed on a fixed-term basis.

Returning students

Various factors affect students' decisions to return to their home country after studying abroad. From a survey of nearly 1 000 international students studying business management in five universities in the United Kingdom and the United States, Baruch *et al.* (2007) found the most influential factors in a student's decision to remain or return were: *i)* perception of the labour market in the host country; *ii)* the student's perception of his/her adjustment to the host country; and *iii)* the strength of family ties. Overall, 30% of students indicated their intention to return home after their studies, while another 27% intended to return after a year of practical training. Only 2% indicated an intention to reside in the host country. Indian students were the least inclined to return home; students from China, Chinese Taipei and Thailand, and from countries in Africa, the Arabian peninsula and Latin America, were more inclined to do so.

Preliminary data from Canada, Portugal and the United States on doctorate holders' intentions to move show that among recent foreign doctorate holders, 25% intended to leave Portugal within the next year (compared with approximately 15% of Portuguese citizens) (Table 3.7). In the United States, 40% of foreign citizens who recently received a doctorate intended to move in the next year, compared with only 5% of citizens.

Table 3.7. **Percentage of recent doctorate holders having declared their intention to move out of the country in the next year**

	Canada (2003-04)	Portugal (2000-04)	United States (2003)
Citizens	16.6	14.6	5.0
Foreign citizens	39.2	25.0	40.1

Source: Auriol (2007).

More disaggregated data on the number of temporary visa holders who received an American doctorate and who still work in the United States reveals wide diversity across subject fields. Table 3.8 shows that among

Table 3.8. **Percentage of temporary residents who received US S&E doctorates in 1998 and were in the United States, 1999-2003**

Degree field	Number of foreign doctorate recipients	Percentage in the United States				
		1999	2000	2001	2002	2003
Physical science	1 419	75	74	72	71	69
Mathematics	447	67	63	62	60	59
Computer science	328	71	71	72	72	70
Agricultural science	463	48	47	47	47	46
Life science	1 620	72	68	67	68	67
Computer/electrical engineering	688	78	76	75	74	70
Other engineering	1 894	69	67	67	65	64
Economics	516	40	39	37	37	36
Other social science	583	39	38	37	37	37
Total, all fields	7 958	66	64	63	62	61

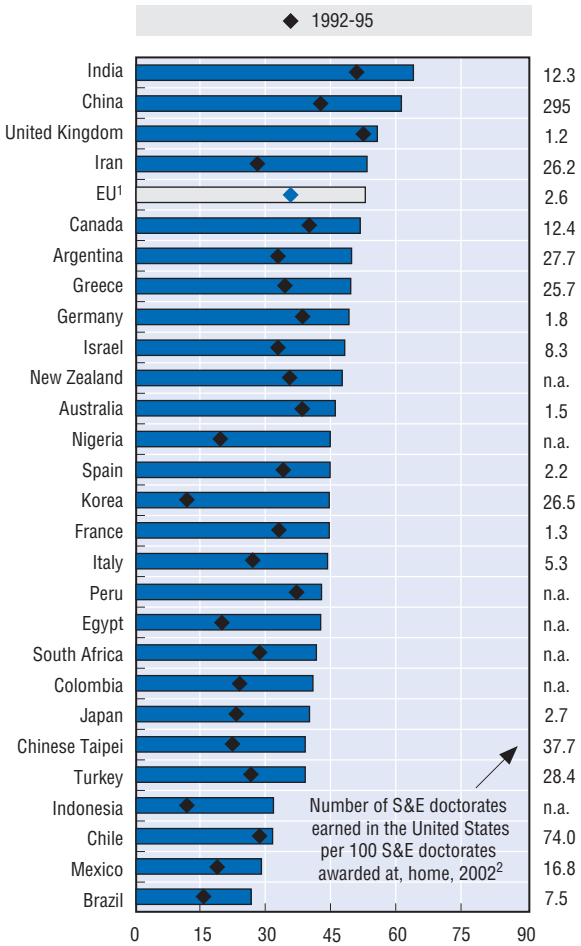
Source: Finn (2005), p. 6.

foreign students with temporary visas who received American doctorates in science and engineering (S&E) in 1998, an average of 61% were still in the United States in 2003. Across fields, the stay rate ranged from 36% in economics to 70% in computer science and computer/electrical engineering.

Stay rates also vary according to students' country of origin. Data from the United States suggest that the propensity of new doctorate holders to remain has increased for all citizenships since the beginning of the 1990s, with the intensity varying according to country of origin (Figure 3.16). The data also show that two-thirds of Indian and Chinese recipients of science and engineering doctorates, and over half of European recipients, receive a postdoctoral appointment or job in the United States after graduation (OECD, 2007a, p. 46).

Korean data from 1995 to 2004 show that the stay rate for Korean recipients of science and engineering doctorates in the United States increased substantially from the mid-1990s, peaked in 2002, and has since declined slightly (Figure 3.17). Korea has the largest international student group in the United States, overtaking the former leader, India, with over 87 000 students in March 2006. The Korean Ministry of Science and Technology hopes to involve these expatriate researchers in its Korean Scientist and Engineers Network (KOSEN), which now exists in 11 countries and receives funding for its activities.

Figure 3.16. **Foreign science and engineering doctorates who intend to stay in the United States, 2000-03**



1. Includes all European countries.
2. OECD estimates based on NSF data. The ratio compares the number of new foreign citizens graduating at doctoral level in S&E fields in the United States to the number of earned S&E doctoral degrees in the country of origin. New S&E doctorates refer to 1996 for Chile, 1999 for Brazil, 2001 for Canada, China, Greece, Italy and Spain, 2003 for Germany, Japan and the United Kingdom.

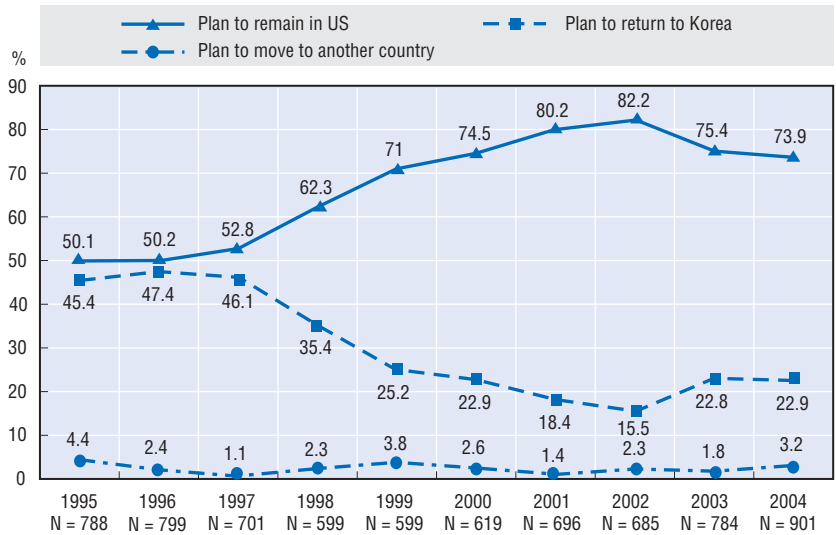
Source: OECD (2007a), p. 47.

Attitudes to mobility in Europe

Evidence on return and circular migration in Europe can be found in the analysis of the 2005 Eurobarometer survey results on attitudes to mobility (see Box 3.3). A comparison of the intentions to move in the next five years of

Figure 3.17. **Post-graduation plans of Korean doctorate recipients from US universities in science and engineering fields**

Percentages



Source: Korean Ministry of Science and Technology (2007), p. 138.

Box 3.3. **Attitudes to mobility in Europe: the 2005 Eurobarometer survey**

As part of preparations for the European Year of Workers' Mobility in 2006, a Eurobarometer survey on geographic and labour market mobility was undertaken in September 2005. More than 24 000 EU citizens were surveyed, with face-to-face interviews in people's homes and in the appropriate national language.

Past moves

The survey found that one-third of Europeans had moved out of their region of origin at least once in the past, with 24% of respondents having settled in another region, 4% in another member state and 3% in a country outside the EU, and 12% said they had participated in a training or education programme in another EU member state. In general, Nordic countries had the highest overall levels of mobility (around 40% of the working-age population had lived in a different region or country), followed by Ireland and the United Kingdom. Southern Europe and the eastern European member states had the lowest levels of mobility. The data are likely to under-represent the true level of mobility, because respondents who did move are underrepresented in host country samples and are not included in samples of the country of origin.

Box 3.3. **Attitudes to mobility in Europe: the 2005 Eurobarometer survey** *(cont.)*

In all cases, the higher the level of education, the greater the willingness to migrate. The survey showed that around 7% of the highly educated (that is, people who left full-time education after the age of 20) had moved within the EU since leaving the parental home, compared to 4% among the less educated.

Long-distance moves (*i.e.* outside the region, within the EU) were often related to the labour market; 34% of respondents cited a new job or a job transfer as the key reason for the move. However, gender differences were apparent for long distance moves, with 27% of women and 44% of men citing a new job or job transfer as the motivation. Women more often made long distance moves in order to follow their partner (EFILWC, 2006, p. 19). Of those who had moved in the past, more than 45% declared that no aspect of their life deteriorated after the move, and many saw their job, money and housing conditions improve (25%, 22% and 36%, respectively).

Future moves

Only 3% of respondents expected to move within the EU in the next five years. The intention to migrate was greater among men, people under 35 years of age, singles, the better educated and students, and the unemployed (EFILWC, 2006, p. 22). The four countries in which respondents most expected to move were Latvia, Poland, Lithuania and Estonia. In this group, 75% of people with mobility intentions were under 35 years of age, 32% had high levels of education and 34% were still studying.

Benefits of mobility

Europeans overall view long-distance mobility positively; 49% say it is good for individuals (12% against), 50% say it is good for the labour market (21% against), and 62% say it is good for European integration (11% against) (EFILWC, 2006, p. 21). When asked about what the EU represents for them, 53% said "freedom to travel and work in the EU". This answer came first, and well ahead of the euro (44%) or safeguarding peace (36%). Views are split across member states, however, with more than 60% of respondents in Denmark, Ireland, the Slovak Republic and Sweden saying mobility is good for individuals against less than 30% in Greece.

Source: EC (2006); EFILWC (2006).

respondents who had and had not moved in the past showed that those who had moved in the past had a higher propensity to move in the near future, especially if they had moved over a long distance. The European Foundation for the Improvement of Living and Working Conditions (EFILWC) suggested that this could imply that they are ready to move to another new location, but

that it could also reveal a wish to move back to their original region or country (EFILWC, 2006, p. 24).

The survey also shed light on factors that may bolster any trend towards increasing circular migration. In particular, respondents were asked what they thought would be the greatest difficulties they would have to face if they wished to move to another EU country. Concerns included culture and language (67% of respondents), employment (43%), transferability of pension rights (13%), housing (15%), and access to public facilities such as healthcare and social benefits (14%) (EFILWC, 2006, p. 26). As long as such concerns exist, potential migrants will be tempted to take advantage of more temporary forms of migration, so that ties with the home country remain close and the challenge of living permanently in a different culture can be avoided.

Impact

It is not easy to find clear quantitative evidence on the impact of mobility. In many cases, causality cannot be proven, and it is challenging to construct a counterfactual case. Many variables and factors influence science and technology outcomes and they are hard to untangle. This section presents data and evidence on internationalisation of the labour market, innovation and research collaboration. In some cases the link to mobility is clear, while in others, it seems logical but has not been proven.

Labour market internationalisation

A direct impact of mobility of highly skilled workers is increasing internationalisation of the labour market for the highly skilled. This is occurring both in private industry and in academia. For example, results from the Australian innovation survey found that 7.1% of innovating businesses employed new skilled staff from overseas as a way to acquire knowledge or abilities, while 2% used overseas consultants or advisors and 1.2% exchanged staff with other businesses overseas (ABS, 2005, p. 29). The use of overseas talent to acquire knowledge was greatest in the communication services industry. To acquire knowledge or abilities from overseas higher education or research institutions, 0.6% of innovating businesses employed new graduates, 0.7% employed academic or research staff and 0.7% used consultants.

A firm-level survey of 850 enterprises with highly qualified staff in France, Germany, the Netherlands and the United Kingdom also found international employees playing an important role in industry (Winkelmann, 2002). Overall, nearly 40% of firms hired highly qualified foreign employees for an average of 11% of the total highly qualified staff. Among the main reasons for hiring foreign staff – derived from the data on German firms – were knowledge of foreign languages, including English, and knowledge of foreign

markets. Data from the United States also reveal the importance of flows of foreign skilled workers, and Table 3.9 shows the increasing number of visas issued to workers with specialty occupations, as well as visas issued under NAFTA provisions and for intra-company transfers.

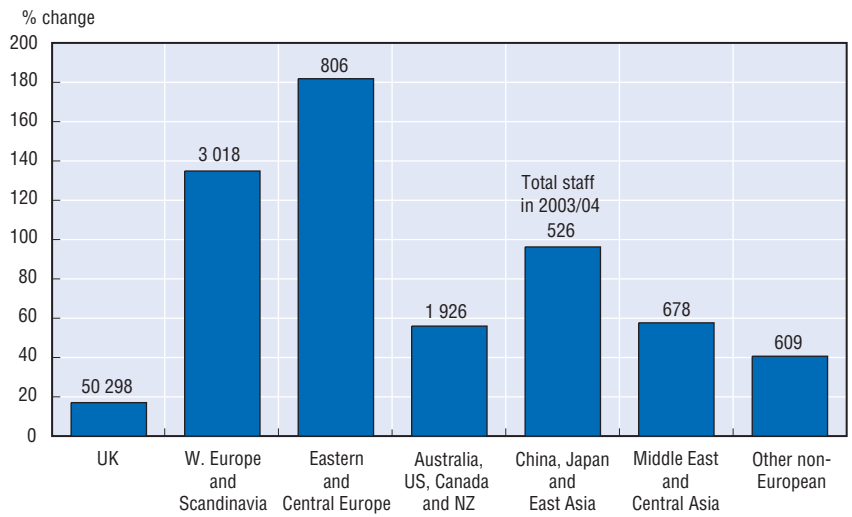
A report by Universities UK (2007) found that academic staff recruited from overseas are now a significant element of the UK university workforce. Figure 3.18 shows the growth in permanent academic staff by nationality from 1995/96 to 2003/04 and the strong increase in international staff, albeit

Table 3.9. **US inflows of highly skilled workers**

	1985	1990	1995	2000	2001	2002	2003
Specialty occupations (H-1B visa)	47 322	100 446	117 574	355 605	384 191	370 490	360 498
Professional workers (NAFTA TN visa)			23 904	91 279	95 486	73 699	59 446
Intra-company transferees (L1 visa)	65 349	63 180	112 124	294 658	328 480	313 699	298 054

Source: D'Costa (2008), p. 61.

Figure 3.18. **Percentage change in permanent academic staff in UK universities, by nationality, 1995/96 to 2003/04**



Source: Universities UK (2007), calculated from Table 8, p. 11.

sometimes from a small base. Universities UK highlighted the positive aspects of this staffing profile, noting that international staff provide the British system with highly qualified and talented people, who are likely to develop research collaborations with academics that will continue for the rest of their careers. They also noted the importance of international staff in ensuring the continued provision of teaching and research at appropriate levels in key subjects in which there are declining numbers of British nationals (2007, p. 20).

In Norway 16% of scientific academic staff held foreign citizenship in 2001 (Nerdrum and Sarpebakken, 2006). Foreign researchers were distributed unevenly across scientific fields, but their share rose in all fields from 1991 to 2001. The highest share of foreigners in 1991 was in humanities (14% of staff), but in 2001, the highest share was in engineering and technology (22%).

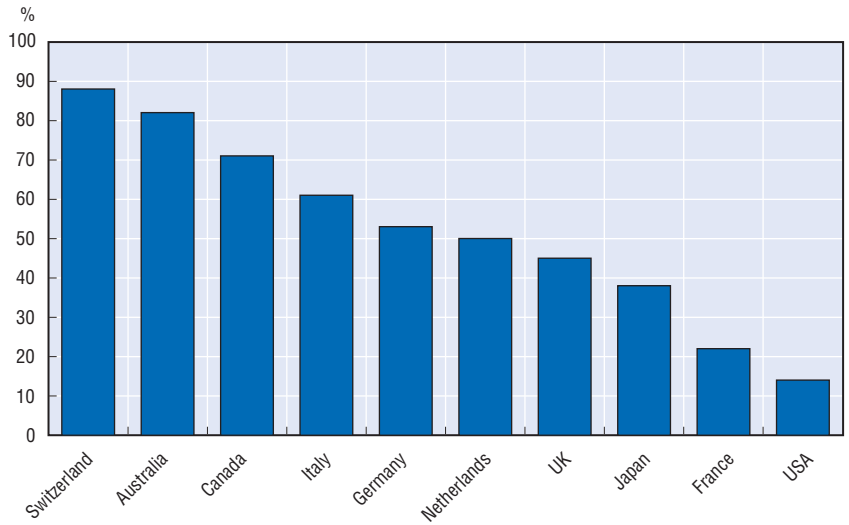
The international mobility of academic staff may help countries meet the challenge of ageing academic workforces. The OECD's recent review of tertiary education showed that in many OECD countries the average age of academics is high. In the Netherlands, 47% of teaching staff in universities of applied science were aged 50 or more in 2005, while data from 2003 for Austria, Belgium (Flemish Community), France and Sweden showed that over 50% of professors were over 55 (OECD, 2008b, pp. 191-192). Recruiting staff from abroad, or developing joint international exchanges in teaching and research, might help academic institutions adjust as older cohorts of workers begin to retire.

There is some evidence that mobility of academics is associated with higher quality output. A study of highly cited researchers (Evidence, 2005) found that a very large share had research experience out of their home country. For example, 45% of highly cited researchers based in the United Kingdom had spent some time in another country during their research careers (Figure 3.19). The study suggested that relative national mobility and international research performance may be related: "The mobile populations of Switzerland and the Netherlands produce high relative research performance for a small research economy. Mobility may lead to better international connections and hence to better collaborative research, which may overcome the constraints of smaller research economies." (Evidence, 2005, p. 10)

The most common reason given by the highly cited for moving was related to career development, followed by intellectual opportunities, with 80% of those moving judging that their career had strongly improved (Bekhradnia and Sastry, 2005). Many British researchers subsequently maintained the overseas research links that they had established.

Figure 3.19. **Share of highly cited researchers with research experience outside of their home country**

By country of current institution



Note: Based on a sample of 494 researchers from the ISI Highly Cited database (1985-2004).
Source: Evidence (2005), p. 25.

Innovation

It is difficult to find empirical evidence that directly links mobility with innovation outcomes. Two studies described below attempt to assess immigrant contributions to innovation-related activities, in particular patent applications and creation of engineering/technology firms. However, it is not straightforward to prove causality or to say that this has strengthened innovation more than would have otherwise occurred.

The first study, analysing patent applications filed with the World Intellectual Property Organization (WIPO) at its United States office, found that the proportion of applications naming foreign nationals residing in the United States as inventors or co-inventors had increased from 7.6% in 1998 to 25.6% in 2006 (Wadhwa *et al.*, 2007a). Applications filed by foreigners were greatest in technology hubs such as California, Massachusetts, New Jersey and New York. Chinese (mainland and Chinese Taipei) and Indian immigrants were the largest contributors in 2006: an estimated 30.5% of inventors named on patent applications were either Chinese or Indian nationals residing in the United States or Chinese or Indian-born US citizens. The top patent areas for

these inventors were sanitation/medical preparations, medicine, pharmaceuticals, semiconductors and electronics. Foreign nationals residing in the United States, plus foreign nationals based outside the United States, also made a substantial contribution to the patent filings of a number of large multinational companies, including Qualcomm (72%), Merck and Co (65%), General Electric (64%), Siemens (63%) and Cisco (60%).

The second study looked at the involvement of skilled immigrants in firm creation. When observing the engineering and technology companies started in the United States from 1995 to 2005, Wadhwa *et al*. (2007b) found that more than 25% had at least one key founder who was foreign-born, with California, New Jersey, Georgia and Massachusetts displaying an above-average rate of immigrant-founded companies. Nationwide, these companies produced an estimated USD 52 billion in sales and employed 450 000 in 2005. Almost 80% of immigrant-founded companies were in software and innovation or manufacturing-related services.

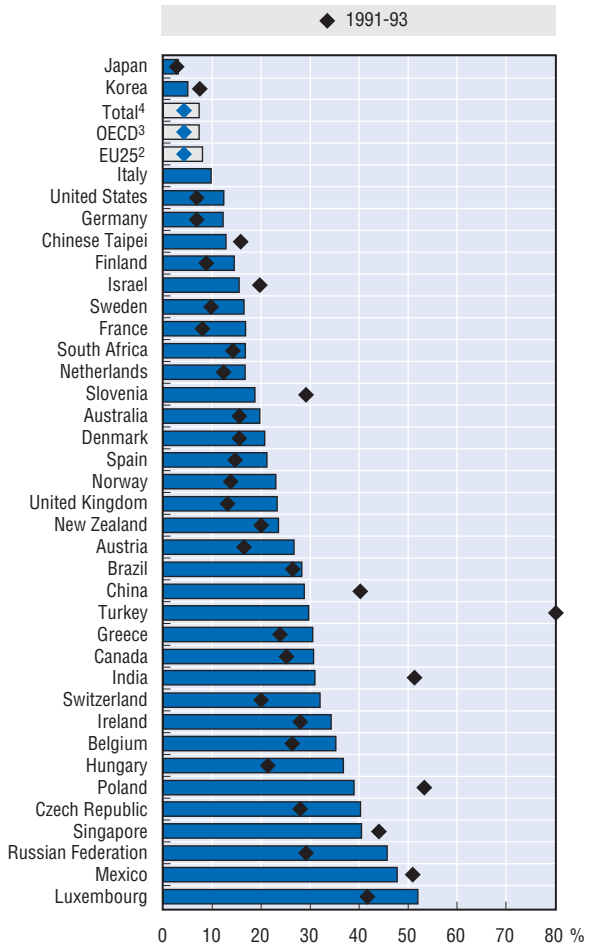
More broadly, there is certainly evidence of increasing international co-operation in invention, as measured by patents. The world share of patents involving international co-invention increased from 4% in 1991-93 to 7% in 2001-03, with small and less developed economies particularly actively engaged in international collaboration. Figure 3.20 presents data on the number of patents with foreign co-inventors for a number of countries. While the share with foreign co-inventors declined in some countries from 1991-93 levels, it rose in most countries. Again, it is difficult to link this directly to the mobility of HRST.

Research collaboration: international co-authorship

Another trend that has emerged in parallel with the greater mobility of HRST is increased research collaboration. International co-authorship, *i.e.* articles written by two or more authors of different countries, has grown in the last decade. This may indicate the crucial role of interaction among researchers with different knowledge backgrounds in order to diversify their sources of knowledge.

Studies undertaken by OECD member countries point to this trend. For example, motivated by an unexpected plateau in the absolute number of science and engineering articles published by United States-based authors in major peer-reviewed journals, the National Science Foundation (NSF) examined patterns and trends in articles produced between 1988 and 2003. A striking change over the period was the increase in various types of international collaborative articles, while single-author and single-institution output declined. This trend was apparent in all major S&E publishing centres (Table 3.10).

Figure 3.20. **Patents with foreign co-inventors**[1]
2001-03



Note: Patent counts are based on the priority date, the inventor's country of residence, using simple counts.

1. Share of patent applications to the European Patent Office (EPO) with at least one foreign co-inventor in total patents invented domestically. This graph only covers countries/economies with more than 200 EPO applications over 2001-03.
2. The EU is treated as one country; intra-EU co-operation is excluded.
3. Patents of OECD residents that involve international co-operation.
4. All EPO patents that involve international co-operation.

Source: OECD (2007a), p. 167.

The number of single institution-authored S&E articles from the United States fell over the period 1988-2001, from 60% to around 45% (NSF, 2007, p. 31). According to field-specific data, in the biological sciences, geosciences and

Table 3.10. **Indicators of international collaboration for major S&E publishing centres**

Selected years, 1992-2003

Indicator and publishing centre	1992	1997	2003
Ratio of fractional to whole S&E article counts			
United States	0.931	0.905	0.871
EU15	0.913	0.890	0.862
Japan	0.938	0.913	0.887
East Asia-4	0.865	0.874	0.873
Proportion of international to domestic addresses			
United States	0.135	0.193	0.261
EU15	0.170	0.217	0.271
Japan	0.143	0.211	0.255
East Asia-4	0.359	0.354	0.316
Per cent of S&E articles with an international address			
United States	13.9	18.8	24.8
EU15	17.3	21.8	27.2
Japan	11.8	16.5	21.5
East Asia-4	25.3	25.5	25.4

Notes: For articles with collaborating institutions from multiple publishing centres, fractional counts assign each publishing centre fractional credit on the basis of the proportion of its participating institutions, and whole counts assign each publishing centre one credit for its participation regardless of the number of participating institutions. Proportion of foreign to domestic addresses measured across total articles of each publishing centre. An international address is an institutional address outside the indicated publishing centre. East Asia-4 includes China, Korea, Singapore and Chinese Taipei. China includes Hong Kong.

Source: NSF (2007), p. 11.

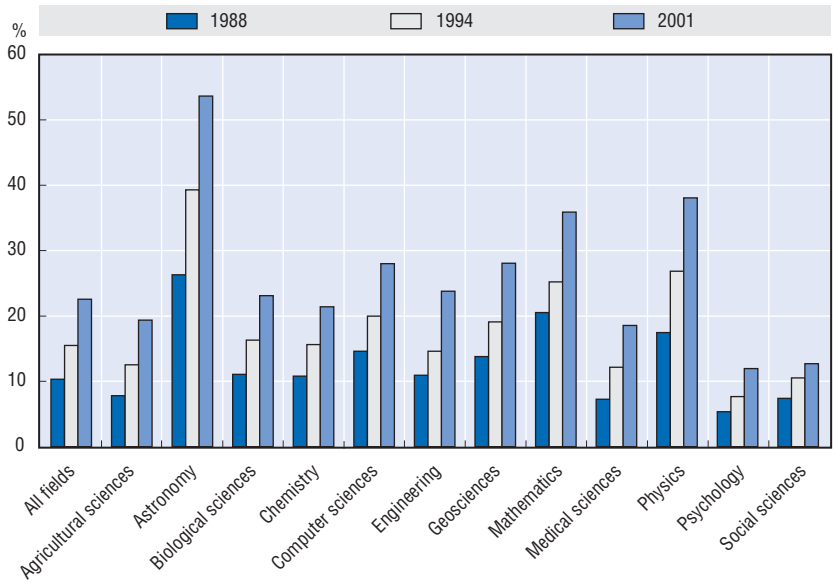
medical sciences more than 90% of the top 200 research universities had more collaboration in 1995-2001 than in 1988-94 (NSF, 2007, p. 29). Over all fields, the number of S&E articles with authors from multiple countries increased from 1988 to 2001; over 50% of astronomy articles, for instance, are now internationally co-authored (Figure 3.21).

There is evidence that some of this collaboration is associated with linkages between highly skilled migrants and their country of origin. Regets (2007) presents data showing a positive correlation (0.66) between the number of US doctorates received by foreign-born students and the percentage of that country's internationally co-authored articles with the United States (Figure 3.22). Regets suggests that contacts with former colleagues and educational institutions may facilitate the formation of international networks and knowledge exchanges, thus bringing benefits to sending countries.

Greater international collaboration in terms of co-authorship was also found in a study for the United Kingdom's Office of Science and Innovation (Evidence, 2007). Focusing on seven research fields, and analysing the data for eight partner countries, the study found that the volume of international

Figure 3.21. **US S&E articles (whole counts) with at least one author at a top 200 research university and one author at a foreign institution**

By field, selected years 1988-2001

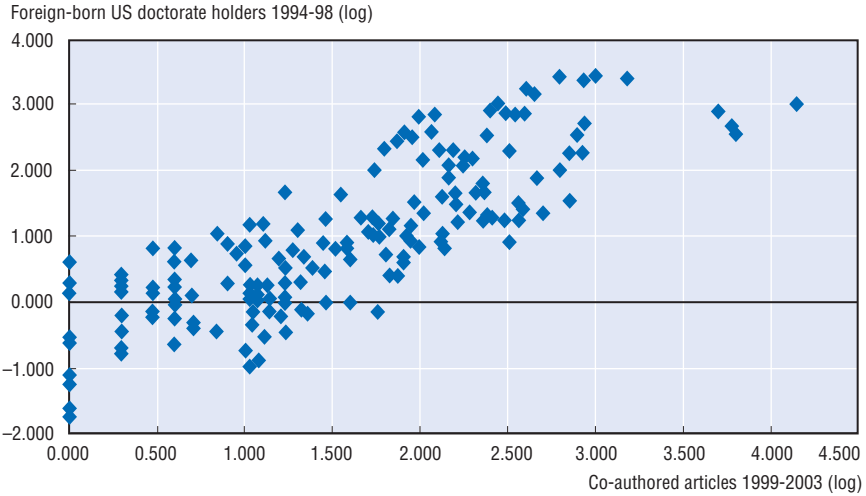


Note: Articles on a whole count basis (*i.e.* for articles with collaborating institutions, each group of institutions receives one credit for its participation, regardless of the number of participating institutions within that group). "All fields" includes health sciences and professional fields. Top 200 research universities based on total R&D expenditures during the 1988-2001 period.

Source: NSF (2007).

Figure 3.22. **Relationship of foreign-born US S&E doctorate recipients to their country's scientific collaboration with the United States**

1994-98 graduates and 1999-2003 articles



Source: Regets (2007), p. 6.

collaboration increased significantly between 1996-2000 and 2001-05. The increase in the absolute volume of collaborative papers varied across countries; for France, collaborative output increased by 30%, while for China it increased by more than 100% (p. 3). Of the focus countries, the United Kingdom displayed the most rapid increase in the share of international collaboration relative to domestic output, with 40% of output in 2001-05 being collaborative, compared to 29% in 1996-2000. Table 3.11 presents the United Kingdom's collaborative output by field and by partner country; it shows that the change in collaborative output has been strongly positive across the board.

In Finland too collaboration has increased, especially since the mid-1990s. Lehvo and Nuutinen (2006) report that joint publications with researchers from other EU countries rose by 85% from 1995 to 2004, while joint publications with other Nordic countries increased by 78%. The most important partner countries for Finnish researchers were the United States, Sweden, the United Kingdom, Germany, France, the Netherlands and Russia.

Particular patterns of co-authorship are likely to be affected by the relative capacity (in both quantity and quality) of countries in each research field, as well as by geographical proximity and language. Evidence (2007) noted that the United Kingdom has expanded collaboration with Germany which has complementary research strengths. In Finland, Lehvo and Nuutinen (2006) found that the intensity of publishing co-operation with each partner country depended on whether or not the work was on the natural sciences or medical sciences, the two fields that accounted for over 80% of all Finnish publications. Work by Igami and Saka (2007) for the OECD also shows that the amount of collaboration depends on the research area.

Table 3.11. **Change in international collaboration in the United Kingdom, 1996-2000 to 2001-05**

Research field	% change in total output	% change in collaborative output				
		United States	France	Germany	China	India
Clinical	41	45	36	56	77	70
Health	29	39	23	43	43	23
Biological sciences	35	36	34	39	109	36
Environment	57	65	53	88	115	89
Mathematics	43	16	78	44	70	55
Physical sciences	28	32	38	36	98	75
Engineering	28	31	29	29	87	34
Average	*37*	*38*	*42*	*48*	*86*	*55*

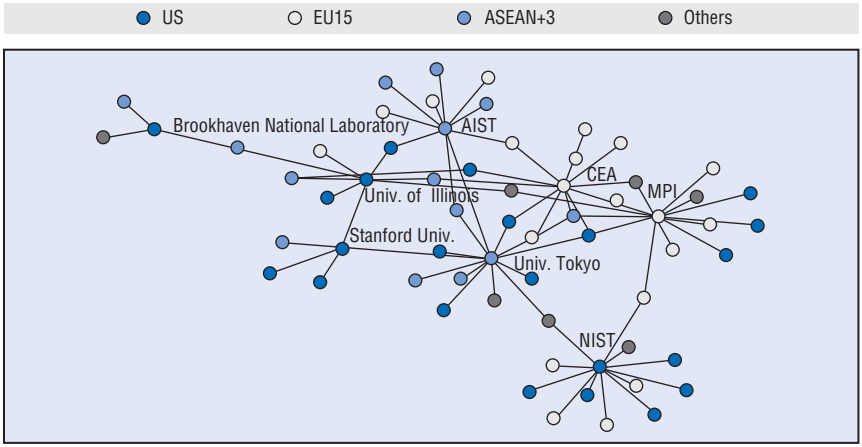
Source: Evidence (2007), p. 17.

The research categories of "Superconductivity and quantum computing", "Particle physics and cosmology" and "Environment" showed higher rates of international co-authorship from 1999 to 2004 than categories such as "Chemical synthesis" or "Health care". The authors noted a higher rate of international co-authorship in the EU countries than in the Asian countries studied, especially in countries producing small numbers of papers, while the rate of co-authorship between the EU15 (as a group) and other countries was similar to Asian co-authorship rates. The authors suggest that individual EU countries access a wide variety of researchers via international co-operation within the EU.

Institutional linkages are also important determinants of collaboration patterns. The work of Igami and Saka (2007) revealed striking patterns of co-operation and collaboration at the institutional level. For the top 81 institutions (based on highly cited papers) in the area of "Superconductivity and quantum computing", for example, the authors produced a map of co-authorship networks, which clearly shows the complex international interaction between centres of excellence in this area of research (Figure 3.23).

Evidence (2007) found that the average impact of collaborative work, as measured by citations, was significantly higher than the average impact of national work. Table 3.12 presents data on biological sciences papers that highlight the superior citation performance of collaborative work. The report

Figure 3.23. **Co-authorship network in "Superconductivity and quantum computing"**



Note: Each circle represents an institution. AIST: National Institute of Advanced Industrial Science and Technology (Japan); CEA: French Atomic Energy Commission (France); MPI: Max Planck Institute (Germany); NIST: National Institute of Standards and Technology (United States).

Source: Igami and Saka (2007).

Table 3.12. **Average impact of national papers and co-authored papers, 2001-05**

Biological sciences

Author	Impact[1]
United Kingdom only	*1.42*
United Kingdom + United States	2.40
United Kingdom + France	2.20
United Kingdom + Germany	2.24
United Kingdom + China	1.67
United States only	*1.43*
United States + United Kingdom	2.40
United States + France	2.31
United States + Germany	2.24
United States + China	1.22
France only	*1.17*
France + United Kingdom	2.20
France + United States	2.31
France + Germany	2.38
France + China	2.86

1. Citation counts are normalised to take account of year of publication and field.

Source: Evidence (2007), p. 25.

notes that work with China often records a lower impact than that of co-authored work with other countries. Nevertheless, the value of research collaboration cannot be interpreted solely in bibliometric terms, with access to knowledge and facilities and the establishment of longer-term relationships also valuable outcomes of collaboration.

The link between increased mobility and increased international joint publishing again seems logical but is not empirically proven. However, there is some support for the link. For example, Bell *et al.* (2007) suggested that the increased collaboration in American academic research was driven by advances in electronic communication and improvements in travel that allowed more conference attendance (thus enabling academics to meet potential collaborators and initiate working relationships), although encouragement from funding agencies and university faculties also played an important role. Bell's work also suggested that the increased presence of foreign institutions and academics, both through collaborative and sole-authored work, may be linked to student mobility. Interviews conducted with academics suggested that other nations have benefited from training their citizens at international centres of research excellence, often in the United States: "Many of these researchers either return to their native countries or maintain strong professional ties to institutions in those countries, thus

improving the research infrastructure." (p. 22) This was posited to have contributed to the substantial improvement of research capacity in major European countries, Japan and emerging Asian economies.

Outlook – the internationalisation of R&D

When looking towards future patterns of HRST mobility, it is useful to look at the broader context of R&D activity. Over the past decade, many countries, including newly emerging economies, have greatly improved their ability to exploit and perform research. This is resulting in a changing geography of research and scientific activity, with more countries participating more intensively.

Figure 3.24a shows that the percentage of GDP spent on R&D varies across the OECD, with Sweden, Finland and Japan in the lead. However, in some countries with lower R&D intensity, such as Turkey and Mexico, R&D expenditure is growing faster and should help narrow the spread.

Some non-OECD countries are also becoming important R&D spenders (Figure 3.24b). For example, with gross domestic expenditure on R&D (GERD) at USD 87 billion, China's spending is around one-third that of the European Union and has been growing at around 18% annually (in real terms) since 2000. GERD has also grown strongly in South Africa (11.3% a year between 1997 and 2005) and it reached USD 20.2 billion in Russia in 2006. Figure 3.25 shows GERD as a percentage of GDP in selected non-OECD economies.

Human capital resources are also increasing rapidly in non-OECD countries. In the four large emerging economies, Brazil, Russia, India and China, for example, 171 million people aged 25-64 had a tertiary degree in 2004, as many as in the entire OECD area. In China alone, 3.9 million students entered university for the first time in 2005, about half of the OECD total. However, the number of tertiary-educated individuals as a proportion of the total population aged 25-64 still remains much higher in the OECD area (25.1% as compared to 7.8% for Brazil, 9.5% for China and 11.4% for India), indicating that these countries' knowledge base still has much room for catching up (OECD, 2007a, p. 60). There are also likely differences in the types of skills of tertiary graduates in different countries, so that these human capital resources may not be fully substitutable for those in OECD countries.

Patent activity and research publications also show a broadening of science and technology activity across countries. OECD figures on triadic patent families (a set of patents taken at the European Patent Office, the Japan Patent Office and the United States Patent & Trademark Office that protect the same invention) show that, against a backdrop of steadily increasing patent filings, the United States and Europe have experienced a decline in their share of the total, while that of Asia has surged. Japan's share in triadic patent

Figure 3.24a. **R&D intensity,[3] 2006 (left) and evolution of GDP expenditure on R&D, 1996-2006 (right)**

Average annual growth rate, constant prices

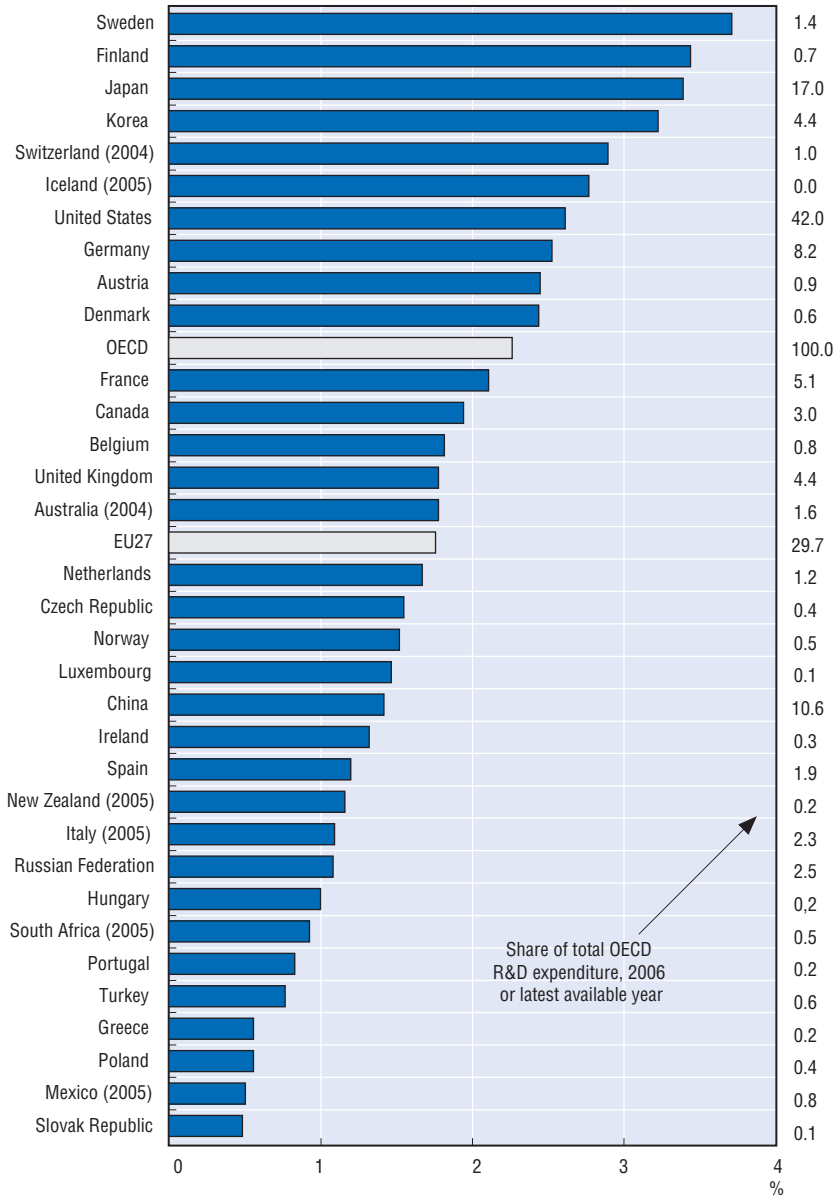
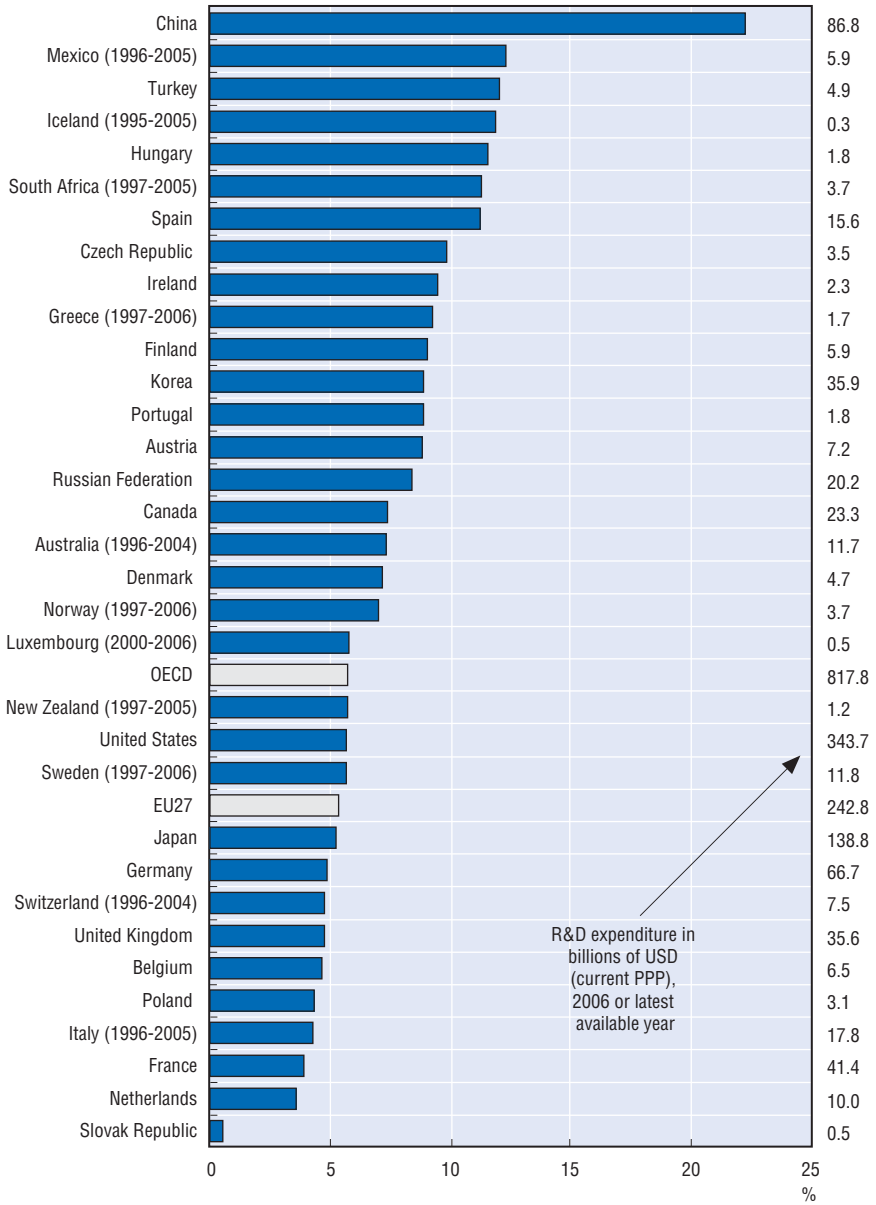


Figure 3.24b. **R&D intensity,[3] 2006 (left) and evolution of GDP expenditure on R&D, 1996-2006 (right)**

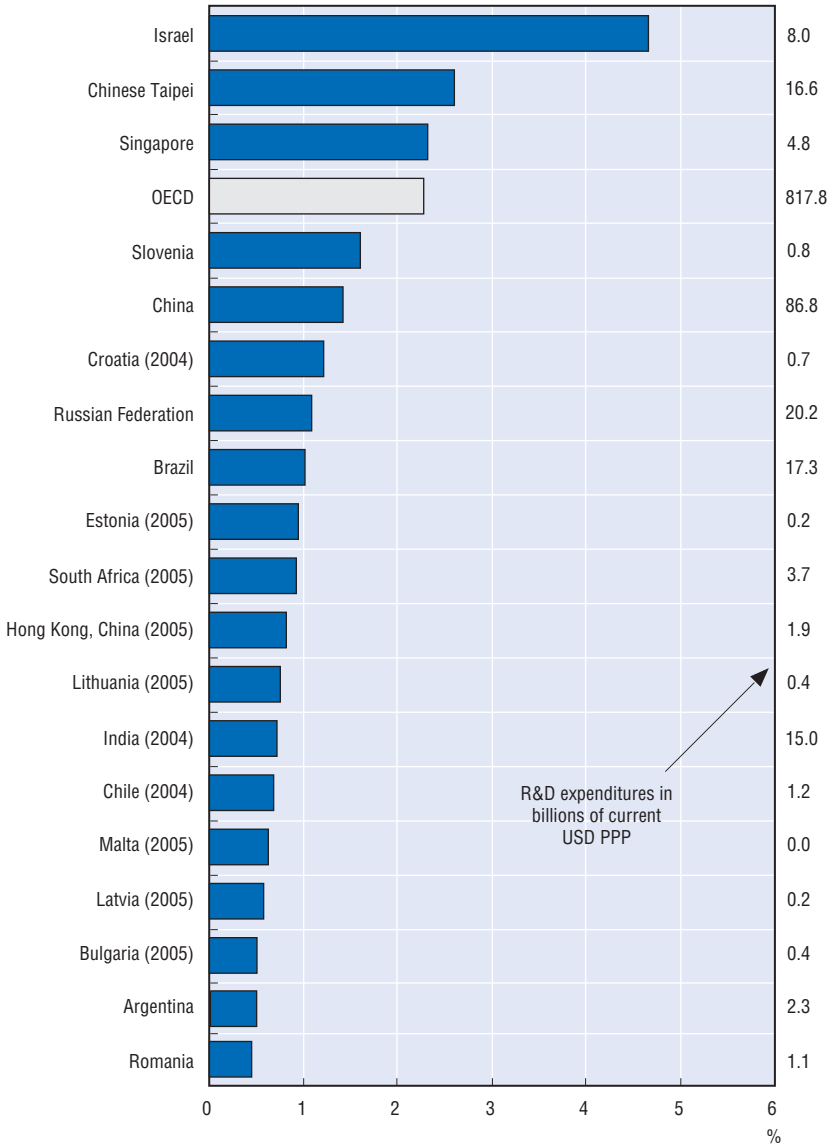
Average annual growth rate, constant prices



3. Gross domestic expenditure on R&D as a percentage of GDP.

Source: OECD MSTI database, April 2008 and OECD (2007a), p. 25.

Figure 3.25. **Gross expenditure on R&D (GERD), 2006**
As a percentage of GDP, in billions of current USD PPP



Source: OECD MSTI database, April 2008; Eurostat, *NewCronos database*, June 2007; and OECD, based on national sources.

families gained almost 2 percentage points, to reach nearly 29% in 2005, and the annual rise in triadic patent filing from China, India, Korea and Chinese Taipei ranged from 20 to 37%. China has entered the top 15 countries, having gained 16 positions since 1995 (OECD, 2007a, p. 84). Over the past ten years, research publication intensity has also increased worldwide and has expanded remarkably in some emerging economies. Scientific articles from Latin America more than tripled, closely followed by Southeast Asia (Indonesia, Malaysia, the Philippines, Thailand and Vietnam) (OECD, 2007a, p. 92).

The technological activities of multinational firms are also increasingly internationalised (OECD, 2008, forthcoming). As firms search for technological competence, better adaptation to markets and lower R&D costs, research activities are being moved overseas ever more intensively. Indicators include the increasing amount of foreign ownership of domestic inventions (in Mexico, over 50% of domestic inventions belong to foreign residents, for example) and an increase in the domestic ownership of inventions made abroad (for example, 21% of France's patents include foreign inventions) (OECD, 2007a, pp. 162-164). The share of foreign affiliates in total R&D is higher than their share in total manufacturing turnover in most OECD countries, a sign that research is now more internationalised than production (OECD, 2007a, p. 172). There is also a global shift of high- and medium-high technology manufacturing towards non-OECD countries (OECD, 2007a, p. 210).

Summary

The data and information presented in this chapter suggest that the international mobility of highly skilled HRST is a significant phenomenon. For most OECD countries, emigration of the highly skilled to other OECD countries represents up to 15% of native stocks of the highly skilled, and for a number of countries, intra-OECD flows add substantially to the stock. Non-OECD flows are also important, with Canada, France and the United States attracting large numbers of skilled non-OECD nationals. The number of students enrolled outside their country of citizenship has risen sharply over the past decade, with China, India and Morocco the three top non-OECD source countries. In addition to these growing flows, there is also evidence that return and circular migration is increasing, an indication that temporary migration is a key consideration for mobility policies.

With the appropriate caveats about causality and counterfactuals, there is also evidence that mobility has been accompanied by increasing collaboration and increasing foreign involvement in innovation and job creation. Co-authored articles, involving academics from several institutions and countries, are becoming more frequent, and there is increasing

international co-invention, as evidenced by patent data. Increased mobility is clearly associated with the increasing internationalisation of labour markets.

At the same time, the data show that R&D activity is continuing to internationalise, with more countries participating in science and technology activity. Some non-OECD countries are becoming important R&D spenders, and Asia has experienced a surge in patent filings.

What does this mean for policy? A key question is whether mobility will continue as R&D activity is increasingly internationalised, or whether the spread of innovative activity will gradually encourage more circular migration, or lower mobility, as highly skilled professionals find increasing opportunities at home. Should OECD governments focus their efforts on enabling greater temporary and circular migration, and are there areas in which government intervention is particularly necessary? Policy making in this area would be assisted by further work to improve the data, so that countries can better understand the patterns and changes in stocks and flows of scientists, engineers and researchers and the broader highly skilled group. While there have been major efforts in recent years to improve the data on international stocks and flows of the highly skilled, difficulties relating to the comparability of international data, differing and/or insufficient disaggregation of classifications and the timeliness of data still remain.

Notes

1. "Emigration rates" are calculated by dividing the number of foreign-born residing in OECD countries and originating in a particular country by the total number of natives of that country, including those no longer living in the country. This does not correspond to the usual definition of an emigration rate, which relates flows of migrants over a certain period of time to the initial stock of persons in the country of origin. See Dumont and Lemaître (2005, p. 7).
2. The database (version 4c) was constructed using data from the 2000 round of censuses (taken between 1995 and 2004) and covered 226 countries and territories.
3. Birrell *et al*. (2004) found most Australian residents who depart "long-term" return to Australia within two years. Thus the overall return rate of skilled Australians was calculated as a ratio of departures at time x to arrivals at time x + 2 years.

References

ABS (Australian Bureau of Statistics) (2005), "Innovation in Australian Business", 8158.0, Canberra.

Adepoju, A. (2004), "Changing Configurations of Migration in Africa", Migration Information Source: Migration Policy Institute, 1 September.

Arvanitis, S. and Wörter, M. (2005), *The Swiss Innovation System: Governance, Public Policy, Performance and Assessment of Strengths and Weaknesses: Background Report to the*

OECD Country Review of Switzerland's Innovation Policy, on behalf of the Swiss Innovation Promotion Agency (KTI), April, Zurich.

Auriol, L. (2007), "Labour Market Characteristics and International Mobility of Doctorate Holders: Results for seven countries', *OECD STI Working Paper* 2007/2, DSTI/DOC(2007)2, OECD, Paris.

Aydemir, A. and C. Robinson (2006), "Return and Onward Migration among Working Age Men", Statistics Canada Analytical Studies Branch Research Paper Series, Catalogue No. 11F0019MIE No. 273, Ottawa.

Baruch, Y., P.Budhwar and N. Khatri (2007), "Brain drain: Inclination to stay abroad after studies", *Journal of World Business*, 42, pp. 99-112.

Bekhradnia, B. and T. Sastry (2005), "Migration of Academic Staff to and from the UK", *www.hepi.ac.uk/pubdetail.asp?ID=180&DOC=Reports* (downloaded 24 August 2007).

Bell, R., D. Hill and R. Lehming (2007), "The Changing Research and Publication Environment in American Research Universities", Working Paper SRS 07-204, National Science Foundation: Division of Science Resources Statistics, Arlington, VA.

Birrell, B., V. Rapson, I. Dobson and F. Smith (2004), *Skilled Movement in the New Century: Outcomes for Australia*, Centre for Population and Urban Research, Monash University, April.

Bratsberg, B., O. Raaum and K. Sørlie (2007), "Foreign-born migration to and from Norway", in Ç. Özden and M. Schiff (eds.) (2007), *International Migration, Economic Development and Policy*, The World Bank, Washington DC.

D'Costa, A. (2007), "Adjusting to Globalization: Japan and the Mobility of Asian Technical Talent", *Asia Research Institute Working Paper Series* No. 97, October, *www.ari.nus.edu.sg/pub/wps.htm*.

D'Costa, A. (2008), "The International Mobility of Technical Talent: Trends and Development Implications", in Solimano, A. (ed.) (2008), *The International Mobility of Talent: Types, Causes and Development Impact*, UNU-Wider Studies in Development Economics, Oxford University Press.

DIAC (Department of Immigration and Citizenship) (2007), "Emigration 2005-06: Australia", Research and Statistics Section, March, Canberra.

Docquier, F., A. Marfouk and B.L. Lowell (2007), "A gendered assessment of the brain drain", October, sourced at *www.ires.ucl.ac.be/CSSSP/home_pa_pers/Docquier/works.htm* (accessed 27 February 2008).

Dumont, J-C. and G. Lemaître (2005), "Counting Immigrants and Expatriates in OECD Countries: A New Perspective", *OECD Social, Employment and Migration Working Papers* No. 25, DELSA/ELSA/WD/SEM(2005)4, OECD, Paris.

EC (European Commission) (2006), "Europeans and mobility: first results of an EU-wide survey", Eurobarometer survey on geographic and labour market mobility, European Communities, Belgium.

EFILWC (European Foundation for the Improvement of Living and Working Conditions) (2006), *Mobility in Europe: Analysis of the 2005 Eurobarometer survey on geographical and labour market mobility*, Dublin, Ireland.

Eurostat (2007), "How mobile are highly qualified human resources in science and technology?", *Statistics in Focus: Science and Technology*, 75/2007.

Evidence (2005), "Tracking UK and international researchers by an analysis of publication data", Report prepared for the Higher Education Policy Institute, Evidence: Karen Gurney and Jonathan Adams, June, Leeds.

Evidence (2007), "Patterns of international collaboration for the UK and leading partners: Summary report", Report commissioned by the UK Office of Science and Innovation, Evidence: Jonathan Adams, Karen Gurney and Stuart Marshall, June, Leeds.

Finn, M. (2005), "Stay rates of foreign doctorate recipients from U.S. Universities, 2003", Oak Ridge Institute for Science and Education, United States.

Fontes, M. (2007), "Scientific mobility policies; how Portuguese scientists envisage the return home", *Science and Public Policy*, Vol. 34(4), May, pp. 284-298.

Graversen, E., M. Lemming, M. Åkerblom and M. Virtaharju (2001), "Migration between the Nordic countries: What do register data tell us about the knowledge flow?", in OECD (2001), *Innovative People: Mobility of Skilled Personnel in National Innovation Systems*, Paris.

Guellec, D. and M. Cervantes (2002), "International Mobility of Highly Skilled Workers: From Statistical Analysis to Policy Formulation", in OECD (2002), *International Mobility of the Highly Skilled*, Paris.

Hugo, G. (2007), *Issues and Options for Enhancing the International Mobility of Researchers: An Australian Perspective*, Paper presented at OECD workshop on The International Mobility of Researchers, 28 March 2007, Paris.

Hugo, G., D. Rudd and K. Harris (2003), *Australia's Diaspora: Its Size, Nature and Policy Implications*, Committee for Economic Development of Australia (CEDA) Information Paper 80, December.

Igami, M. and A. Saka (2007), "Capturing the evolving nature of science, the development of new scientific indicators and the mapping of science", *OECD STI Working Paper* 2007/1, DSTI/DOC(2007)1, OECD, Paris.

IOM (International Organization for Migration) (2005), *World Migration 2005: Costs and Benefits of International Migration*, Volume 3 – IOM World Migration Report Series, Switzerland.

Khadria, B. (2004), "Migration of Highly Skilled Indians: Case studies of IT and health professionals", *OECD STI Working Paper* 2004/6, DSTI/DOC(2004)6, OECD, Paris.

Korean Ministry of Science and Technology (2007), *Reviews of National Science, Technology and Innovation Policy: Republic of Korea Background Report*, Draft 1 October 2007 (internal working document).

Lehvo, A. and A. Nuutinen (2006), "Finnish Science in International Comparison", Publication of the Academy of Finland 15/06, Helsinki.

Mahroum, S. (2000), "Scientific Mobility: An Agent of Scientific Expansion and Institutional Empowerment", *Science Communication* 21(4), June.

Martinelli, D. (2001), "Labour Market Entry and Mobility of Young French PhDs", in OECD (2001), *Innovative People: Mobility of Skilled Personnel in National Innovation Systems*, OECD, Paris.

Ministry of Education, China (2005), *Educational Statistics Yearbook of China 2005*.

National Advisory Council on Innovation (2006), *The South African National System of Innovation: Background Report to the OECD Country Review*, Pretoria: NACI.

Nerdrum, L. and B. Sarpebakken (2006), "Mobility of foreign researchers in Norway", *Science and Public Policy*, Vol. 33(3), April, pp. 217-229.

NSF (National Science Foundation) (2007), *Changing US Output of Scientific Articles: 1988-2003*, NSF 07-320, Division of Science Resources Statistics: Derek Hill, Alan Rapoport, Rolf Lehming and Robert Bell, Arlington, VA.

OECD and Eurostat (1995), *Manual on the Measurement of Human Resources Devoted to S&T – Canberra Manual*, OECD, Paris.

OECD (2002), *Proposed Standard Practice for Surveys of Research and Experimental Development – Frascati Manual*, OECD, Paris.

OECD (2006), *Thematic Review of Tertiary Education (China Background Report on Tertiary Education)*, Paris.

OECD (2007a), *OECD Science, Technology and Industry Scoreboard 2007: Innovation and Performance in the Global Economy*, OECD, Paris.

OECD (2007b), *Education at a Glance 2007*, OECD, Paris.

OECD (2007c), *International Migration Outlook, 2007*, OECD, Paris.

OECD (2008a), *A Profile of Immigrant Populations in the 21st Century: Data from OECD Countries*, OECD, Paris.

OECD (2008b), *Tertiary Education for the Knowledge Society. OECD Thematic Review of Tertiary Education: Synthesis Report: Volume 2*, OECD, Paris.

OECD (2008, forthcoming), *The Internationalisation of Business R&D: Evidence, Impacts and Implications*, OECD, Paris.

Office for National Statistics (2007), *International Migration: Migrants entering or leaving the United Kingdom and England and Wales, 2005*, National Statistics, Series MN No. 32, London.

Ohler, F. (2005), *OECD Country Review of Luxembourg's Innovation Policy: Background Report*, Draft November 2005, Technopolis, Vienna.

Parey, M. and F. Waldinger (2007), "Studying Abroad and the Effect on International Labour Market Mobility: Evidence from the introduction of ERASMUS", Paper presented at the CESifo Venice Summer Institute, 18-19 July 2007, *www.cesifo.de/venice*.

Parsons, C., R. Skeldon, T. Walmsley and A. Winters (2007), "Quantifying International Migration: A database of bilateral migrant stocks", in Özden, Ç. and Schiff, M. (eds.) (2007), *International Migration, Economic Development and Policy*, The World Bank, Washington DC.

Regets, M. (2007), "Research issues in the international migration of highly skilled workers: A perspective with data from the United States', National Science Foundation Working Paper SRS 07-203, June.

Universities UK (2007), "Talent wars: the international market for academic staff", Policy Brief, July, London.

Wadhwa, V., G. Jasso, B. Rissing, G. Gereffi and R. Freeman, (2007a), "Intellectual Property, the Immigration Backlog, and a Reverse Brain-Drain: America's New Immigrant Entrepreneurs, Part III", Duke University, New York University, Harvard Law School and Ewing Marion Kauffman Foundation, August.

Wadhwa, V., A. Saxenian, B. Rissing and G. Gereffi (2007b), "America's New Immigrant Entrepreneurs", Duke University and UC Berkeley, January.

Wadhwa, V., B. Rissing, A. Saxenian and G. Gereffi (2007c), "Education, Entrepreneurship and Immigration: America's New Immigrant Entrepreneurs, Part II", Duke University, UC Berkeley and Ewing Marion Kauffman Foundation, June.

Winkelmann, R. (2002), "Why do firms recruit internationally? Results from the IZA International Employer Survey 2000", in OECD (2002), *International Mobility of the Highly Skilled*, OECD, Paris.

ISBN 978-92-64-04774-7
The Global Competition for Talent
Mobility of the Highly Skilled
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Chapter 4

Current Policy Approaches

Chapter 4 provides the most recent information on current mobility policies in selected member countries, gathered via a questionnaire sent to members of the OECD's Ad Hoc Working Group on Steering and Funding of Research Institutions. It explores the policies adopted by various OECD governments, highlighting commonalities and differences.

As part of the OECD's work on international mobility, information was collected on the mobility policies of member and observer countries. The *OECD Questionnaire on the International Mobility of Researchers* targeted national government ministries or the public organisations primarily responsible for dealing with the international mobility of human resources for science and technology (HRST). The purpose was to establish an inventory of government policy practices and programmes to encourage the inward and outward international mobility of HRST, including doctorate holders, doctoral students and researchers, and to gather information on evaluations that had been undertaken to assess the impact of such practices and programmes.

Responses were received from Australia, Austria, Belgium, Canada, the Czech Republic, the European Commission, Finland, Japan, Korea, the Netherlands, New Zealand, Norway, South Africa, Switzerland and the United Kingdom.[1] Detailed information on specific countries, which does not necessarily capture all mobility-related policies in the countries surveyed, may be found at www.oecd.org/sti/stpolicy/talent. The material presented in this chapter draws together information provided by the delegates to the OECD's Working Group on the Steering and Funding of Research Institutions (SFRI), based on the survey questionnaire.

Mobility strategies

The questionnaire began by gathering information on each country's overall strategy regarding the international mobility of HRST, in particular on mobility strategies, mobility websites and diaspora strategies. The responses (summarised in Table 4.1) revealed widely different degrees of "intensity" in countries' approach to the mobility of HRST. Most countries perceive mobility as important in terms of retaining and attracting HRST talent and have policies to assist and encourage mobility. However, while some make these policies part of an explicit strategy on mobility, often accompanied by a dedicated website, others have no overall strategy. Japan and the United Kingdom have perhaps the most formalised mobility strategies. The United Kingdom's strategy document notes:

> "Interaction of scientists at an international level keeps scientists in touch with the most profound developments in their field, wherever they occur; and encourages the cross-fertilisation of skills, approaches, techniques, and ideas as well as an exchange of knowledge; it provides

> training opportunities for early stage researchers. These links keep research at the cutting-edge, and benefit the individual researcher, the particular research projects and the institutions involved. Returning researchers build scientific capacity in their 'home' institutions and countries through the application of the knowledge and skills acquired overseas." (Global Science and Innovation Forum, 2006, p. 22)

The European Commission's strategy is also clearly set out in "A Mobility Strategy for the European Research Area" [COM(2001)331], which suggests specific actions to enhance mobility of researchers as a tool for further training and transfer of knowledge. This is complemented by later communications that urge progress towards a genuine European labour market for researchers.

Countries that are members of the European Union appear to gain valuable leverage from EU initiatives. For example, each country has a mobility portal that is linked to the wider European Researcher's Mobility Portal, which provides a wealth of information. The specific content differs slightly by country but generally includes information on: working and living, and culture and leisure in the country; funding opportunities available; research job vacancies and employment search engines; locations of mobility centres; women and science; and intellectual property rights. Information about research policies at the national, European and international level and advice on "going abroad" are also often included. These portals can be a vital tool for countries seeking to enhance HRST mobility and are a good example of the benefits of economies of scale that can be achieved through multilateral co-operation.

Few of the surveyed countries have specific strategies to maintain contact with their diaspora. They focus more on initial retention and re-attraction. However, in 2001, Austria's Office of Science and Technology (OST) at the Austrian Embassy in Washington, DC, set out to establish a network for expatriate researchers – the OST Scientist Network. It was later accompanied by an independent association called ASciNA – Austrian Scientists and Scholars in North America *(www.ascina.at)*. The OST Network serves as a foundation for a broader understanding of the needs of Austrian researchers in North America and provides a basis for recognising those needs in the Austrian scientific landscape. It advises on government-related matters and keeps members informed about science and technology policy issues. The OST also maintains online publications, supplying news on new developments in Austrian and European research to keep expatriates up to date on their fields in Austria. The ASciNA network is more of a "peer network", giving advice on personal matters and fostering contact between scientists on a local level. It helps ease the transition of a scientist or scholar from Austria to the new surroundings, and the knowledge of colleagues in the

Table 4.1. **Mobility strategies**

	Strategy to encourage mobility of HRST	Webpage or organisation providing information to inflows of HRST	Diaspora strategy
Australia	Initiatives in place to promote international research collaboration, including mobility of researchers.	Mobility portal established in conjunction with FEAST (Forum for European-Australian S&T Cooperation) – *www.mobility.org.au*	
Austria	Mobility mentioned in Programme of the Austrian Federal Government for the 23rd Legislative Period.	Yes. Primary site is the Researcher's Mobility Portal Austria *(www.researchinaustria.at).*	Networks for HRST in North America – ASciNA (Austrian Scientists & Scholars in North America) at www.ascina.at and OST (Office of Science and Technology) scientist network at *www.ostina.org/content/view/7/26*
Belgium	The relevant federated authorities put emphasis on their own priorities; however, mobility is a focus of policy efforts in each area.	Yes. Primary site is the Researcher's Mobility Portal Belgium *(www.eracareers-belgium.be).*	Networking events in the United States (Flemish government initiative), in the framework of the European ERA-Link project.
Canada	Mobility is central to a national strategy to make Canada one of the world's top countries for R&D and to build an innovative and competitive economy.		
Czech Republic	The need for mobility support is detailed in many recent documents *e.g.* Strategy of Economic Growth; National Reform Programme; National Innovation Policy for 2005-2010; National Development Plan of the Czech Republic.	Yes. Primary site is the Researcher's Mobility Portal Czech Republic *(www.eracareers.cz).*	
Finland	General goal of internationalisation in S&T and higher education.	Yes. Primary site is the Researcher's Mobility Portal Finland (accessed via Academy of Finland website *www.aka.fi*).	
Japan	Yes – "Strategic Promotion of the International Activity of Science and Technology" – Ministry of Education, Culture, Sports, Science and Technology (MEXT). High priority on strengthening collaboration with Asian countries and internationalising universities.	No central website	
Korea	Enhancing international mobility of researchers in two categories: Korean natives who go abroad for study and research; and the inflow of foreign researchers.	No central website, but individual websites for each programme.	Web portal has been established for knowledge exchange among Korean researchers worldwide. Also distinguished scientists residing abroad are invited to visit Korea and establish networks with domestic researchers.

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Table 4.1. **Mobility strategies** *(cont.)*

	Strategy to encourage mobility of HRST	Webpage or organisation providing information to inflows of HRST	Diaspora strategy
The Netherlands	Ministry of Education, Culture and Research encourages mobility of researchers. Policy executed by Netherlands Organisation for Scientific Research (NOW).	Yes. Researcher's Mobility Portal: the Netherlands *(www.eracareers.nl)*. Also NWO website *(www.nwo.nl)*.	
New Zealand	Ministry of Research, Science and Technology currently developing a strategy to ensure New Zealand continues to attract, retain and develop top-performing people and teams in research, science and technology.		
Norway	No specific strategy, but the government assigns high priority to internationalisation of Norwegian research and invests large resources in international research programmes, in which mobility is a central measure.	Yes. Primary site is the Researcher's Mobility Portal Norway *(www.eracareers.no)*.	
South Africa	Various mechanisms exist to encourage inward and outward mobility of researchers, doctoral students and HRST, mostly managed by the National Research Foundation (NRF).	NRF website (particularly the link to the South African Research Chairs Initiative) provides information on inflows of HRST *(www.nrf.ac.za/sarchi/)*.	Platforms such as the African Union – African Diaspora Ministerial Conferences are used. Also, the Department of Science and Technology holds "South Africa Days" in several destinations abroad where there is South African talent.
Switzerland	No explicit strategy.	Yes – portal for science, research and innovation in Switzerland *(www.myscience.ch)*	SwissTalents database of Swiss scientists and scientists with a strong link to Switzerland *(www.swisstalents.org)*. Also www.myscience.ch (see left).
United Kingdom	Yes. International mobility of students and researchers is embedded in "A Strategy for International Engagement in Research and Development", published by the Global Science and Innovation Forum (GSIF). See *www.berr.gov.uk/files/file34726.pdf*.	Yes. Primary site is Network UK – the researcher's mobility portal *(www.britishcouncil.org/eumobility)*.	The GSIF Strategy for International Engagement in Research and Development recognises that the United Kingdom should encourage and promote an alumni network of researchers who have been working in the United Kingdom. A new International Fellowships Scheme, with linked alumni engagement and operated in partnership by the Royal Society, British Academy, Royal Academy of Engineering and Research Councils UK, will be launched in 2008/09.
European Commission	Yes. See European Commission COM(2001)331 (20/6/2001). Aim of strategy is to develop an open, trans-European labour market for researchers.	Yes. Primary site is the European Researcher's Mobility Portal.[1]	The European Commission has proposed to network all EU researchers working abroad, beginning with the United States *(http://cordis.europa.eu/eralink/)*, followed by other countries, such as Japan.

1. From June 2008, the principal website is the EURAXESS portal *(http://ec.europa.eu/eracareers/index_en.cfm)*

Source: OECD Questionnaire on the International Mobility of Researchers (2007); Pilot Questionnaire (2006) for Australia, Canada and South Africa.

network often provides support and advice on how to proceed with practical tasks related to relocating. More broadly, the European Union is also working to network its researchers abroad via the ERA-Link project. Recently, European researchers in Japan expressed enthusiasm for the planned ERA-Link/Japan that will provide researchers with information and services about career and research funding opportunities in Europe as well as openings for research collaboration (Europa, 2007).

Another point of interest raised by the information on mobility strategies is the role played by regional entities. Belgium's approach offers an interesting example of the promotion of mobility via policies at the sub-national level. In contrast to most other respondents, policy efforts on the mobility of researchers and the attractiveness of research careers are undertaken at the sub-national level in Belgium, in accordance with the division of responsibilities under Belgium's constitution. The effect of a sub-national approach on the efficiency and effectiveness of mobility policies is not clear. Generally speaking, addressing mobility at the regional level may have advantages: for example, policies may be better aligned with regional labour market conditions, they may be better co-ordinated with other policies at local level (in particular, economic development policies), and there may be more scope for new ideas and flexible approaches. However, there are also potential difficulties, particularly with regard to coherence with national objectives, adequacy of capacity at the local level (both financial and administrative), accountability, and the ease with which the target audience can find and understand its mobility options. Evaluation of regional-level policies is essential to determine whether such policies are adding value and are an efficient and effective way of meeting mobility objectives.

Overview of policies

Just as there is a range of "intensity" in countries' approaches to mobility at the strategic level, there is a range of intensity and policy breadth at the operational level. This section presents summary tables of countries' policy approaches to mobility, based on the information obtained from the survey. An attempt is made to categorise policies for purposes of presentation and comparison, following the broad groupings emerging from the data provided. It should be noted that some policies are larger than others, in terms of funding and target numbers of recipients or outcomes. This means that the tabulated summary data on numbers of programmes only gives a sense of the intensity and breadth of policy activity and not the absolute level of activity. Available information on funding levels and recipients/outcomes for particular programmes may be found at *www.oecd.org/sti/stpolicy/talent*.

Table 4.2 presents an overview of policies that provide economic incentives for inflows of HRST. The approaches range widely, from a large number of policies across a number of policy categories to just a few programmes in selected categories. At one extreme is the Czech Republic, which has no policies that explicitly offer economic incentives to inflows of HRST. Finland and Switzerland have focused their efforts on a few programmes that offer economic incentives; in Switzerland's case, this is likely due to the attractive salaries and other conditions that already attract researchers and other HRST to the country. Korea and New Zealand offer the broadest range of programmes, with incentives offered via fellowships, grants, scholarships, tax benefits and other policies. The United Kingdom has the largest number of programmes, including a wide range of collaboration-targeted funding programmes provided through its Research Councils.

Table 4.3 summarises immigration policy-oriented approaches to facilitating inflows of HRST. Around half of the countries indicated that they offer mobility opportunities via their general high-skill migration policies. In addition, almost all have targeted policies to assist HRST inflows, ranging from special visas to facilitated procedures that reduce delays or waive certain requirements. The Scientific Visa procedure adopted by European Commission Directive 2005/71 has been transposed into domestic legislation

Table 4.2. **Economic incentives for inflows of HRST**

	Fellowships	Grants and project funding	Scholarships and allowances	Tax benefits and subsidies	Other
Australia	✓✓✓✓✓✓✓✓✓				
Austria	✓	✓✓✓			
Belgium	✓✓✓	✓✓✓	✓✓		✓
Canada	✓	✓✓✓✓			✓
Czech Republic					
Finland		✓		✓	
Japan	✓✓✓✓	✓	✓✓✓		✓
Korea	✓	✓✓✓	✓✓	✓	✓✓
The Netherlands		✓✓✓✓			
New Zealand	✓✓	✓	✓	✓	✓✓✓
Norway		✓✓✓	✓✓✓		
South Africa	✓	✓✓	✓		✓✓
Switzerland		✓			✓✓
United Kingdom	✓✓✓✓	✓✓✓	✓✓✓✓✓		✓✓✓✓✓✓
European Commission		✓✓			

✓ = number of programmes offering this type of support.

Source: OECD Questionnaire on the International Mobility of Researchers (2007). Pilot Questionnaire (2006) for Australia, Canada and South Africa.

Table 4.3. **Immigration policy to facilitate inflows of HRST**

	Facilitated procedures for HRST	Special visas for HRST	General highly skilled migration policy
Australia		Yes – Business Long-Stay visa, Educational visa, Visiting Academic visa	Yes
Austria	Yes	Yes – Scientific Visa (under EC Directive 2005/71)	
Belgium		Yes – Scientific Visa (under EC Directive 2005/71)	
Canada	Yes – Canada Chairs applicants exempt from Labour Market Opinion requirement	Yes – Off-campus Work Permit	Yes
Czech Republic	Yes	Yes – Scientific Visa (under EC Directive 2005/71)	Yes
Finland	Informal arrangement based on co-operation between Directorate for Immigration and higher education institutions.		
Japan	Yes	Multiple-entry visa available	
Korea		Yes – Science Card, IT Card, Gold Card	
The Netherlands		Yes – Scientific Visa (under EC Directive 2005/71)	Yes – a fast procedure for highly skilled with no work permit required. Facilitated procedures for family members.
New Zealand	Yes, for occupations on shortage lists		Yes
Norway	Facilitated procedures for accompanying family members	Yes – work permit for researchers, scholarship holders and lecturers	Yes – skilled worker/ specialist work permit quota scheme
South Africa		2002 Immigration Act provides for work permits for foreign experts	
Switzerland			Yes (for non EU-EFTA countries)
United Kingdom	Yes – no work permit requirements for certain students	Sponsored Researcher work permit category for non-EEA nationals	Yes
European Commission		Scientific Visa (EC Directive 2005/71)	

Source: OECD Questionnaire on the International Mobility of Researchers (2007). Pilot Questionnaire (2006) for Australia, Canada and South Africa.

by Austria, Belgium, the Czech Republic and the Netherlands. The Directive is legally binding on member states (except the United Kingdom and Denmark) and was to be transposed into national law by 12 October 2007.

Table 4.4 outlines policies related to recognition of foreign qualifications. Almost all countries have an institution charged with assessing and providing information on foreign qualifications, and several of these also undertake more general information dissemination tasks. The European Union-led ENIC-NARIC networks provide the basis for a number of these institutions and are another example of beneficial policy synergy at the multi-country level. Switzerland has bilateral agreements with several European countries on recognition of diplomas, and Canada has a Foreign Credentials Recognition programme for fostering fairer and more transparent recognition processes, by working with provinces, territories, regulatory bodies and sector councils.

Table 4.4. **Recognition of foreign qualifications to facilitate inflows of HRST**

	Institutions	Information dissemination	Other
Australia	National Office of Overseas Skills Recognition (AEI-NOOSR)		
Austria	ENIC-NARIC Austria	Undertaken by ENIC-NARIC Austria	
Belgium			
Canada	Information provided by Canadian Information Centre for International Credentials (CICIC)		Foreign Credentials Recognition programme
Czech Republic	NARIC	Undertaken by NARIC	
Finland	Finnish National Board of Education (ENIC-NARIC)		
Japan			
Korea			
The Netherlands			
New Zealand	New Zealand Qualifications Authority		
Norway	Norwegian Agency for Quality Assurance in Education (NOKUT)		
South Africa	South African Qualifications Authority – Centre for the Evaluation of Educational Qualifications		
Switzerland	Swiss ENIC		Agreements with Germany, Austria, Italy and France on diploma recognition
United Kingdom	UK NARIC	Undertaken by UK NARIC	
European Commission	NARIC network, ENIC network		

Source: OECD Questionnaire on the International Mobility of Researchers (2007). Pilot Questionnaire (2006) for Australia, Canada and South Africa.

Table 4.5 shows the social and cultural support offered to facilitate inflows of HRST. Most countries have non-targeted assistance that helps migrants in general to settle in their new environment, with support offered by non-governmental organisations (NGOs), community organisations, educational institutions and government agencies. Several countries have web-based information sites that offer information on social and cultural support as part of their broader information provision. Offering the most targeted assistance are Austria, Belgium, the Czech Republic, the Netherlands and the United Kingdom, which have launched researcher mobility centres as part of the European Network of Mobility Centres. These centres, with local service centres often located at universities, offer a wide variety of services to mobile researchers.

Table 4.6 provides an overview of policies to facilitate research abroad. Support is provided through a range of mechanisms, including grants and

Table 4.5. **Social and cultural support to facilitate inflows of HRST**

	Service providers	Web information	Non-targeted assistance
Australia			Yes
Austria	Yes – two mobility centres and 33 local service centres (32 as of summer 2007)	*www.researchinaustria.info*	Yes – via communities, federal states, universities, etc.
Belgium	Yes – 20 mobility centres	*www.eracareers-belgium.be/mercator/index.asp*	
Canada			
Czech Republic	Yes – 8 mobility centres	*www.eracareers.cz*	Yes – via NGOs
Finland		*www.aka.fi*	Yes – via community and higher education institutions
Japan			Yes – via Strategic Fund for Establishing International Headquarters in Universities
Korea			
The Netherlands	Yes – 3 mobility centres	*www.eracareers.nl*	
New Zealand			Yes – via government agencies
Norway			
South Africa			Yes
Switzerland			Yes – general support mechanisms for foreigners
United Kingdom	Yes – 12 mobility centres	*www.britishcouncil.org/eumobility*	
European Commission	European Network of Mobility Centres (200 centres in 32 countries)	*Central portal http://ec.europa.eu/eracareers/index_en.cfm*	

Source: OECD Questionnaire on the International Mobility of Researchers (2007). Pilot Questionnaire (2006) for Australia, Canada and South Africa.

scholarships, fellowships, travel and living support, exchange programmes, and other policies. The United Kingdom provides the broadest range of support and has the most policies in this area. Australia also has many programmes, delivered predominantly through fellowships. However, comparing Table 4.6 (support for outflows of HRST) with Table 4.2 and related policies supporting for inflows of HRST, there appears to be less support overall for research abroad than for inflows of HRST. This is further discussed below.

Table 4.6. **Policies to facilitate research abroad (outflows of HRST)**

	Research grants and scholarships	Fellowships	Travel and living support	Exchange programmes	Other
Australia	✓✓✓	✓✓✓✓✓✓✓			✓
Austria		✓✓✓✓✓✓			
Belgium	✓✓		✓✓✓✓	✓	
Canada	✓✓✓	✓✓			✓
Czech Republic	✓✓	✓ (access)			✓
Finland	✓✓ (most grants offered by AKA and Tekes include opportunity to receive research and travel funding for research abroad)		✓✓ (see previous)		
Japan	✓	✓		✓	✓
Korea	✓✓✓		✓✓	✓	
The Netherlands	✓✓		✓		✓
New Zealand		✓✓	✓		✓
Norway	✓✓✓✓✓		✓		
South Africa	✓	✓	✓✓✓✓		
Switzerland		✓	✓	✓	
United Kingdom	✓✓✓✓✓	✓	✓✓✓	✓	✓✓✓✓✓
European Commission					

✓ = number of programmes offering this type of support.

Source: OECD Questionnaire on the International Mobility of Researchers (2007). Pilot Questionnaire (2006) for Australia, Canada and South Africa.

In addition to the policies outlined above, participating countries also provided information on a number of other policy options for facilitating mobility (Box 4.1).

Material provided to the OECD by country authorities for the *Science Technology and Industry Outlook 2008* (OECD, 2008, forthcoming) showed that the mobility policy approaches discussed above are similar to those taken in other

Box 4.1. **Other policy options to facilitate mobility**

Related policy options that can be used to facilitate international mobility of HRST include:

- The Czech Republic's *Education for Competitiveness* (an Operational Programme with European funding) aims to support human resources in R&D in a variety of ways, including preparation for involvement of individuals and teams in international networks and projects. This programme "prepares the ground" for later mobility of HRST.
- The MEXT and the Japan Society for the Promotion of Science (JSPS) have selected 20 universities to take part in the programme Strategic Fund for Establishing International Headquarters in Universities. These headquarters aim to support university-wide international activities with co-ordination among various university organisations. The programme aims to include social and cultural support for foreign researchers and to expand overseas research opportunities for researchers.
- The United Kingdom operates a Science and Innovation Network (SIN) comprising a global network of science officers who provide country-specific intelligence, promote access to and sharing of scientific expertise, resources and facilities, and help shape opinions and attitudes towards the United Kingdom and promote the United Kingdom as the R&D partner of choice. This helps to attract young people, know-how and foreign investment, and to facilitate access to facilities and expertise. Switzerland offers something similar, with its Swiss Houses, a professional network of science counsellors and science consulates operating in close co-operation with the Federal Department for Foreign Affairs, which aims to increase awareness of Switzerland's skills as an internationally competitive location for scientific research and technological development and to promote worldwide co-operation in R&D at personal and institutional levels.
- Several of the Research Council UK members fund subscriptions to international facilities and programmes, so as to provide access for British researchers and to support collaborative work between the researcher and other international users. Examples include the European Synchrotron Radiation Facility, CERN, the European Space Agency and the Human Frontier Science Programme.
- Several recent European-level initiatives aim to give individual researchers the same rights and obligations wherever they may work throughout the European Union. In particular, the European Charter for Researchers addresses the roles, responsibilities and entitlements of researchers and their employers or funding organisations. It aims at ensuring that the

Box 4.1. **Other policy options to facilitate mobility** *(cont.)*

relationship between these parties contributes to successful performance in the generation, transfer and sharing of knowledge, and to the career development of researchers. The Code of Conduct for the Recruitment of Researchers aims to improve recruitment, to make selection procedures fairer and more transparent, and proposes different means of judging merit.

Source: OECD Questionnaire on the International Mobility of Researchers (2007).

OECD countries, suggesting that the sample of countries responding to the OECD Questionnaire on the International Mobility of Researchers is relatively representative. Examples of policies in other OECD countries are presented in Box 4.2.

Box 4.2. **Further mobility policy examples (1)**

Hungary

Hungary operates bilateral educational, scientific and cultural exchange programmes, linked to scholarships and grants, with 45 countries. These international agreements enable students, postgraduates, professors, researchers and artists to widen their professional experience in Hungary. The Hungarian Scholarship Board (HSB) nominates candidates for scholarships and grants by evaluating and ranking over 2 000 applications a year. The grants and scholarships are largely financed by the Hungarian Ministry of Education. There is also a Campus Hungary initiative that was launched to promote and market Hungarian higher education abroad and support the internationalisation of the higher education and training sector in Hungary. Campus Hungary was co-founded by over 40 actors in Hungarian higher education: higher education institutions, the Federation of Hungarian Conferences on Higher Education, HSB and the Ministry of Education.

Poland

The Polish Science Foundation implements a Welcome programme to attract eminent foreign and Polish scientists and researchers to conduct research in Poland. The programme envisages financing the realisation of research projects carried out in Polish public and non-public research and scientific entities (higher education institutions, Polish Academy of Science units, R&D units) under the supervision and direction of eminent researchers in priority research areas. It aims to contribute to establishing and

Box 4.2. **Further mobility policy examples (1)** *(cont.)*

strengthening collaboration between Polish and foreign scientific units, enhancing the transfer of knowledge and skills, and improving the human resources of the Polish science sector. Other programmes on mobility include the Supporting International Mobility of Researchers programme, started in 2006, to enable Polish researchers and scientists to participate in research programmes carried out abroad. It can cover the participant's costs of living and accommodation during the stay abroad (1-3 years). There is also an International Doctorate Studies programme for career development of young scientists, researchers and academics to enable them to participate in high-quality international research teams. It links PhD studies in Poland with PhD studies elsewhere (especially EU member states) and provides financial support for R&D undertaken by young researchers.

Portugal

Portugal has implemented a number of actions that support the mobility of HRST. During 2006-07, the Portuguese government launched an innovation initiative based on new international partnerships involving Portuguese and foreign universities, research institutions and business sector companies, in specific areas. These partnerships aim to stimulate the international opening of universities and excellence in R&D. Initial partnerships were established with the Massachusetts Institute of Technology (MIT), Carnegie Mellon University (CMU), the University of Texas at Austin, and the Fraunhofer Society. Degree programmes have been launched in association with MIT and CMU, and the potential for collaboration in medicine between Portuguese universities and research laboratories and Harvard University is being explored. The new advanced studies programmes developed with MIT have boosted the capacity of Portuguese institutions to attract students from various countries and already involve around 130 students. The Portuguese Science and Technology Foundation has also launched competitions for study grants leading to PhDs and post-doctoral training in Portuguese universities. Portuguese candidates and candidates from countries including Brazil, Finland, Greece, Italy, Moldova and Romania have applied.

Other actions in support of mobility include legal recognition of foreign degrees and a new law defining a specific framework for immigration of researchers and other highly qualified human resources, which facilitates and promotes their mobility and conditions for living in Portugal. Practical issues involving visa applications and issuance are also facilitated through a network of contact points between the main services involved in the process.

Source: Material provided to the OECD for the *Science, Technology and Industry Outlook 2008* (OECD, 2008, forthcoming).

Information from other national authorities (see Box 4.3) supports this view.

Box 4.3. **Further mobility policy examples (2)**

Germany

Academics from abroad in all disciplines, who are internationally recognised as leaders in their field and can contribute to enhancing Germany's sustained international competitiveness as a research location, are eligible to be nominated for an Alexander von Humboldt Professorship International Award for Research in Germany. The Alexander von Humboldt Professorship is financed by the Federal Ministry of Education and Research through the International Research Fund for Germany. It enables award winners to carry out long-term and ground-breaking research at German universities and research institutions. The prize money, totalling EUR 5 million for academics in experimental disciplines and EUR 3.5 million for researchers in theoretical disciplines, is made available for a period of five years. The programme is very similar to the Canada Research Chairs Program.

Italy

Italy facilitates mobility of HRST in a number of policies. For example, the Ministry for Universities and Research operates a "Rientro dei cervelli" (reverse brain drain) programme to ease the repatriation of Italian scholars and researchers abroad and to attract foreign researchers and scientists. This scheme allows universities to offer dedicated contracts of two to four years to foreign researchers or Italians who have been abroad for at least three years. Details are available at *www.rientrodeicervelli.net*. Italy also offers tax incentives for non-resident researchers who return to Italy. The Italian Foreign Affairs Ministry manages bilateral agreements on scientific and technological co-operation between Italy and EU and non-EU countries (35 countries in 2006) to facilitate short-term mobility of researchers. For each approved research programme, the agreement promotes the exchange of researchers between the two countries via support for travel, accommodation and living costs (per diem). There are specific schemes for China and India. The Conference of Italian University Rectors created the Marco Polo programme in 2005, under which Chinese undergraduates and PhD students, as well as researchers, are able to access various services and facilities. Under an agreement with the Indian Ministry for Science and Technology, the Italian government provided 100 fellowships for Indian researchers in 2007, in areas such as information technology, electronics and environmental protection. Italy also has a mobility portal (*www.fondazionecrui.it/eracareers/*) and operates 17 mobility centres.

Box 4.3. **Further mobility policy examples (2)** *(cont.)*

Spain

In Spain, all public calls for the hiring of researchers in public R&D centres are open to both Spanish and foreign researchers. The selection criteria relate solely to scientific excellence. The Ministry of Education and Science provides information on programmes related to the hiring, training and mobility of researchers (see *www.mec.es/ciencia/rrhh/*). Examples include: the FPI (Programme for the training of researchers) to train pre-doctoral researchers who have finished their university degree within the last four years; the RyC (Programme Ramón y Cajal) to provide R&D centres with senior researchers who have been awarded a PhD within the last ten years; and the JdC (Programme Juan de la Cierva) to provide R&D centres with young researchers who have received a PhD within the last three years. Spain also provides information for immigrant researchers through its network of mobility centres, funded by the Ministry of Education and Science, with the aid of the Science and Technology Foundation and other entities from the Autonomous Communities Administration. The associated weblink is: *www.eracareers.es/fecyt/red.jsp*.

Spain also provides opportunities for research abroad – the Ministry of Education and Science offers an Integrated Actions Programme to finance stay and travel allowances for research groups that work with groups in other countries (currently Austria, France, Germany, Greece, Hungary, Italy, Portugal and South Africa). The Ministry also finances short stays and travel allowances in Spanish and foreign R&D centres to help pre-doctoral researchers to establish connections with other R&D centres, which can be useful for their thesis and career.

Source: National authorities.

Discussion of national-level policies

A primary goal of the policy inventory was to assess information on policy aims, geographical targets, budgets and numbers of HRST personnel involved, to analyse whether national measures overlap or whether there is a pattern of specialisation, and to determine how HRST policies link with other policy areas. This section discusses these issues, and concludes that there are strong similarities in national policies and their targets, as well as increasing levels of policy co-ordination within countries.

Coverage of inflows, outflows and diaspora

At a broad level, policies related to mobility may address inflows of HRST (both attraction from abroad but also creation at home via the education system; the latter are not a focus of this study), outflows, and the diaspora.

As noted above, there is generally more policy support for inflows of researchers and other HRST than for outflows. Based on an approximate count of policies related to economic incentives (Tables 4.2 and 4.6), Australia, Austria and the Czech Republic have more policies for outflows than for inflows, Canada, Finland, the Netherlands, Norway, South Africa and Switzerland have relatively even support, and Belgium, Japan, Korea, New Zealand and the United Kingdom have more policies for inflows than outflows. The emphasis on inflows may indicate that researchers and other HRST are already outwardly mobile and require fewer incentives in this respect. It may also indicate that countries are relatively more reluctant to encourage outward mobility despite arguments about the benefits of brain circulation.

While there appears to be more emphasis on policies for inflows, there is little explicit support for contacts with the diaspora. Yet a country's stock of skilled HRST abroad can represent a large potential resource, and can be successfully tapped to support science and technology activity at home. Some policies for facilitating inflows are targeted at the diaspora, in that they seek to attract back skilled researchers and other HRST from abroad. Examples include Australia's NHMRC Howard Florey Centenary Fellowships, offered to junior Australian researchers actively engaged in research overseas in the biomedical or health fields, Belgium's Return Grants for Belgian post-docs who have been working abroad for at least two years, Korea's Exchange of International Researchers for Koreans who have lived abroad for more than ten years, and South Africa's Research Chairs Initiative to attract back qualified research scientists. The relative scarcity of programmes to maintain contact with the diaspora may be due to the fluid nature of this group and the difficulty of knowing where expatriate HRST actually are. It will be important to evaluate existing policies, such as Austria's ASciNA association and OST scientist network in North America, to see whether these networking and contact schemes have been effective at maintaining useful links with the diaspora and facilitating knowledge and information flows from the diaspora to the country of origin.

As noted, a number of countries have no specific mobility strategy. This increases the risk of a lack of coherence among policies on inflows, outflows and the diaspora. Ideally, mobility policies should be part of a wider strategy on mobility that contributes to the country's objectives for science, technology and innovation and sets out the rationale for intervention in mobility issues.

Resources allocated and HRST affected

From the information provided, it was not possible to establish each country's approximate annual budget for mobility or the approximate number of people affected, in order to undertake a full comparison across

countries. Nevertheless, the data provided by some countries on resources allocated and outcomes in recent years give a broad indication of the scale of activity (see *www.oecd.org/sti/stpolicy/talent*). They are not strictly comparable as the time period is not consistent and they are incomplete. They should be regarded as a rough indication of the range of activity levels across countries. For example:

- Austria spent approximately USD 14.5 million a year and made over 250 individual and team awards (financial data from 2006 and 2007).
- Canada's largest programme (the Canada Research Chairs Program) allocates approximately USD 240 million a year.
- Japan spent approximately USD 320 million a year and made over 2 000 individual and project awards (financial data from 2006 and 2007).
- Korea spent approximately USD 28 million a year and made over 600 individual and project awards (financial data from 2006 and 2007).
- The United Kingdom spent approximately USD 92 million a year on programmes and a further USD 320 million on subscriptions to international facilities and programmes (financial data from 2006 and 2007/08).
- The European Union's PEOPLE programme (which implements Marie Curie actions) and the IDEA programme have an average annual budget of more than USD 2 billion over seven years (2007-13).[2]

Even this rough comparison suggests a vast difference in the scale of resources dedicated to mobility and the number of HRST affected by mobility policies. This likely reflects not only differences in the total resources available to governments, but also the priority accorded to mobility relative to other science and technology and education activities.

It is also useful to note that policies on the international mobility of researchers and other HRST are influencing mobility only at the margin. As noted above, from 1990 to 2000, 5 million tertiary-educated adults moved from a less developed to a more developed country, while 2 million moved between more developed countries. The United Nations estimates the total stock of international migrants at approximately 190 million. In this context, even 2 000 individual awards are relatively minor. Nevertheless, if the target population tends to be the most talented cohort, or concentrated in a specific scientific field, then their mobility may have a relatively large impact on science and technology activity.

Policy commonalities across countries

Analysis of questionnaire responses suggests that national policies generally target the same population and that there is little specialisation according to national scientific and technological interests. As might be expected,

many programmes are targeted at "leading", "outstanding", "internationally recognised", and "highly qualified" researchers, or at promising students. This is particularly true for programmes offering fellowships, scholarships and grants. In addition, most programmes are not restricted to specific fields. While some fellowships and scholarships target health and medical researchers, or humanities and social sciences, for example, most programmes make funding available regardless of scientific discipline. Only a few attempt to explicitly target domestic priorities, although New Zealand has programmes specifying that researchers are to work in key areas of strategic interest to New Zealand.

However, this policy overlap does not necessarily mean that "talent wars", a term common in the media, are a reality for countries attempting to attract skilled researchers and other HRST. With many policies offering funding for mobility (as compared to permanent migration), it is possible that mobile researchers will avail themselves of the policies of a number of countries – essentially dispersing their time and knowledge across a number of locations so that no one country monopolises the physical presence of researchers. However, it is true that some shorter-term mobility can lead to more permanent migration (for example, when students remain after their studies for work purposes). As discussed above, it is also important to note that the movement of researchers and other HRST abroad does not necessarily result in a net loss to the sending country. In fact, competition for talent may encourage increased levels of human capital formation and lead to an increase in the supply of skilled people.

While the similarity of countries' policies may reflect a move towards best practice, it is not clear that this is the case. Most policies have not been subjected to evaluation and thus cannot be assessed in a comparative way. In some cases this is because the policies have only been operational for a short time and it is too early to judge their level of success. Future policy development in this area would benefit from information gathered from evaluation exercises. Evaluation is discussed in more depth in Chapter 5.

Geographic focus

The similarity among countries' policies might be tempered if they had different geographical targets. In fact, some mobility programmes do target particular regions or countries, either to attract applicants or as destinations for funded stays abroad. These arrangements can be the result of bilateral agreements. For example, an arrangement between South Africa and Russia brings Russian academics to South Africa each year, and New Zealand's Julian von Haast Fellowship Award brings German scholars to New Zealand. Other programmes are regionally based, such as Japan's Asia Science and Technology Strategic Co-operation Programme, which supports symposiums and joint projects in Asia. A few programmes target developing countries. For

example, Norway's Quota Scheme Scholarships go to students from developing countries in south, central and eastern Europe and central Asia, in order to provide them with an education that will benefit their home countries on their return. Several countries also indicated that funding for research abroad is only open to citizens or to those with a minimum period of residence in the funding country.

However, programmes most often do not place restrictions on applicants' country of origin or country of destination for mobility, provided that they meet the criteria for application, such as level of experience. In theory then, many HRST mobility policies have a global focus.[3] Nevertheless, geographic focus points may emerge as a result of individuals' location decisions; they may prefer to stay in the same region, or may be more aware of opportunities closer to home. Therefore, a globally oriented policy may become, *de facto*, regionally focused.

In this respect, it is interesting to note countries' "marketing" approaches. Most policies appear to rely on passive advertising, that is, they provide information about funding or migration opportunities on a website or in brochures. Few take the information directly to the target market. However, Korea holds Study Korea Expos in ten cities in China, Vietnam, Mongol, Uzbekistan and Kazakhstan. Also, Norway's NordForsk Research Programmes are promoted via direct mail campaigns to particular departments and persons at universities and ministries, as well as via the Internet and information leaflets.

Active marketing of policies is likely to be considerably more expensive than providing information on a website. If the target market is global, it may also be difficult and unwieldy to organise. Websites are undoubtedly an efficient way to make information widely available, although this may also reinforce geographical focus. Researchers and other HRST from the same region are more likely to know where to look for information than people from further afield. In addition, the language used on the website will affect how effectively it reaches a wide audience: information must be presented in multiple languages, including English, to achieve a geographically diverse coverage. Policy evaluations could help to shed light on whether website information is effective in reaching and attracting a global audience.

Cross-portfolio approaches

The information provided indicates that mobility policies are increasingly co-ordinated with policies in other relevant areas, such as labour market, immigration and science policies. In some cases this is reflected in strategy documentation, in others through the practical arrangements for project funding and delivery which may involve several agencies. In some cases, co-ordination is quite informal; for example, Finland has an informal

co-operation arrangement between the Directorate for Immigration and higher education institutions, which speeds up the immigration procedure for incoming researchers.

There also appears to be some policy coherence with development and aid policies. For example, Belgian Science Policy's post-doctoral fellowships to non-EU researchers target regions in terms of neighbourhood and foreign policy, such as countries in eastern Europe, the non-European Mediterranean region, central and southern Africa and Latin America. For its part, the Study Korea programme provides scholarships to bachelor's degree students from developing countries. Norway has several mobility programmes aimed both at development co-operation and increased mobility and collaboration in higher education and in research, such as the Norwegian Programme for Development, Research and Education (NUFU) which focuses on Norway's partner countries in Sub-Saharan Africa, Asia, Central America and the Middle East.

Policy at the institutional level

As part of the policy inventory questionnaire, supplementary information was requested on institutional-level policies and programmes to encourage international mobility, in order to include specific programmes in universities, public research organisations, funding agencies or other bodies not included in the presentation of national policies and programmes. (The distinction between national policies and institutional policies can be blurred; the categorisations provided by the country respondents are generally used). This information was received from Austria, Belgium, the Czech Republic, Finland, Japan and Switzerland.

To promote inflows of researchers and other HRST, the assistance most frequently offered, predominantly by universities, was social support relating to language, housing, visas, insurance and similar issues. The assistance was commonly provided via on-campus centres for international students and staff or general student service centres, or through web-based helpdesks. Other examples of social support offered included child care, student associations, cultural expeditions and counselling services for employment and part-time jobs.

Facilitating student exchange was also common, particularly for Japanese universities. Frequently this was linked with the activities of overseas offices or liaison centres located in target cities and countries. These offices aim at enhancing academic networking and collaboration and raising the profile of the university as a destination for study or work. Overseas offices are located in a number of areas, commonly in Asia (the University of Tokyo noted that its Beijing office was the first foreign university office to be officially registered in

China), but also in such diverse places as the University of Cambridge, the Siberian Branch of the Russian Academy of Sciences, Germany and the United States.

Grants for travel and related expenses, invitations to foreign academics, and scholarships for foreign students and researchers were also offered to attract inflows of researchers and other HRST. In some cases, travel funding was only available to academics coming from partner universities with agreements on joint research, student exchange and exchange of faculty members. Grants, fellowships and international advertising of positions were also noted as examples of institutional initiatives.

To promote research abroad, the support most commonly provided was assistance with travel and related costs and research grants/scholarships. Some were aimed at younger researchers, often under 35-40 years of age, but travel funds were also available to all faculty members.

Policies and programmes at the institutional level, with a greater focus on information provision and practical social/cultural assistance, complement those at the national level. The institutions surveyed, mostly universities, also have established networks and links with other universities and research centres abroad, which may create opportunities for targeted mobility related to particular projects or topics of interest. Institutional mobility initiatives also tend to provide support for short-term visits, which are less often supported at the national level. Some institutional initiatives also complement development policies; for example, Belgium's Institute of Tropical Medicine in Antwerp collaborates with the Belgian Directorate General for Development Co-operation to support partner institutions in the South (currently 20 in Africa, Asia and South America) via joint research projects.

Summary

The responses revealed a wide variety in the degree of "intensity" with which countries approach the mobility of HRST. Most consider mobility important in the context of retaining and attracting HRST and have policies to assist and encourage mobility. These range from economic incentives to encourage inflows, immigration-oriented assistance, recognition procedures for foreign qualifications, social and cultural support, and support for research abroad. Each of these policy areas relies on a range of mechanisms, including scholarships, fellowships, grants, facilitated procedures, institutional arrangements and service centres. Some countries focus on just a few policy mechanisms, while others offer "something for everyone".

In some countries these policies are part of an explicit mobility strategy, but in others they are not. This increases the risk of a lack of coherence between policies on inflows, outflows and the diaspora. Ideally, mobility

policies should be part of a mobility strategy that contributes to the country's objectives for science, technology and innovation, and which sets out the rationale for intervention in mobility issues. Few countries have specific strategies to maintain contact with their diaspora, although many use economic incentives to attract back talented HRST. There is generally more support for inflows of researchers and other HRST than for outflows, perhaps indicating that outward mobility is adequate or that countries are reluctant to encourage outward mobility, despite arguments about the benefits of brain circulation.

Very provisional comparisons of budgets and targets suggest a vast difference in the scale of countries' resources dedicated to mobility and in the number of HRST affected by mobility policies. This likely reflects not only differences in the total resources available to governments, but also the priority accorded to mobility relative to other science and innovation activities. In total, the numbers of HRST targeted by national policies are relatively small compared to overall movements of skilled migrants. However, if the target population is concentrated in a particular cohort or scientific field, their mobility may have a significant impact.

National policies appear generally to target the same population, with little specialisation according to national scientific and technological interests. However, this does not necessarily mean "talent wars" among countries attempting to attract skilled researchers and other HRST. With many policies offering support for mobility, as compared to permanent migration, it is possible that mobile researchers will avail themselves of the policies of a number of countries – essentially spending time and dispensing their knowledge in various locations. Moreover, the movement of HRST abroad does not necessarily result in a net loss to the sending country as competition for talent may encourage more human capital formation and increase the supply of skilled workers. It is difficult to assess whether the similarity of policies reflects a move to best practice, as few policies have been evaluated.

In most cases, national policies do not place restrictions on the country of origin of applicants or on the country of destination for mobility. In theory, then, many mobility policies have a global focus. Nevertheless, a geographic focus may emerge as a result of individuals' decisions (*e.g.* researchers may be more aware of opportunities closer to home or be more willing to move shorter distances), owing to the efficacy of countries' marketing.

From the information provided, it appears that mobility policies are increasingly co-ordinated with policies in areas such as labour markets, immigration and science. There also appears to be some policy coherence with development and aid policies.

At an institutional level, the most common mobility assistance provided concerns social support related to language, housing, visas, insurance and other similar issues. Student exchanges are also popular, as are travel grants for research abroad. Policies and programmes at the institutional level, with their greater focus on information provision and practical social/cultural assistance and greater assistance for short-term visits, complement those at the national level.

Notes

1. Australia, Canada, Japan and South Africa piloted the questionnaire in 2006. Their responses (including an updated Japanese response) were collated with those received for the full survey undertaken in 2007.
2. Currencies converted to USD at 2006 purchasing power parity (PPP) exchange rates (USD 1=EUR 0.86, JPY 124.5, GBP 0.62, CAD 1.23). Rates from OECD:Stat, series PPPGDP.
3. In practice, most mobility flows are between developed countries, or from developing to developed countries.

References

Europa (2007), "Enthusiasm for new networking tool among European researchers in Japan", Press Release IP/07/1806, 29 November 2007, Brussels.

Global Science and Innovation Forum (2006), *A Strategy for International Engagement in Research and Development*, October, *www.berr.gov.uk/files/file34726.pdf* (accessed 7 September 2007).

OECD (2008 forthcoming), *Science, Technology and Industry Outlook 2008*, OECD, Paris.

ISBN 978-92-64-04774-7
The Global Competition for Talent
Mobility of the Highly Skilled
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Chapter 5

Looking Ahead: Mobility Policy

Chapter 5 discusses the role of government policy in the area of international mobility of human resources for science and technology. It considers future policy options by examining the underlying rationale for government intervention, exploring the potential scope, objectives and approaches of future mobility policies and discussing the importance of the coherence between mobility policy and other government policies.

The key messages emerging from the preceding chapters are: that mobility is not a zero sum game – both sending and receiving countries at all levels of development can benefit from the international mobility of human resources for science and technology (HRST); that mobility is increasing; that the positive impacts of this mobility are appearing in the data; and that the geographic spread of R&D and scientific activity is creating the impetus for moving to more and more countries worldwide. Chapter 4 pointed to the range of policies already in place to encourage mobility and highlighted the differences in the "intensity" of countries' approach to mobility. Given this background, what should governments' mobility policy entail?

Establishing the rationale for government intervention

When contemplating government intervention in a particular area, it is necessary first to define the "problem" and its significance.[1] The problem should be specified in terms of the loss, harm or other adverse consequences that will result if action is not taken, and ideally highlight who or what would suffer. It is also important to estimate, at least in a preliminary way, the size of the impact of the problem – if the impact is low, then no action may be warranted, particularly considering the costs involved with government action and potential unforeseen side-effects. Identifying the consequences of "doing nothing", and assessing the likelihood of "self-correction", can help to put the problem into perspective. Clearly specifying the problem at an early stage helps guard against unnecessary or inappropriate actions, and improves the chances of the problem being successfully tackled.

What sort of problems might be identified? In general, market failure, relating to the presence of externalities, public goods, or lack of information, is often cited as the justification for government action (see Box 16). Market failures move the economy away from an efficient allocation of resources, and create the possibility that government action may improve on market-derived outcomes and welfare levels. Risk mitigation or social/equity issues may also feature in the problem definition stage.

The rationale for mobility policies

The literature review in Chapter 2 suggested that mobility is associated with the creation and diffusion of knowledge, which is vital for innovation processes. In creating codified knowledge and spreading tacit knowledge, not

Box 5.1. **Market failure**

Market failure refers to situations in which markets do not produce economically efficient outcomes, that is, resources are not being allocated to their most valued uses. The classic types of market failure include:

Asymmetric information

Markets may not allocate resources efficiently if one party in a transaction has significantly more information about a good or service than another. One party may have an incentive to conceal information, to gain a better price or more favourable conditions. Over time, markets can develop responses to issues of imperfect information – for example, third parties may collect and publish information and buyers may share their experiences.

Externalities

A positive externality (or positive spillover) occurs when one party enjoys benefits from the actions of another, which are not paid for through market prices. A negative externality (or negative spillover) occurs when the party imposes on others costs that are not compensated through market prices. Many activities generate some sort of externality – the question is whether the size and nature of the externality, and the likelihood that government intervention will be successful in addressing it, justifies government action.

Abuse of market power

Problems with market power can arise when market structures are not competitive – when markets have few producers, there are no or few close substitutes for their output, and the producers are able to restrict output and maintain prices at higher than competitive levels. However, not all markets with few producers are characterised by market power, as the threat of new competitors in the market may serve to keep prices and services competitive. Generally, a barrier to entry (such as regulation, or a patent for a product) is required to prevent other businesses from entering the market when an existing firm attempts to raise prices over competitive levels. Identifying this barrier to entry is a key element in defining government intervention in response to market power.

Public goods

Public goods are goods or services that are non-excludable and non-rival, that is, once they are provided, anyone can simultaneously have access and their use by one person does not reduce the availability to others. Free markets may provide fewer public goods and services than the community as a whole would be willing to pay for, since as long as people think others desire the good or service and will pay for its provision, they will be unwilling

Box 5.1. **Market failure** *(cont.)*

to contribute voluntarily to its provision. Goods and services that are non-rival (for example, lighthouses) or non-excludable but rivalrous (known as common property resources, such as a public beach), may also justify government intervention.

Source: Australian Government (2007), pp. 60-62.

only do researchers, scientists and engineers share their know-how with colleagues, they also spark knowledge spillovers – positive externalities that allow many more individuals, firms and organisations to benefit from the knowledge carried by the mobile person. Sending countries can also tap into benefits associated with mobility and knowledge flows, through "brain gain" effects, brain circulation and engagement with the diaspora.

This raises the possibility that government intervention in mobility may be justified by market failure arguments, particularly those associated with externalities and information asymmetries. If HRST make mobility decisions based on private returns that differ significantly from social returns, or if information about mobility opportunities is lacking or difficult to obtain, the amount of mobility may be less than would be socially optimal. Governments may see scope to act to internalise some of the social costs and benefits of mobility or to improve information provision.

That said, different countries have different mobility patterns, economic and social contexts, and overall goals, so that the rationale and impetus for government intervention and the ultimate shape it takes will differ as well. Chapter 5 showed that even within the OECD area, patterns and contexts vary widely: some countries have net gains of skilled HRST while others have net losses; in some countries the mobility rate of their highly skilled population is low while in others it is high. This makes it unlikely that a "one size fits all" approach will emerge.

Policy makers' perception of the obstacles to mobility gives insight into the rationale behind current policies. In general, these tend not to address market failure but the immediate problems faced by mobile HRST. For example, in work related to the establishment of the European Research Area, the European Commission (2001) pointed to several groups of obstacles facing mobile researchers:

- First, "legal and administrative" obstacles, including immigration (particularly for third-country researchers), social security and taxation issues. For example, mobile persons may have to contribute towards benefits they cannot enjoy or receive compensation for, or they may not be

able to recover their pension contributions at the end of their stay. However, as the Commission noted, these obstacles are not specific to researchers but are faced by all mobile workers.

- Second, "social, cultural and practical" obstacles, such as: access to information about rules and regulations and about funding; knowledge of the local language; finding job opportunities for partners, schools for children and suitable family accommodation; and dealing with obligations in the home country, such as mortgage payments or elderly parents. These problems differ depending on the researcher, the length of stay and career stage and again are not necessarily specific to researchers.
- Third, the "obstacles to a European dimension in research careers" include difficulties for obtaining positions upon return to the home country (and a fear of being "left out of the system" if they go abroad), lack of recognition of the value of mobility for career advancement, inadequate funding, age limits in mobility schemes (particularly problematic for female researchers), and lack of recognition of diplomas.

The Commission found that obstacles to researcher mobility depend significantly on the duration of the stay and the researcher's career stage, with a concentration of obstacles appearing for mid-career researchers in medium-term stays (two to five years) (EC, 2001).

Academic research provides further insight into obstacles to mobility, *i.e.* the "problem" potentially to be addressed by government intervention. For example, a survey of Italian PhD students found that 72% had never left Italy for a study period while preparing their PhD (Avveduto, 2001). The survey results suggested that the biggest obstacle to international mobility was insufficient funds (34%), followed by personal commitments related to family or work (21%). Lack of information, lack of time and inadequate knowledge of scientific opportunities abroad were also cited. Finnish research also highlighted family issues – in particular, spouse employment, children, and personal financial matters:

> "… by far the most quoted main obstacles to international mobility were related to family issues. The most important and most quoted of these was the spouse or partner being unable to leave his or her job in Finland or his or her potential difficulties in finding a job abroad. Having young children in general, children's school and childcare issues, issues such as possible difficulties in finding family housing, renting out the family's home in Finland during the stay abroad and other similar practicalities were also quoted repeatedly. Many respondents also mentioned other family-related reasons such as an unwillingness to be far away from the family in general, and from elder family members in particular." (Kulonpalo, 2007, p. 41)

The factors or conditions that can motivate HRST to move may also point to potential obstacles to mobility. Various drivers of mobility, including opportunities for increased pay and research funding, career advancement, higher quality research facilities and infrastructure, working with "stars" or in a prestigious institution, and freedom to debate, were identified earlier. Identifying why these conditions are not met may reveal some barriers or obstacles to mobility.

However, the crucial question is which of the potential obstacles discussed above stem from a valid market failure, a social/equity issue or other issue to which government attention should be turned? There is a line to be drawn between what constitutes a potential government responsibility and what should remain personal responsibilities and choices. Identification of an obstacle to mobility does not necessarily constitute a rationale for government intervention, particularly if the impact is small compared to the costs that would ensue.

There is certainly no universal agreement, even within individual countries, about the nature of the obstacles to mobility. For example, a report on the United Kingdom's Research Councils suggested that the bulk of international engagement and collaboration is usually undertaken by researchers directly, often without reference to the government or the Research Councils (House of Commons, 2007, p. 12). This "bottom up" approach, in which scientific need and assessment of the mutual benefits of working together drive interactions, has led some Research Councils to focus activities on addressing barriers to collaboration such as funding or bureaucracy. However, some participants in the inquiry felt no need for the Research Councils to stimulate international mobility of researchers, while others argued that it was unclear that such activities had any impact on mobility (2007, p. 29).

In considering the rationale for intervention, policy makers may also wish to consider how potential obstacles to mobility might change in the future, both in response to current policy efforts and as a reaction to changes in the environment. For example, Chapter 3 pointed to the increasing internationalisation of R&D; will it lead to greater short-term and circular mobility, as researchers find interesting work and collaboration opportunities in an increasing number of locations which outweigh issues such as family or spouse employment? Other considerations include the extent to which the observed obstacles to mobility are specific to HRST and warrant specific intervention. In some cases, a wider group of mobile individuals may be concerned, so that broader issues should be considered before deciding on intervention. Finally, in addition to estimating the scale of the related administrative costs, it is also important to consider potential side effects. For example, Kulonpalo (2007) found that some mobile researchers experienced a

divorce or break-up with their partner during a working period abroad or as a direct or indirect consequence of international mobility.

What role for mobility policy?

If a valid rationale for intervention is identified, and if the potential benefits are estimated to outweigh the costs, the question is whether government intervention can have an impact. Governments only have influence over some of the obstacles cited above. For example, as noted by Nerdrum and Sarpebakken (2006), it is difficult to use policy instruments to influence the behaviour of people who immigrate for personal or emotional reasons. In their survey, one-third of foreign researchers moving to Norway "followed their hearts" and travelled to Norway with a spouse or to join someone they were emotionally attached to. Similarly, it is difficult to see what governments can do to address personal obstacles to mobility, such as unwillingness to leave family.

However, for researchers, scientists and engineers that move primarily for non-personal reasons, there may be more scope for effective government action. Factors such as increased pay, career advancement, and higher-quality research or educational facilities can induce mobility and are certainly amenable to policy. Administrative obstacles, such as those relating to immigration or pension portability, may also be candidates for improved policy approaches. Language is another area amenable to (longer-term) policy. A study of outward student mobility from the United Kingdom found that non-movers typically cited financial constraints and lack of foreign language skills as a key factor in their decision not to study abroad (Sussex Centre *et al.*, 2004, pp. 37-39). When asked to suggest areas of action to increase student mobility, many interviewees (both movers and non-movers) emphasised the need to enhance the teaching of foreign languages at school.

Once the rationale and potential for action are established, it is necessary to set clear objectives and define the contours of government action (in particular, to avoid overlaps, duplication or crowding out of existing public or private activity). This allows policy makers to identify a range of options. It is important not to confuse objectives with the means of obtaining results (encouraging HRST mobility to stimulate innovation is an objective, offering travel grants is one of many means of achieving it). Objectives should also be formulated in a way that will allow policy makers to evaluate the extent to which the objectives have been met.

While the formulation of mobility policy objectives will differ according to countries' context and preferences, all should aim for clarity and objectives that will facilitate later policy evaluation. Achieving clarity may require trade-offs between certain goals. For example, the United Kingdom's House of

Commons report on Research Councils raised a fundamental question about support for international activities: should Research Councils fund proposals because they involve collaboration with countries identified as strategically important or should they only fund the best science? Participants in the inquiry called for clarity, saying while there is clearly a scientific reason for supporting international collaboration, there may also be strategic or economic reasons (for example, funding a collaborative proposal with a country that may be a leading world player in five to ten years) (House of Commons, 2007, pp. 24-25). Achieving clarity might also require better knowledge of the local context. For instance, Kulonpalo (2007) notes that declining interest in international mobility among Finnish researchers occurred against a backdrop of rapid growth in the number of Finnish publications in international scientific journals and in the number of international networks and research projects in which Finnish researchers have participated. This raises the question of what sort of mobility is involved in these activities and what additional mobility would add to innovation and scientific endeavour, over and above what is added by international papers and projects with less mobility.

Formulating objectives for mobility policies raises the issue of mobility strategies. As noted in Chapter 4, while many countries support HRST mobility, most do not have an explicit mobility strategy. A mobility strategy does not guarantee that support for mobility will be more successful, and some may view it as "over-engineering" a specific policy area. Nevertheless, thinking about a mobility strategy may help to clarify what governments are hoping to achieve, thus leading to improved policy design and coherence.

Policies

Countries already have various policy initiatives to encourage and facilitate inward and outward mobility of skilled researchers, scientists and engineers (see Chapter 4). In the main, these initiatives involve funding for individuals but also include information provision and some facilitated administrative procedures, especially for immigration.

In contrast to the policies themselves, there is little information available on their effectiveness. The OECD Questionnaire on the International Mobility of Researchers collected some material on the evaluation of mobility policies (see Box 5.2), but the sample is too small to draw conclusions about best practice. Evaluation is not costless, and the approach must balance the advantages of greater precision and information about efficiency and effectiveness with the additional administrative and compliance costs. Nevertheless, countries would likely benefit from putting additional resources into evaluation of selected mobility schemes to assist in policy design and help increase returns on government investments in this area.

Box 5.2. **Evaluation of current mobility policies**

Policy evaluation has become a central part of the management and governance of public support for science and innovation. It has been driven by factors such as greater recognition of the importance of science and innovation for economic growth and welfare and a desire to make effective investments in this area, a broader trend towards learning from past policy successes and failures, and a general push for clear accountability and transparency on the part of government and minimisation of distortions arising from government policies. For mobility policies, evaluation offers the chance to better understand the policy choices made by countries and whether they are efficient and effective, and potentially to point towards some best practices.

As part of the OECD Questionnaire on the International Mobility of Researchers, information was received on the results of five policy evaluations (OECD 2008). The small number of evaluations can partly be explained by the relative novelty of many mobility policies, although in-depth evaluation seems to have been infrequent overall. Two of the evaluated policies focused on inward mobility (the Lise Meitner programme in Austria and the Canada Research Chairs Program), two focused on outward mobility (the Erwin Schrödinger programme in Austria and the EU Marie Curie fellowships), while the fifth supported mobility via recognition of qualifications (EU Network of National Academic Recognition Centres – NARIC). Overall, the evaluations concluded that the mobility funding programmes were broadly successful. However, the evaluation of NARIC identified a number of areas for improvement.

The small sample size precludes drawing conclusions about best practices in mobility policies. However, some interesting insights did emerge. First, an appropriate level of grant funding at the individual level is crucial for attracting the target population. Second, the duration of grant funding is important – the objectives of the programme, in terms of the type of research supported (social science, biology, natural science, etc), may not be achieved if they are not matched by funding durations that are attractive to researchers in that area and allow them to reach concrete goals within the funded period. Third, the use of funds by recipients may need to be monitored to ensure that the allocations are broadly in line with policy intentions. A related issue is flexibility – a balance must be struck between prescription and flexibility, so as to keep the programme in line with its objectives but not stifle valid and useful differences among recipients in how the funds are spent. Fourth, uptake of funding is greatest when personal objectives match programme objectives; this raises the question of whether mobility has the desired long-term impacts if the objectives of funding recipients are not aligned with the goals of the programme. Fifth, clarity of programme goals is essential, as is policy coherence across government.

Box 5.2. **Evaluation of current mobility policies** *(cont.)*

All five evaluations took a similar methodological approach. All used a case study/survey combination, with information predominantly from interviews, surveys and administrative databases. Most assessed programme relevance, efficiency and effectiveness – the core issues for evaluations – and three presented their conclusions around these themes, making it easier for policy makers to identify important issues. The Marie Curie evaluation noted the utility of combining assessment of operational issues with broader impact issues, in terms of economies of scale in evaluation and avoidance of "questionnaire fatigue". The evaluations presented quite extensive statistical information about programmes and participants; however, there was often no control group with which to compare the information, making it difficult to determine the additional contribution of the programme. Overall, more data was presented on inputs to the programme than outputs; this makes it difficult to assess efficiency and effectiveness. Suggestions by the Marie Curie evaluation team highlighted the need for policy makers to consider the needs of evaluation ahead of time and to put in place appropriate systems for collecting relevant data and information.

While the evaluations provided a substantial amount of information about the programmes and their participants, the questions of whether government intervention is necessary and whether the support provided by the programmes corresponds to the government's goals for innovation, science and technology are left unanswered. Some issues raised in the evaluations suggest that it would be useful to ask these questions to learn if the original problems or barriers to mobility that inspired the policies still need to be addressed and if the policies are designed appropriately.

Given the differences among countries (and the lack of information on best practice), it is not possible to identify a "recipe" for what governments should do more of, what they should do less of, and what should stay the same. Chapter 4 showed that while countries may use similar types of policies, they have quite different "intensities" of approach to mobility, in relation to money spent, numbers targeted and number of policies. It is also clear that different countries face different challenges – for some, language may be the biggest barrier, while for others, research infrastructure may be an issue. It is nonetheless possible to suggest some policy ideas that governments may wish to consider.

Economic incentives and programme duration

One lesson that emerged from evaluations undertaken by governments was that funding levels and the duration of funding are crucial factors in the

success of mobility schemes. If the levels are too low, the policies may fail to attract the target population. For example, the evaluation of Austria's Lise Meitner scheme noted that grants were raised in 2001/02 when it appeared that the programme did not attract researchers with sufficient experience to have an effect on local research teams. The duration of funding must also match the programme's objectives. The evaluations of both Austria's Erwin Schrödinger programme and the European Union's Marie Curie scheme showed that the appropriate duration depends on the field of study, as some require more time to achieve concrete research outputs (particularly laboratory or experiment-based research). If the objective is to enhance research output, the funding duration must be adequate. For instance, the Marie Curie evaluation found that for the life sciences, the environment, geosciences and physics stays of more than two years were preferred, for chemistry, engineering, mathematics and IT, stays of one to two years were preferred, while for social sciences, the humanities and economics stays of 6-12 months were preferred.

Immigration

The data and evidence in Chapter 3 suggested that the mobility of highly skilled workers is increasingly temporary, with HRST engaging in circular and return migration in response to both opportunities and personal commitments. Shorter (and potentially repeated) working periods abroad may circumvent some of the obstacles that currently deter mobility. Removing barriers to short-term and circular mobility would support knowledge flows associated with brain circulation, enhance network building, and potentially stimulate better linkages with the diaspora. At a basic level, freer short-term mobility may also more effectively balance supply and demand for skilled researchers, scientists and engineers among countries.

Recognition of qualifications

A number of countries participating in the OECD survey indicated that they have an institution charged with assessing and providing information on foreign qualifications. This is a useful complement to recognition processes at the institutional-level (*e.g.* universities, companies) and a way for governments potentially to add value by reducing information asymmetry.

The diaspora

As noted in Chapter 4, very few countries have a strategy for maintaining contact with their skilled diaspora. Governments might explore ways to facilitate networks and contact between mobile researchers and home-based institutions and colleagues.

General

In formulating policy approaches, it is important to recognise the heterogeneity of researchers and the limits this imposes on any policy initiative. For example, Kulonpalo's (2007) study of Finnish academic mobility found that Finnish researchers are a highly heterogeneous group, with no significant mobility patterns and increasingly diverse career trajectories. Among Finnish researchers there are large and obvious differences in scientific disciplines and their working methods, researchers' institutional positions, and structural differences in employing organisations, individual career trajectories and prospects. The study suggested that this diversity warranted more flexible and responsive funding instruments and services that recognise researchers' individual needs. The discussion earlier also pointed out that researchers' motivations differ, with the evidence suggesting that some professions are more attracted by salary while others are more attracted by the nature of the work and the research environment.

At the same time, policy makers must be cautious to weigh flexibility against the risk of losing sight of the programme's original objectives. There is also the question of whether governments can ever have enough information to meet the individual needs of researchers efficiently and effectively. As more initiatives are offered, administrative costs and the potential for confusion in the target population rise. The right balance is a matter of judgement for each government.

Policy coherence

Successfully reaching policy goals requires some coherence across policy areas. For example, if a firm is to innovate successfully, the system in which it operates should facilitate innovation. It is the total of the interfaces with government agencies and policies that affects innovative capacity, and it is the net effect of diverse (and sometimes disparate) policy actions that constitutes a government's actual "innovation policy" (OECD, 2005a, p. 23). When government objectives and the impacts of policy actions on different areas of society are examined in terms of policy coherence, inconsistencies are revealed and governments are challenged to minimise them.

For mobility, the first task is to ensure the co-ordination and coherence of various mobility policies, for example by the formulation of a mobility strategy. But mobility policies should also fit within the broader policy environment for innovation. The evidence shows that additional funding is not the only attraction for mobile researchers (including those thinking of returning home), as a strong research environment and supportive infrastructure also affect mobility decisions. In addition, knowledge flows

and knowledge spillovers from mobile HRST are more likely to be absorbed if the environment is conducive., An educated, skilled populace, a labour market that allows people to use their skills to their maximum productivity, and a strong science base are an important part of this. Mobility policies should also consider some of the government's wider goals, such as development and aid. This section looks at the environment for innovation, the links between mobility and development and some of the challenges raised by coherence.

The environment for innovation

HRST mobility policies and the broader policy environment for innovation need to be complementary. Mobile researchers clearly often look for more than simply higher wages when they move across borders – they also want quality research infrastructure, a stimulating research environment and opportunities to explore new areas. In addition, when governments seek to improve innovation outcomes, it is not sufficient to increase the number of a country's skilled HRST. Skilled people must also operate in a system that enables them to use, create and disseminate knowledge. The OECD's 2006 *Going for Growth* highlighted a range of policy areas that influence innovation outcomes, broadly grouped under "framework policies" and "R&D-specific policies" (Box 5.3) which aim to address various market failures in innovation activity.

Box 5.3. **Encouraging innovation – policy levers**

Innovation effort and performance are influenced by a wide spectrum of policies. These can be broadly grouped into two categories: framework policies, those that may have been put in place for other reasons but have an important impact on innovation; and R&D-specific policies, those policies designed to strengthen innovation outcomes. Taken together, combinations of these policies can help or hinder a country's efforts to improve their innovation performance.

Framework policies include:

- **Education policies:** Education is fundamental for the conception and implementation of innovation. The ability to adapt to new technology begins with a compulsory school system that provides students with strong skills in core fields, including science and mathematics. An education system that performs effectively and is broadly accessible at the tertiary level is also important to facilitate the adoption and widespread diffusion of innovation.

Box 5.3. **Encouraging innovation – policy levers** *(cont.)*

- **Financial market policies:** A well-developed financial system helps foster investment by reducing the cost of finance from sources external to the firm. The ability for entrepreneurial individuals to turn new ideas into new products, often by setting up a new company, creates an important role for the market for high-risk capital (in particular, venture capital and less formal sources of finance such as business angels' funds). Policy determinants that influence the supply of and demand for venture capital include: taxation of capital income and capital gains; portfolio restrictions; regulations on cross-border mergers and acquisitions; and bankruptcy procedures.
- **Policies affecting product market competition and intellectual property rights:** The right policy environment for innovative activity is one that gives adequate rewards to innovation while ensuring competitive pressures that encourage firms to create, implement and diffuse innovations. The balance is sometimes difficult to strike – strong competition encourages companies to innovate to stay ahead of competitors, but market power over commercially interesting inventions may stimulate innovation activity by facilitating cost recovery of related expenses. Innovation processes and the role of intellectual property rights in protecting competitive advantage also vary considerably across industry sectors and types of invention. Overall, strict competition-restraining regulation significantly reduces business R&D intensity.
- **Openness and regulations on foreign direct investment:** Greater openness can lead to increased absorption of knowledge through many channels – the importation of goods and services, inward or outward direct investment, international mobility of workers, and collaborative research and innovation, all of which can be affected by policies.
- **Labour market regulation and institutions:** The influence of labour market regulation on the incentives to innovate varies according to the type of industry and wage bargaining systems in place. For most industries, not least in services, full exploitation of cost-reducing innovations will often require staff reduction or changes in the skill mix in the workplace. Stringent job protection raises the costs of such changes, reducing the profitability of new innovations.

Innovation-specific policies include:

- **Public research:** Basic scientific and engineering research is a major source of technical progress, and research undertaken by government and non-profit organisations may play an important role in preserving the "public good" nature of major scientific advances as well as in stimulating private-sector R&D. The effectiveness of public R&D in fostering private R&D and

Box 5.3. **Encouraging innovation – policy levers** *(cont.)*

overall innovation performance depends on a number of factors, including the strength of industry-science linkages and the governance of public research organisations. Strong links between industry and public research organisations are essential to improve the match between research conducted in the public sector and the needs of industry and to facilitate the transfer of knowledge and technology between them. In terms of governance, the tendency is to shift towards more decentralised systems with funding from various sources, often linked to specific projects.

- **Financial support to private R&D:** All OECD countries provide financial support to stimulate private-sector innovative activity via tax breaks for R&D spending or direct subsidies. Both forms of support involve potential deadweight losses (that is, the activity would have taken place even without public support), so that policies must be carefully designed. Different countries use different mixes of these policies, owing to their different perceptions of the types of failures to be addressed (financial, risk, etc.), as well as different industry and institutional structures.

Source: OECD (2006), Chapter 3.

Research has shown that framework and innovation conditions (that is, a country's capacity to absorb and exploit foreign knowledge, and broad financial and economic conditions) made the largest net contribution to the change in R&D intensity in OECD countries in the 1990s (OECD, 2006, p. 75). This reflects in particular the relatively strong influence of the capacity to absorb foreign knowledge, which largely depends on domestic innovation capabilities. Changes in product market regulations and/or the strength of intellectual property rights had a positive influence on R&D in all countries. The contribution of public R&D funding was generally smaller, in part because levels of public funding did not change in many countries over the period, as policy action focused more on the effectiveness of funding.

Development policies

Improving policy coherence between policies for the mobility of HRST and development policies implies considering the consequences of mobility for development in sending countries that are the target of development and aid policies. Linking policy design and implementation in these areas aims to better achieve the goals of both mobility and development and to contribute to more effective management of migration. It is a two-sided process, with

efforts also required by the developing country (for example, pursuing appropriate policies for stimulating economic and employment growth).

Ensuring the coherence of HRST migration and development co-operation policies and finding synergies and complementarities that will work nationally and to the benefit of migrants and their sending countries can help HRST mobility benefit all participating countries. Dayton-Johnson *et al.* (2007, p. 65) note that migration can have a number of positive effects on the development of sending countries, via reductions in unemployment, expansion of development through remittances, improvements in knowledge and skills, and introduction of new technology. At the same time, however, it can affect equality, family life and social relations, and provision of social services.

Some steps to manage better the flows of highly skilled migrants from developing countries and to limit negative impacts on these countries were proposed in the OECD's recent *Policy Coherence for Development* (2007). These include: closer monitoring of migration, with better collection of data, statistical capacity building and more effective harmonisation and data sharing across countries; general guidelines on the recruitment of workers such as health-care workers; and partnership arrangements that link recruitment with capacity building and replenishment in the countries of origin (p. 124). Similar ideas were also proposed by Dayton-Johnson *et al.* (2007) aimed particularly at the European Union (see Box 5.4).

In designing mobility policies that are effective for both developed and developing countries, Hart (2006) warns against making major and irreversible policy commitments, given the "error bars" (or uncertainty surrounding the

Box 5.4. **Migration and development – some policy proposals for Europe**

Dayton-Johnson *et al.* (2007) comment that joint consideration of migration and development co-operation policies can form the basis of genuine migration and development partnerships between sending and receiving countries (and transit countries, where appropriate). Aimed at EU member countries, the report recommends the following:

- Innovative "circular migration" schemes should manage migration flows more effectively without crippling social services in sending countries, for example if receiving countries commit to helping sending countries upgrade and modernise social service delivery systems (*e.g.* education and health). Measures that would help ensure appropriate training of personnel, staff deployment and replenishment for maintaining social service delivery at the desired level could also be included.

Box 5.4. **Migration and development – some policy proposals for Europe** *(cont.)*

- EU member states should continue to develop guidelines for the recruitment of highly skilled workers (*e.g.* health workers) from developing countries, with visibility and peer pressure created by non-binding guidelines helping to restrain movements or more flexibly link circular mobility to training resources.
- Lowering the costs of financial transfers through formal channels and expanding financial services to poor rural communities (where many migrants' families live).
- Encouraging sending countries, through partnership arrangements, to design human resource policies that take migration into consideration, for example, by investing in service delivery systems, personnel training, working conditions and transport and communication infrastructure.
- Establishing inter-ministerial initiatives to promote co-ordination of development and migration policies (one example is Sweden's 2003 Government Bill, which commits various ministries to greater policy coherence in measures that affect development, with annual reporting to Parliament).
- Crafting trade policy with attention to its impact on labour mobility, in particular, recognising that being able to export products that make intensive use of low-skilled labour is a critical strategy for accelerated growth in developing countries.
- Recognising the nature of insecurity and the relationship between insecurity and mobility, EU policies and programmes could explicitly aim to address the various sources of insecurity (*e.g.* inability to access strategic assets, access to food and water, failed institutional set-ups) that often cause people to emigrate and which hamper development.

Based on the positive impact of migrant organisations and networks on all facets of the migration experience – from helping to recruit qualified labour in home countries, to easing integration, to spurring economic growth in both home and host economies – the report also recommends that EU member states:

- Provide substantial funding to support migrant organisations and networks, using independent mechanisms for the dispersal of funds to ensure transparent and impartial allocation of funding.
- Incorporate migrant organisations into the policy-making process.
- Deepen co-development initiatives that work with migrant organisations to implement development co-operation policy, thereby tapping into migrants' superior information and knowledge about economic, social and other conditions in the home countries.

Source: Dayton-Johnson *et al.* (2007).

data) and the dynamic nature of migration and its associated knowledge spillovers. Nevertheless, Hart advocates seizing the opportunity to expand the mutual gains that might be made through highly skilled migration, first by abandoning zero-sum terminology for conceptualising highly skilled migration and then taking steps to strengthen the capacity of source countries to absorb knowledge and extract benefits from it and nurturing knowledge spillovers from receiving countries to sending countries. His policy recommendations include: stronger educational systems in source countries to assist absorptive capacity; helping source countries to capitalise on supply-chain relationships and foreign direct investment, rather than simply to supply unskilled cheap labour; removing barriers that inhibit communication and travel for expatriates; and subsidisation of the organisational infrastructure of highly skilled diasporas and incentives for them to create educational, scientific and commercial links with partners in the source countries.

Progress towards policy coherence for development is aided by stronger institutional capacities in OECD countries. While at a country level, OECD political systems and structures vary widely, some general principles can help to ensure better coherence:

- Ensuring high-level political commitment and leadership in promoting the development agenda and mobilising support for greater coherence.
- Building capacity in the policy-making process, so as to provide evidence-based, timely analysis on how particular policy choices (potentially) affect developing countries and populations, to promote ownership of the issues across government, and to effectively negotiate policy options.
- Identifying specific institutional challenges faced in different policy areas and making progress to achieve some concrete results (such as in trade, investment and agriculture).
- Building capacity to assess the results of policy coherence efforts to build the case for policy changes (OECD, 2005b, pp. 152-158).

Answers to the OECD Questionnaire on the International Mobility of Researchers showed that countries are making progress in pursuing coherence between mobility and development and aid policies. A number of countries have mobility policies especially designed with development goals in mind and target particular countries and subject areas that are relevant to development.

Challenges to coherence

Achieving policy coherence is not without difficulties. As noted by the OECD (2005a, p. 33), governments cannot be viewed as single (rational) actors that pursue clear objectives with full information and clear and consistent

preferences. There are in-built contradictions and tensions that challenge the quest for coherence, for example:

- Individual policy areas have their own rationales and imperatives, based on the policy community's preferences, ideologies, perspectives and educational backgrounds.
- Short-term outlooks, based on budgetary cycle requirements, can undermine efforts for more strategic, long-term policy making.
- As policy areas attempt to meet multiple goals, they may lose some effectiveness.
- The trend towards multiple agencies, decentralisation and devolution can hinder co-ordination.
- Competition for status and scarce resources, and personal ambitions on the part of policy makers, may lead to rivalry, turf wars and loss of coherence.
- External pressures and priorities may increase complexity and make coherence more difficult.

Working through these tensions requires governments to balance the imperatives of different policy areas, create and communicate a clear goal or vision, encourage networking and collaboration across ministries, develop and implement action plans with monitoring and reporting systems, and incorporate evaluation and learning into the policy making process (OECD, 2005a, pp. 68-69).

Summary

A key first step in policy design is to identify a rationale for intervention and to establish clear objectives. For mobility, the rationale may centre on potential positive externalities from knowledge spillovers and issues of information asymmetry. However, countries will differ depending on their economic and social context and overall goals. The obstacles to mobility that are cited by policy makers and academics include legal and administrative barriers, lack of funding, personal issues and language, among other things. The question is which of these obstacles stem from market failures that government is able to influence through policy.

Few policies have been evaluated, so it is difficult to point to any best practices. However, some lessons can be drawn from evaluation material, including the importance of setting appropriate funding levels and programme durations for the target population (according to desired skill level and field of work). Some interesting questions emerged regarding personal objectives versus programme objectives, in particular, whether the long-term goals of programmes will be achieved if personal objectives diverge from those of the programme. The evaluation material showed the importance of good

data collection, planned from the outset, to enable an assessment of a programme's efficiency and effectiveness.

Given the differences across countries, it is not possible to identify a "recipe" for what governments should do more of, what they should do less of, and what should stay the same. One avenue that may hold promise, however, is removing barriers to short-term and circular mobility. Shorter (but potentially repeated) periods abroad may circumvent some of the obstacles that currently hinder mobility, and would also support knowledge flows associated with brain circulation and the diaspora.

Finally, policy coherence is important – not only within mobility policies but also to ensure that the wider environment for innovation and scientific endeavour is sound and that domestic policies support the domestic supply of HRST and fit with other government policy priorities. Coherence holds challenges, but clear goals and a good understanding of policy impacts can help policy makers progress in this area.

Note

1. This discussion draws on Australian Government (2007).

References

Australian Government (2007), *Best Practice Regulation Handbook*, Canberra.

Avveduto, S. (2001), "International Mobility of PhDs", in OECD (2001), *Innovative People: Mobility of Skilled Personnel in National Innovation Systems*, OECD, Paris.

Dayton-Johnson, J., L. Katseli, G. Maniatis, R. Münz and D. Papademetriou (2007), *Gaining from Migration: Towards a new mobility system*, OECD Development Centre, Paris.

European Commission (2001), *High-Level Expert Group on Improving Mobility of Researchers: Final Report*, Directorate General Research, 4 April.

Hart, D. (2006), "From Brain Drain to Mutual Gain: Sharing the benefits of high-skill migration", *Issues in Science and Technology*, Fall.

House of Commons (2007), *International Policies and Activities of the Research Councils*, House of Commons Science and Technology Committee, Ninth Report of Session 2006-07, HC 472-I, United Kingdom.

Kulonpalo, J. (2007), *Academic Finns Abroad – Challenges of International Mobility and the Research Career*, Academy of Finland Publication 7/07, Helsinki.

Nerdrum, L. and B. Sarpebakken (2006), "Mobility of foreign researchers in Norway:, *Science and Public Policy*, Vol. 33(3), April, pp. 217-229.

OECD (2005a), *Governance of Innovation Systems: Volume 1: Synthesis Report*, OECD, Paris.

OECD (2005b), *Policy Coherence for Development: Promoting Institutional Good Practice*, OECD, Paris.

OECD (2006), *Economic Policy Reforms: Going for Growth 2006*, OECD, Paris.

OECD (2007), *Policy Coherence for Development: Migration and Developing Countries*, OECD, Paris.

OECD (2008), "International Mobility of Human Resources in Science and Technology: Policy Evaluation", OECD internal working document, 20 March, Paris.

Sussex Centre for Migration Research (University of Sussex) and Centre for Applied Population Research (University of Dundee) (2004), *International student mobility*, Issues paper July 2004/30, Report commissioned by the Higher Education Funding Council for England (HEFCE), Scottish Higher Education Funding Council (SHEFC), Higher Education Funding Council for Wales (HEFCW), Department for Employment and Learning Northern Ireland (DEL), Department for Education and Skills (DfES), UK Socrates Erasmus Council, Association of UK Higher Education European Officers (HEURO), British Universities Transatlantic Exchange Association (BUTEX) and the British Council, United Kingdom, *www.hefce.ac.uk/pubs/hefce/2004/04_30/*.

OECD PUBLICATIONS, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(92 2008 08 1 P) ISBN 978-92-64-04774-7 – No. 56309 2008

The Global Competition for Talent

MOBILITY OF THE HIGHLY SKILLED

The international mobility of highly skilled workers is increasing in scale and complexity as more economies participate in R&D and innovation activity. Mobile talent diffuses knowledge both directly and indirectly across borders. This can boost global innovation performance, with benefits accruing to both sending and receiving countries. It is clear that mobility is leading to an increasing level of labour-market internationalisation and integration, and competition for talent is now influencing innovation policy initiatives across the globe. Most countries offer a range of policies focused on assisting and encouraging mobility, although few have a specific and coherent mobility strategy. Many nations aim to attract the same pool of highly skilled talent; thus, relying on international flows to fill existing or future gaps in supply may entail risks. Addressing shortcomings in national policies that may limit domestic supply of skilled workers, and ensuring that the wider environment for innovation and scientific endeavour is sound, are key policy challenges for countries.

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ISBN 978-92-64-04774-7
92 2008 08 1 P