Chapter 1

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY: MEASUREMENT ISSUES AND INTERNATIONAL MOBILITY[1]

by

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SUMMARY AND RECOMMENDATIONS

Policy makers are increasingly interested in the international mobility of highly qualified workers. Yet, the capacity to analyse this mobility is severely limited by the lack of internationally comparable data that capture the flows of such workers.

This chapter seeks to address this problem by identifying the main statistical issues related to measurement of the international mobility of highly skilled workers. The first section shows the lack of an internationally agreed definition of a "highly skilled worker", which limits analysis at international level. One internationally agreed conceptual framework, the "Canberra Manual" on human resources devoted to science and technology (HRST), is then described in length. While this framework is not perfect and requires further development, it may be used to measure the international mobility of the highly skilled by drawing on existing data sources.

HRST are defined as those who have successfully completed education at the tertiary level in an S&T field and/or those not formally qualified in this way but employed in an S&T occupation where such qualifications are normally required. This definition is based both on educational qualification and occupation and therefore covers a very broad population. This is probably one limitation of the

definition, which calls for further refinement. A revision of the "Canberra Manual" is planned for the near future and, to be most useful, should draw on the expertise not only of S&T analysts and statisticians but also those involved in the areas of employment, education and migration. The revision should also build on existing national experience to compile HRST statistics from special surveys and databases. One promising example in this regard in the US SESTAT database described below.

The second section of the chapter is more specifically devoted to data sources and measurement of international migration of HRST. There exists a reasonably large body of statistical data on the stock of persons with scientific and technological skills. The principal sources are censuses and labour force surveys. However, while these sources have the potential to provide very useful information on HRST migration flows, they suffer from some deficiencies that limit their analytical utility. The key deficiency of censuses is their infrequency. Labour force surveys raise the problem of sampling variability, an issue when measuring international migration as flows tend to be small relative to the total population, as well as more serious problems. Most notably, not all relevant inflows can be identified in some countries, since information on the country of previous residence, even though it is sought, is often not supplied. Regarding administrative sources (permanent immigration arrangements, temporary working visas, work permits, etc.), there is a vast amount of statistical information available, but concepts and classification systems vary greatly and are not usually maintained in a form that facilitates cross-country comparisons.

The authors feel that it would be worthwhile to encourage countries:

- To refine the definition of HRST when revising the "Canberra Manual".
- To conduct special S&T surveys (of the SESTAT type) on a more systematic and comparable basis.
- To exploit the results of the 2000 censuses for information on HRST and international migration.
- To work on obtaining better migration inflow estimates from national labour force surveys.
- To classify both permanent and temporary inward migrants according to occupation and educational level in a way that facilitates international comparisons through the use of classifications based on ISCO-88 and ISCED 1997.

Introduction

International mobility of the highly skilled has existed for decades as a means of circulating knowledge and promoting scientific and technological development. More recently, as rapid economic growth has had its source in a rather small base of technologically intensive sectors, such as information and communication technologies (ICT), it has come to the attention of the broader economic policy community. The ability of some countries to sustain fast growth in these sectors without being unduly limited by shortages of key workers, such as software engineers, has focused attention on the role of immigration and, more generally, on its impacts on the labour market. The ability to analyse the relevant issues systematically is severely limited by the lack of internationally comparable data on flows of highly skilled workers.

Human resources in science and technology

Highly qualified workers and their definition

Many different terms are used to discuss possible shortages of highly qualified personnel or their international mobility: highly skilled workers, qualified personnel, human resources in science and technology, scientists and engineers, IT workers, "brains" (in "brain drain", "brain gain" or "brain circulation"), etc. The first questions are therefore: What do we want to measure? What is the difference between qualified and skilled? What is the difference between highly skilled and skilled (or qualified)? Or between highly qualified personnel and human resources in science and technology or any of the other terms used above?

The term "skill" refers to the qualifications needed to perform certain tasks in the labour market. In the most general sense, it reflects the level of human capital in the labour markets. The term "upskilling" can be seen as synonymous with human capital development. Skills are multi-dimensional, since most jobs require a multitude of them to perform tasks adequately, ranging from physical abilities like eye-hand co-ordination, dexterity and strength, to cognitive (analytic and synthetic reasoning, numerical and verbal abilities) and interpersonal (supervisory, leadership) skills (Wolff, 1996).

In empirical work, researchers often use proxies based on education and occupation. Education is usually categorised by years of schooling or final degree obtained. Occupations sometimes provide more information on the skills required of workers, but measures vary considerably across countries and may be ambiguous. Measures of education do not necessarily take into account on-the-job learning and, in particular, skills associated with the use of new technology.

When referring to international standard classifications, "qualified" means formal qualification and corresponds to an existing and widely used international classification, the International Standard Classification of Education (ISCED). "Highly qualified" thus refers to a certain level of education or formal qualification and may therefore be differentiated from "qualified". In the International Standard Classification of Occupations (ISCO), skills are defined in terms of "skill level" and "skill specialisation". The first is defined as a function of the complexity and range of the tasks and duties involved with reference to ISCED levels. Skill specialisation is defined by the field of knowledge required, the tools and machinery used, the materials worked with, as well as the kind of goods and services produced.

There is as yet no agreed definition of highly qualified workers at international level. Existing studies have most frequently used the broad categories ISCO 1, 2 and 3 to define highly skilled occupations. Other definitions have also been used; in particular, the OECD has used an *ad hoc* definition (OECD, 1996).

However, an internationally agreed conceptual framework has been jointly developed by the OECD and Eurostat to measure so-called human resources devoted science and technology (HRST). It is known as the "Canberra Manual" and was prepared by the OECD Group of National Experts in Science and Technology Indicators (NESTI). It is described below.

Basic definition of HRST

The "Canberra Manual" defines HRST as people who fulfil one or the other of the following conditions:

- They have successfully completed education at the tertiary level in an S&T field of study.
- They are not formally qualified as above, but are employed in a S&T occupation where the above qualifications are normally required.

The "Canberra Manual" definition is based both on notions of educational qualification and of occupation and therefore covers a very broad population with either tertiary-level education or an occupation in a field of science and technology (S&T). S&T is understood in a very broad sense, covering all fields of education and occupation, including social sciences and humanities. Tertiary-level education is defined using the former ISCED definitions:[2]

- ***ISCED category 5:*** "education at the tertiary level, first stage, of the type that leads to an award not equivalent to a first university degree".
- ***ISCED category 6:*** "education at the tertiary level, first stage, of the type that leads to a first university degree or equivalent".
- ***ISCED category 7:*** "education at the tertiary level, second stage, of the type that leads to a postgraduate university degree or equivalent".

ISCED distinguishes 21 main fields of study. For macro-measurement of HRST, it is recommended grouping them into the following seven broad fields of study:

- Natural sciences.
- Engineering and technology.
- Medical sciences.
- Agricultural sciences.
- Social sciences.
- Humanities.
- Other fields.

These categories are too broad to capture education in some rapidly developing fields such as biological and computer sciences. It is necessary to disaggregate further to obtain this information.[3]

S&T occupations are defined using the following ISCO-88 categories.

122 Production and operations department managers.

123 Other department managers.

131 General managers.

21 Physical, mathematical and engineering science professionals.

22 Life science and health professionals.

23 Teaching professionals.

24 Other professionals.

31 Physical and engineering science associate professionals.

32 Life science and health associate professionals.

33 Teaching associate professionals.

34 Other associate professionals.

The advantage of the double educational/occupational classification is that it allows for looking at both the supply side of HRST, in terms of qualification, and the demand side, in terms of occupation. Its drawback is that, by definition, it does not allow for homogeneous measurement because the two classifications are based on different premises, and it is too broad to meet specific analytical needs. Hence the need to define subsets of interest within this broad population. This was extensively done in the "Canberra Manual" and has been further refined in subsequent studies.

The first and most obvious subset is what the "Canberra Manual" calls the "HRST core" population; it consists of the HRST population with both tertiary-level education and an S&T occupation. Many studies have also looked at the population of so-called "scientists and engineers", which is in general defined as ISCO categories 21 and 22. The "Canberra Manual" also gives some guidelines for measuring the IT labour force, which is defined on the basis of ISCO at the third- or fourth-digit level, as: 213: Computing professionals (and presumably also 1236 Computing services department managers) and 312: Computer associate professionals. Figure 1 shows the different categories of HRST.

Figure 1. Detailed categories of HRST

OCCUPATIONS				QUALIFICATIONS			
				HRSTE = HRST with third level education			Other ISCED levels
				ISCED level 7	ISCED level 6	ISCED level 5	
HRSTO = HRST employed in S&T	ISCO 1 (subset)	122	Production and Operations Department Managers	HRSTC = HRST core (with third level education and employed in S&T)			
		123	Other Department Managers				
			of which: **1236** Computing Services Department Managers				
		131	General Managers				
	ISCO 2	21	Physical, Mathematical and Engineering Science Professionals				
			of which: **213** Computing Professionals				
		22	Life Science and Health Professionals				
		23	Teaching Professionals				
		24	Other Professionals				
	ISCO 3	31	Physical and Engineering Science Associate Professionals				
			of which: **312** Computer Associate Professionals				
		32	Life Science and Health Associate Professionals				
		33	Teaching Associate Professionals				
		34	Other Associate Professionals				
All other occupations							
HRSTU	Unemployed						
Out of the labour force							

HRST = Human Resources in Science and Technology

Scientists and Engineers = ISCO 21 + ISCO 22

IT HRST occupations = ISCO 1236 + ISCO 213 + ISCO 312

Some characteristics of the HRST population

Table 1 presents some basic HRST data derived from the EU Community Labour Force Survey (CLFS) and from education statistics. HRST data by occupation are given for EU countries only, where comparability is ensured by the use of a common format for the output from national labour force surveys. Further work would be needed to obtain comparable data for non-EU countries.

Education statistics are better harmonised thanks to joint efforts of the OECD, Eurostat and UNESCO. However, while many statistical sources provide information on levels of educational attainment, problems are often encountered when making international comparisons, as the data tend to reflect not only variations in numbers but also differences in national education systems. This applies particularly to what one might describe as the "grey area" between some parts of secondary education, further (non-tertiary) education and the lower cycle of tertiary-level education. The nature and content of programmes at these levels, and way in which the programmes are classified, vary greatly between countries

Table 1. Basic HRST data, 1999

	Total HRST		HRST employed in S&T (HRSTO)		HRST with tertiary-education (HRSTE)		HRST core (HRSTC)	
	Total (thousands)	Females (%)	Total (thousands)	Females (%)	Total (thousands)	Females (%)	Total (thousands)	Females (%)
European Union	64 980	46.0	42 327	47.1	45 947	45.5	23 294	46.9
Belgium	2 055	47.5	1 228	46.2	1 679	50.0	852	50.6
Denmark	1 186	47.7	865	49.1	850	49.5	530	52.9
Germany	17 972	43.8	11 798	49.6	11 887	36.7	5 714	40.9
Greece	1 134	43.6	663	44.9	972	43.8	501	45.8
Spain	5 917	47.3	2 815	44.0	5 169	49.1	2 068	47.6
France	10 244	48.4	6 378	45.8	7 752	51.6	3 886	50.5
Ireland	571	48.5	287	46.4	496	50.2	212	49.5
Italy	6 498	45.3	5 092	43.8	3 298	47.2	1 891	44.6
Luxembourg	78	41.5	61	41.6	48	40.2	31	39.7
Netherlands	3 629	45.9	2 662	47.2	2 291	43.7	1 324	44.5
Austria	1 041	46.2	861	47.5	434	44.3	254	47.2
Portugal	817	50.5	664	49.8	518	57.7	365	59.5
Finland	1 263	55.2	789	56.0	949	54.6	475	55.3
Sweden	2 048	48.7	1 450	48.8	1 515	52.2	917	54.7
United Kingdom	10 529	44.8	6 715	45.8	8 088	45.5	4 275	47.7

Note: Greece and Ireland: 1997

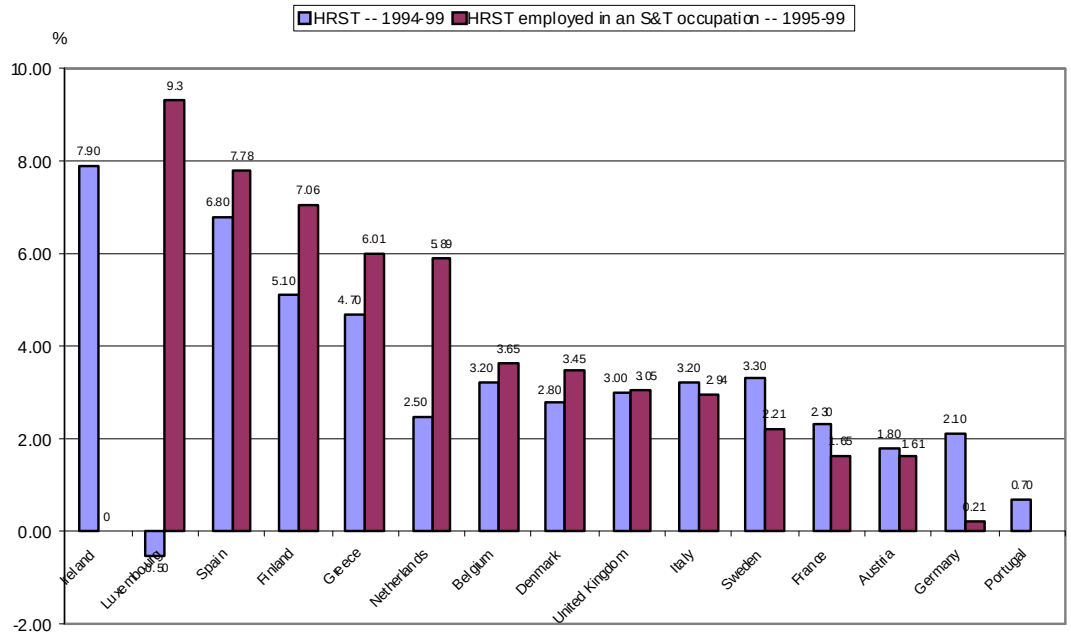
Note: Greece and Ireland: 1997.
Source: Eurostat (CLFS).

There were 65 million HRST in the EU in 1997. Among these, about 42 million were employed in an S&T occupation and 46 million had tertiary-level education. The core HRST population having both an S&T occupation and tertiary-level education was about 23 million. HRST are predominantly men (54%), although women exceed men in Finland and Portugal. In terms of education, women HRST are also more numerous than men in six EU countries: Belgium, France, Ireland, Portugal, Finland and Sweden. Except in Ireland, this is also true for the core HRST population.

Human resources employed in S&T occupations represent about a third of the labour force in Luxembourg, the Netherlands and Sweden, between 20% and 30% in Germany, Denmark, Finland, Belgium, France, the United Kingdom, Italy and Austria, and between 10% and 20% in Ireland, Greece, Spain and Portugal.

Graph 1 shows that occupations for HRST have steadily increased at an average annual rate of 6-8% in the second half of the 1990s in Luxembourg, Spain, Finland, Greece and the Netherlands. In Italy, Sweden, France, Austria and Germany, where the growth rate was below 3%, the overall HRST population, and therefore HRST with tertiary-level degrees, has increased faster.

Graph 1: Average annual growth of HRST

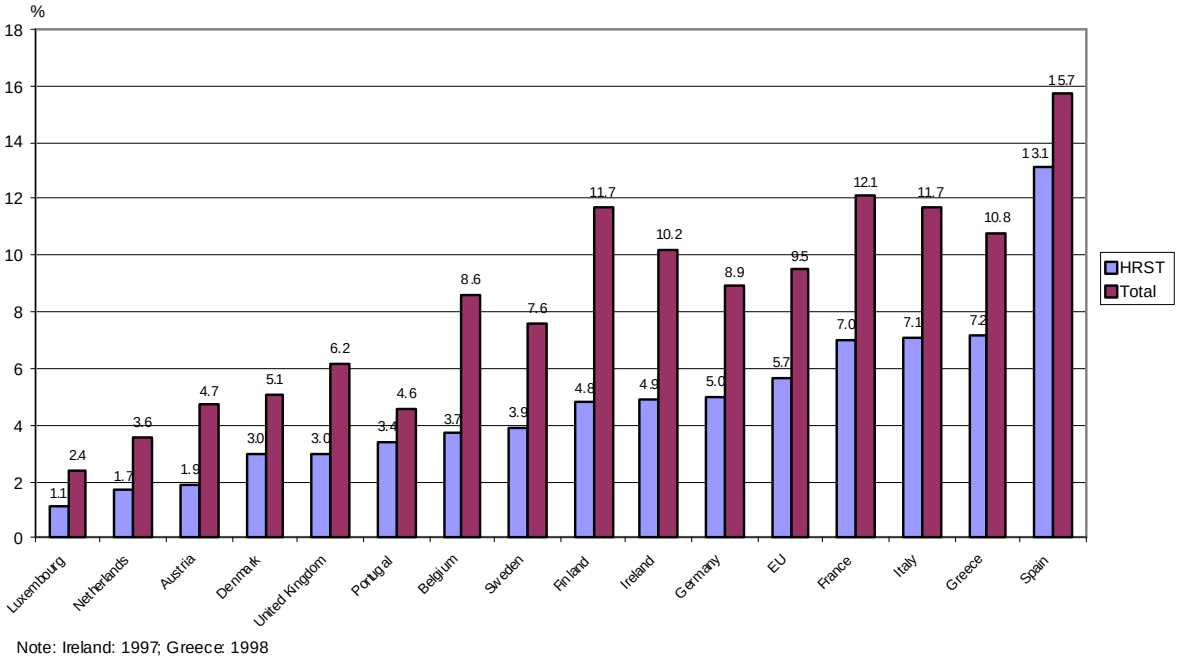


Note: Austria: 95-99; Sweden: 97-99; Finland: 98-99; Portugal: 98-99; Ireland: 94-97; Greece: 94-98 and 95-98.

Note: Austria: 1995-99; Sweden: 1997-99; Finland: 1998-99; Ireland: 1994-97; Greece: 1994-98 and 1995-98
Source: Eurostat (CLFS).

Unemployment rates of HRST (Graph 2) are about half the unemployment rates of the overall labour force, although the levels are related to those of overall unemployment. Unemployment rates of HRST are below 2% in Luxembourg, the Netherlands and Austria, while they are 7% or more and above the average EU level (5.7%) in France, Italy, Greece and Spain.

Graph 2: Unemployment rates of HRST as compared to overall unemployment rates – 1999

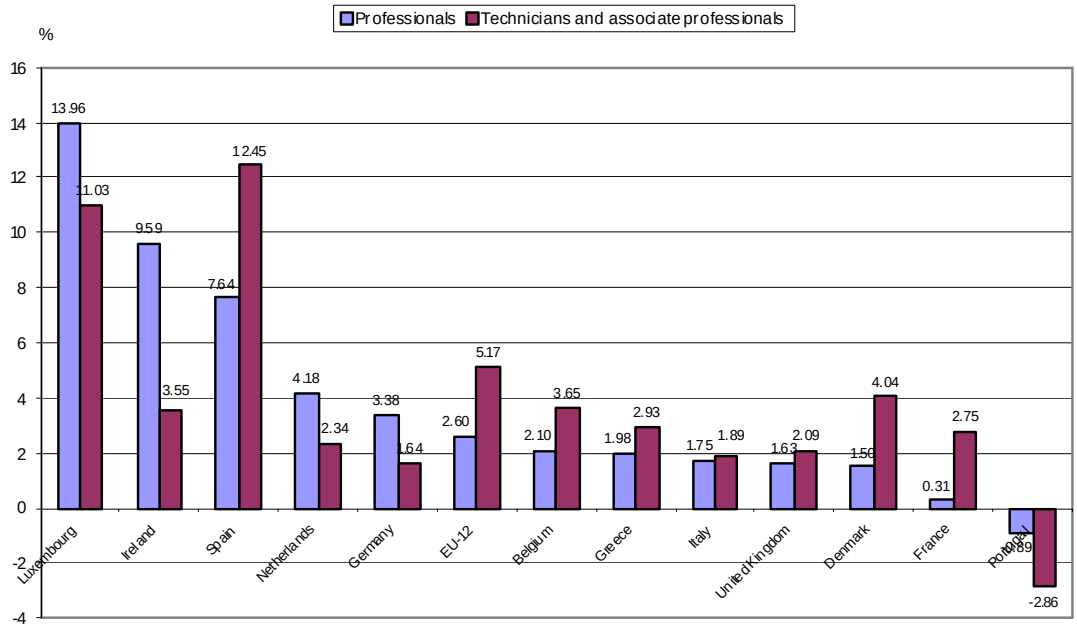


Note: Ireland: 1997; Greece: 1998

Note: Ireland: 1997; Greece: 1998.
Source: Eurostat (CLFS).

During the period 1994-97, average annual growth rates of professionals (Graph 3) have exceeded 7.5% in three countries: Luxembourg, Ireland and Spain. In most countries however, the number of technicians has increased faster than that of professionals. EU average rates were 2.6% for professionals and 5.2% for technicians and associate professionals.

Graph 3: Average annual growth of HRST by occupation category -- 1994-97



Source: Eurostat (CLFS).

In Table 2, scientists and engineers are defined as physical, mathematical and engineering science professionals (ISCO 21) or life science and health professionals (ISCO 22). They numbered about 8 million in the EU in 1999, or about 19% of total HRST employed. The share of women is less than a third of overall EU scientists and engineers, although there are large variations among countries. In particular, there are more women than men scientists and engineers in Ireland and Finland, whereas their share is very low in Germany and France. Average annual growth rates of scientists and engineers generally do not exceed those of total HRST employees (Graph 1). One exception is Finland over the period 1998-99.

Table 2. Distribution of persons employed as scientists and engineers in the European Union, 1999

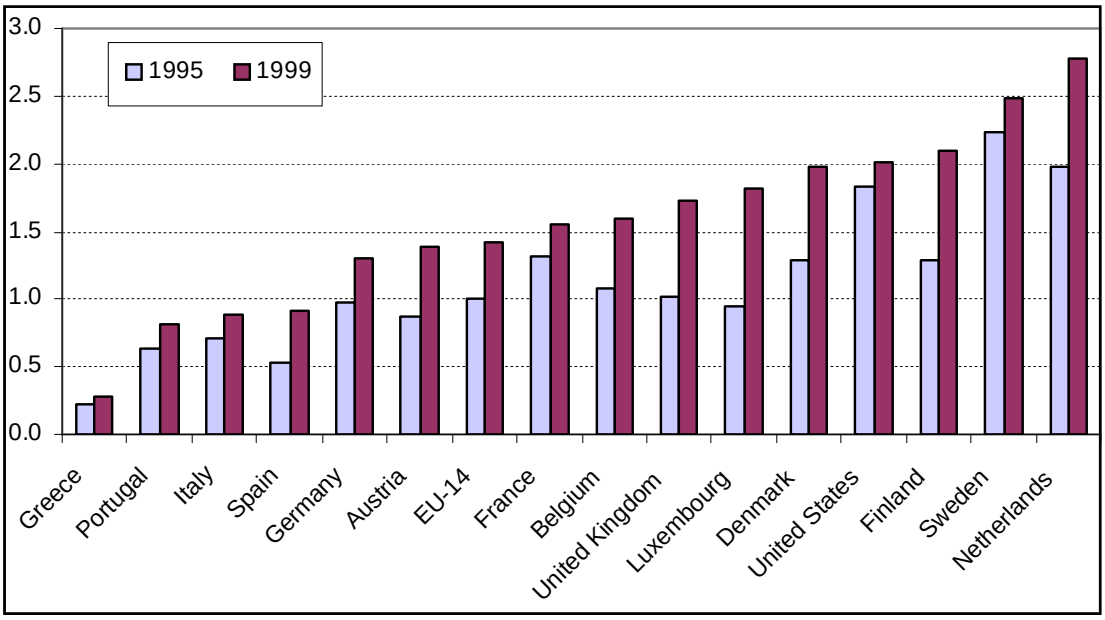
	Total	Females (%)	Annual average growth rate (1994-99)
European Union	7 930 430	31.2	..
Belgium	314 460	47.8	2.4
Denmark	142 780	24.8	6.4
Germany	1 919 540	21.0	3.5
Greece	142 660	29.0	2.9
Spain	573 410	37.3	5.9
France	1 045 550	23.8	2.2
Ireland	111 870	51.0	6.7
Italy	585 070	29.3	4.7
Luxembourg	9 660	20.1	6.4
Netherlands	450 450	31.2	5.7
Austria	82 610	29.0	4.5
Portugal	104 750	43.8	17.6
Finland	200 820	50.9	14.7
Sweden	218 330	40.5	1.9
United Kingdom	2 028 470	37.1	2.9

Note: Greece 1998, Ireland 1997; growth rates: Greece 1994-98, Ireland: 1994-97, Austria 1995-99, Sweden 1997-99, Finland and Portugal 1998-99.

Note: Greece: 1998: Ireland: 1997. Growth rates: Greece 1994-98; Ireland: 1994-97; Austria: 1995-99.
Source: Eurostat (CLFS).

Graph 4 shows that computer workers have increased their share in total employment during the second half of the 1990s. The share is higher for northern European countries and the United States than for southern Europe.

Graph 4. Computer workers as a percentage of total employees in selected OECD countries/regions, 1995 and 1999

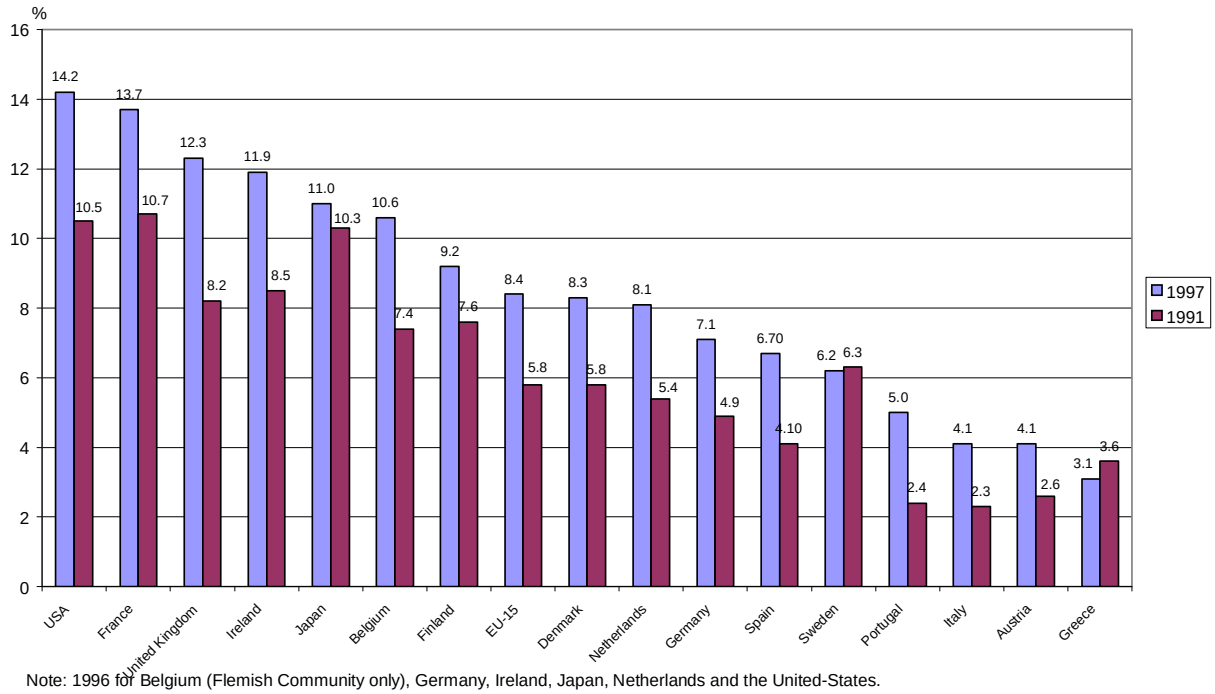


1. 1995 data estimated for EU-14. 1997 instead of 1995 for Finland and Sweden.
2. For Europe, computer workers include ISCO-88 categories 213 and 312; for the United States, CPS categories 64, 65, 229, 308 and 309.

Source: OECD estimates based on data from the European Labour Force Survey (Eurostat) and the US Bureau of Labor Statistics.

Graduation rates at university level, defined as the number of graduates as a share of the population aged 20-24 years (Graph 5), which is the source of the main flow into the HRST population (see also Figure 2), has increased from 5.8% in 1991 to 8.4% in 1997 in the EU-15. Five EU countries (France, the United Kingdom, Ireland, Belgium and Finland) are above the average, together with the United States and Japan. Graduation rates at university level are below 5% in Italy, Austria and Greece. Graph 6 displays the share of graduates in computing science relative to total graduates.

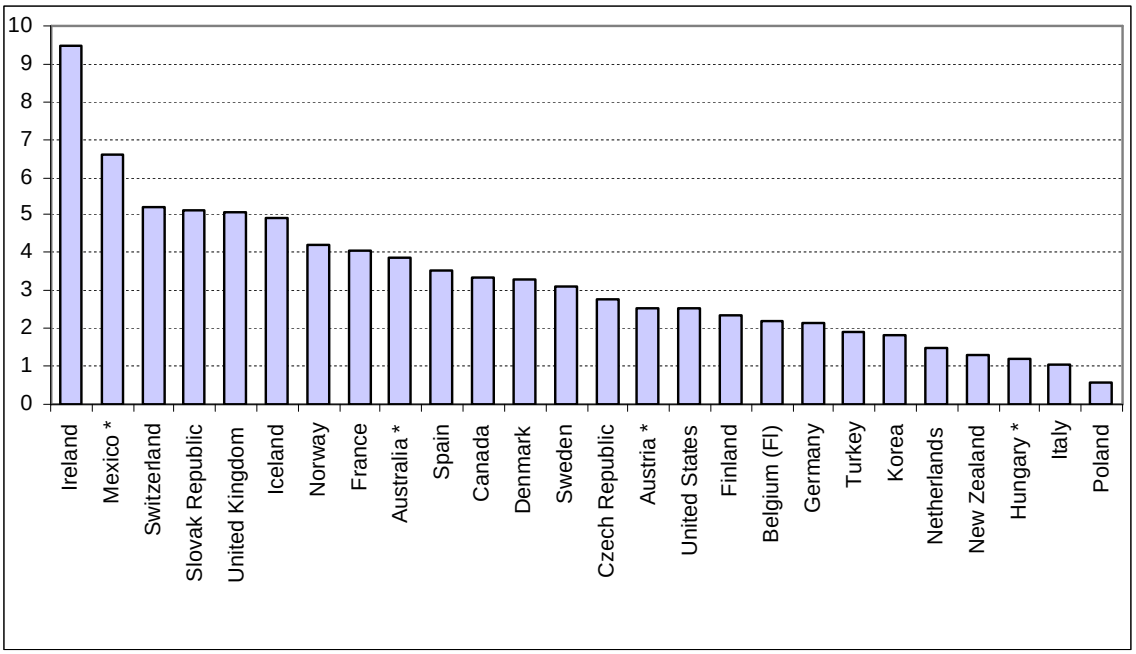
Graph 5. Graduation rates from higher education (percentage of population aged 20-24)



Note: 1996 for Belgium (Flemish Community only), Germany, Ireland, Japan, Netherlands and the United-States.

Note: 1996 for Belgium (Flemish Community only), Germany, Ireland, Japan, the Netherlands and the United States.
Source: European Commission, 2000.

Graph 6. Tertiary-level graduates in computing as a percentage of all fields of study, 1999



Note: For countries marked with an asterisk, data on the first stage of tertiary-level education are not available.
Source: OECD Education database, May 2001.

The US Scientists and Engineers Statistical Data System (SESTAT)

Besides labour force surveys and education statistics, other sources of data for HRST include, in particular, special national population registers or surveys. One is the US Scientists and Engineers Statistical Data System (SESTAT), one of the most comprehensive systems for observing HRST-type data at national level.

SESTAT is a comprehensive and integrated system of information about the employment, education and demographic characteristics of scientists and engineers (S&E) in the United States. It covers those with a bachelor's degree or higher who either work in or are educated in science or engineering, although some additional data are also included.

SESTAT was created by the National Science Foundation (NSF) to provide data for policy analysis and general research. Maintained by the Division of Science Resource Studies at NSF, SESTAT contains data from three NSF-sponsored demographic surveys: the National Survey of College Graduates (NSCG), the National Survey of Recent College Graduates (NSRCG) and the Survey of Doctorate Recipients (SDR). These surveys are conducted biennially from 1993; the 1999 survey is under way. These surveys provide data that are integrated into a single system.

The approach chosen to measure US scientists and engineers (S&E) is very close to that of the "Canberra Manual" in that it looks at the S&E population in terms both of education and of occupation. The coverage of US S&E is, however, more restrictive than that of HRST, *i.e.* it does not cover certain categories of teaching professionals, managers, other professionals and associate professionals in the ISCO sense. On the other hand, the term "scientists and engineers" in the US

sense is much broader than that used in Table 2. Thus, much harmonisation is still needed at international level. Table 3 presents some data extracted from the SESTAT database.

Table 3. US scientists and engineers, by S&E degree status and labour force status, 1997

		Labor Force Status				
	Total	Employed			Unemployed	Not in labor force
S&E degree status		Total	In S&E	In non-S&E		
Scientists and engineers, total	12,530,700	10,585,600	3,369,400	7,216,200	193,700	1,751,400
Educated in S&E	11,962,100	10,057,600	3,074,800	6,982,800	187,300	1,717,200
Highest degree is in S&E	9,269,200	7,704,000	2,840,800	4,863,200	150,500	1,414,700
Highest degree is in non-S&E	2,692,900	2,353,600	234,000	2,119,600	36,700	302,500
No S&E degree*	568,600	528,000	294,600	233,400	6,400	34,100

*The persons without S&E degrees or jobs in 1997 represent individuals who had S&E jobs in 1993, but had later moved to non-S&E jobs, became unemployed, or had moved out of the labor force.

NOTES: The term "Scientists and Engineers" (S&Es) includes all persons who have ever received a bachelor's degree or higher in a science or engineering (S&E) field, plus persons holding a non-S&E bachelor's or higher degree who were employed in a S&E occupation during either the 1993, 1995 or 1997 SESTAT surveys. Figures are rounded to nearest hundred. Details may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Studies (NSF/SRS), Scientists and Engineers Statistical Data System, 1997.

Measuring international migration of HRST

Before giving detailed consideration to the mobility of skilled persons, it is appropriate to refer briefly to the wider general question of measuring migration flows. International agencies (especially the United Nations) have done much to seek to promote the availability of migration statistics by formulating concepts and definitions and striving to establish standardised data collection procedures (UN, 1998a). The aim of the UN is to account for all categories of persons crossing international borders, regardless of their place of residence. The criterion, "duration of stay" in the country of immigration or emigration, in association with the concept of residence, is used as a basic means of distinguishing between "migrants" and "non-migrants". The latter cover such categories as tourists, short-term business travellers, frontier workers, pilgrims, nomads, etc.

The UN recommendations distinguish two basic categories of migrant, long-term and short-term. These are defined as follows:

- A long-term migrant is a person who moves to a country other than that of his/her usual residence[4] for a period of at least one year, so that the country of destination effectively becomes his/her new country of residence.

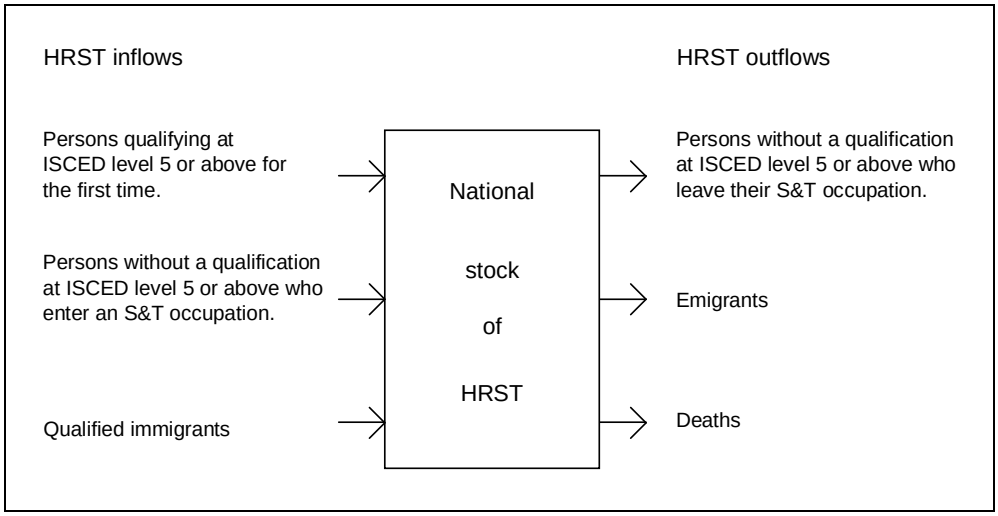
- A short-term migrant is a person who moves to a country other than that of his/her usual residence for a period of at least three months but less than a year (12 months), except if movement to that country is for reasons of recreation, holiday, visits to friends and relatives, business, medical treatment or religious pilgrimage.

Dependants travelling with their parents or carers are also regarded as migrants if the latter are so classified. The definitions apply equally to all population categories, whether nationals or not, foreign-born or not.

While these definitions have not been widely adopted, they provide a useful benchmark and focus for further efforts towards harmonisation.

Before looking at possible measures of international mobility of HRST, it is interesting to look at Figures 2-4, which describe how national stocks and flows of HRST are constituted.

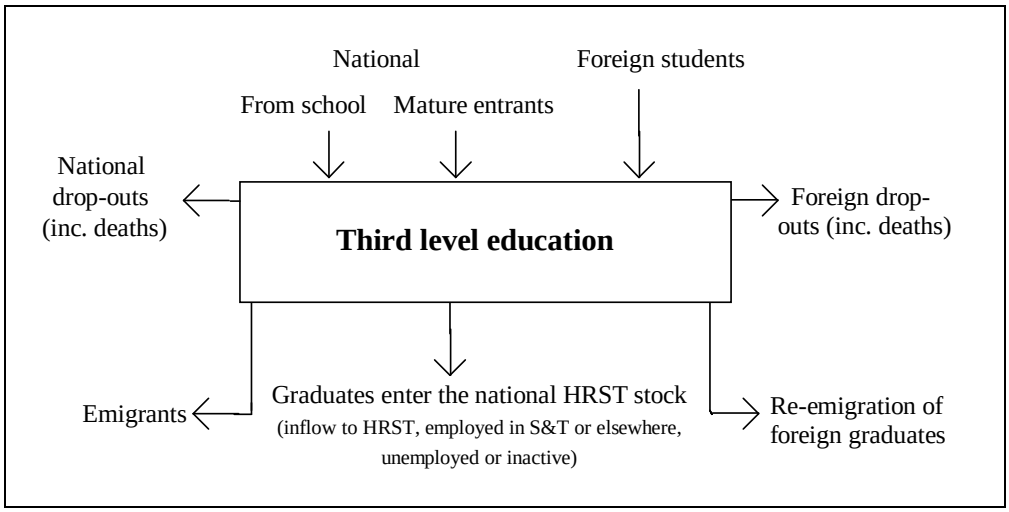
Figure 2. National stocks and flows of HRST: schematic model



Source: OECD, 1995.

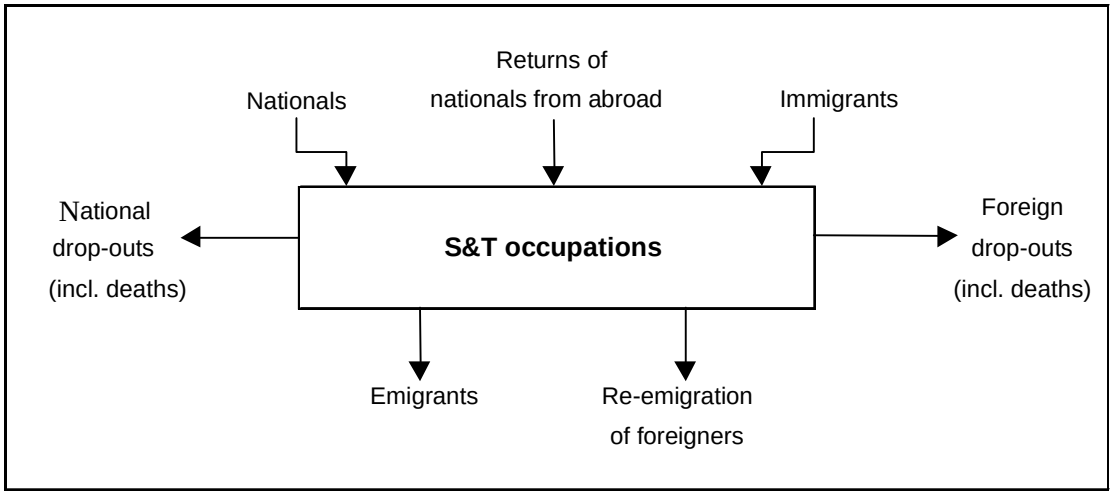
Figure 2 can be refined on the basis of the definition of HRST: Figures 3 and 4 show the stock and flows of tertiary-level students, on the one hand and of S&T workers, on the other.

Figure 3. Main flows in and out of tertiary-level education



Source: OECD, 1995.

Figure 4. Main flows in and out of S&T occupations



It should be kept in mind that the different sub-categories in Figure 10 may, or may not, have completed education at the tertiary level in an S&T field of study (and that, among those having completed tertiary-level education, some may have done so abroad). The "Canberra Manual" defines the "core" HRST population as that with both tertiary-level education and an S&T occupation.

Sources of migration statistics

The principal sources of migration statistics are: *i)* national administrative systems for regulating and monitoring immigration; *ii)* administrative systems relating to temporary residence or work permits for non-nationals; *iii)* population registers; and *iv)* censuses and labour force surveys. However, depending on the circumstances, other data sources are used, such as special surveys, counts of border crossings, analysis of landing cards, studies of personnel transfers within multinational enterprises, etc.[5] It should be noted that published migration statistics are often derived from a number of data sources. In many countries, several sources are used and methods are devised to combine the relevant data in order to achieve comprehensive coverage of relevant categories of persons. Information from the different sources is also usually published, but variations in the definitions and coverage need to be borne in mind. The manner in which the data from the various sources may differ will become more apparent when these sources are discussed in more detail below.

It is not, of course, the primary objective of this chapter to discuss the merits or otherwise of different data sources on international migration. However, the issue will of necessity have to be considered in the context of providing information on migration flows of qualified or skilled personnel. This is necessary because the possibilities for obtaining information on this specific aspect of migration depend very much on the data sources used.

National systems for regulating permanent or long-duration immigration

Virtually all countries have administrative systems to regulate permanent or long-duration immigration. Broadly speaking, in the context of theses sources, an "immigrant" is usually defined as a non-national who seeks to settle or reside permanently in the receiving country or at least intends to stay for an extended duration. In the United States, for example, the legal concept of "immigrant" relates solely to those persons of foreign nationality who seek to reside there permanently. The

situation in Canada, and in other countries, is similar. Thus, movements under such systems would normally cover only a part of aggregate immigration as conventionally understood and would fall well short of covering the migration inflows envisaged under the UN recommendations previously referred to.

Other qualifications apply to the data derived from these systems. A significant share of those accepted as permanent immigrants are already (legally) resident in the country in a different capacity.[6] Thus, actual movements are not necessarily associated with all persons classified as new immigrants in any one period. Furthermore, administrative initiatives, such as campaigns to clear applicant backlogs or one-off procedures to regularise the situation of non-nationals residing illegally in the country, can cause immigration figures to rise sharply, giving the (erroneous) impression that migration inflows are increasing.

Notwithstanding the statistical disadvantages, administrative-based immigration statistics are important in a number of countries. This applies especially to countries with a long-standing, humanitarian-based tradition of accepting immigrants, such as the United States, Canada and Australia. For these countries, inflows of permanent or long-duration immigrants have always been, and still are, quite large. In the United States, for example, over 660 000 persons were officially classified as immigrants in 1998, of which some 78 000 were admitted under the official "employment preference" category. One positive aspect of data derived from permanent immigration systems is the fact that, as countries are in effect making a significant investment in facilitating the entry of such immigrants, detailed and accurate information on personal characteristics is usually obtained. This would normally include details on occupation and education.

In 1999, 189 600 permanent or long-duration immigrants were allowed to settle in Canada, of whom 105 400 (56%) entered as "economic immigrants" under the Skilled Worker and Business Immigration Programmes. Just over 45 100 (43%) of the latter were principal applicants, the remainder (nearly 60 300) were spouses or other dependants. In the context of assessing skill levels or HRST, it is of interest that over 86% of those who entered Canada under the Skilled Worker Programme in 1999 had tertiary-level qualifications (26% with a master's degree or higher), a share that has been increasing (78% in 1997). In the same year, the share for business immigrants (*i.e.* those seeking to enter Canada in a self-employed capacity) was lower at just over 45%.

Over 92 000 permanent immigrants entered Australia in the year to June 2000 (under the Official Migration Programme), somewhat less than 40% of whom entered under what is termed the "skill stream" sub-component. As the term suggests, this arrangement is designed to facilitate the entry of individuals with particular skills.

The administrative-based migration data for Australia have a number of interesting features. Unlike information for many other countries, they provide comprehensive information on all departures and entries (of whatever duration) and cover Australian citizens as well as non-nationals. Furthermore, in addition to flows of permanent migrants, the published information also distinguishes migrants entering for or departing for more than one year, thus making it possible to compile data in accordance with UN recommendations. Australia appears to be one of the few countries where aggregate gross and net migration flows (in both directions) can be derived directly from administrative sources.

Japan also maintains a very comprehensive system to control and monitor entries and departures, which covers both non-nationals and Japanese citizens. Permanent migration to and from Japan is relatively limited, and the great majority of recorded movements relate to short-term trips for leisure, business or personal reasons. However, the system also involves a range of functional "status of

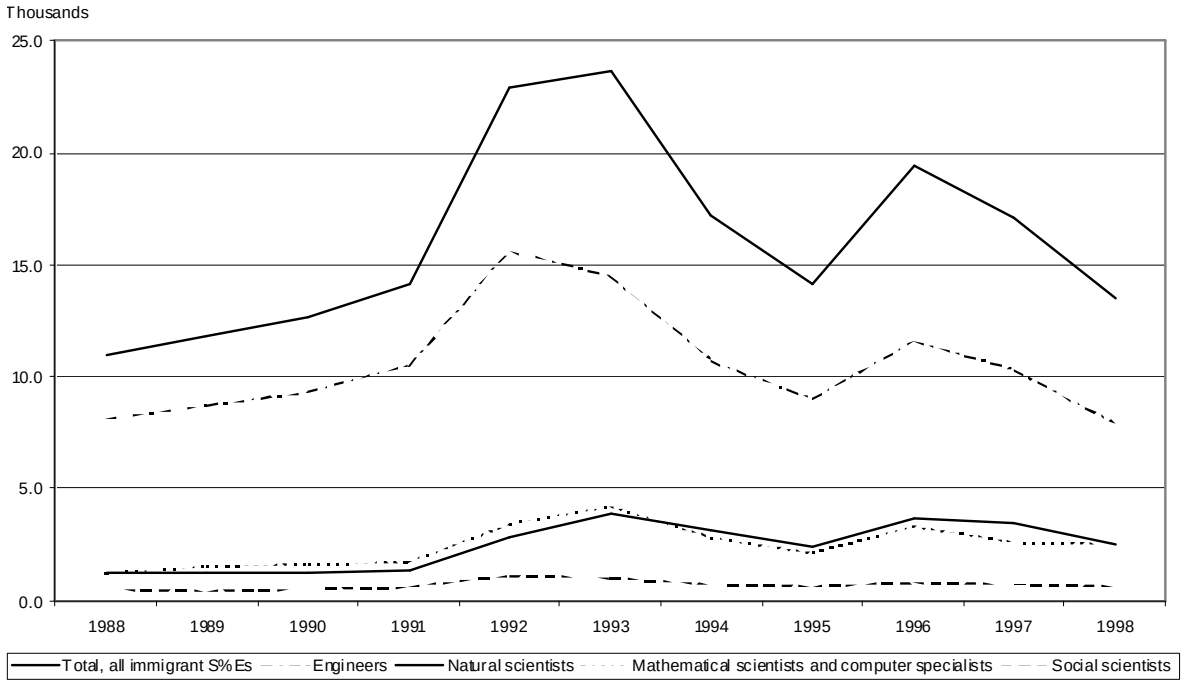
residence" categories designed for those entering Japan on a longer-term (but fixed) basis, many of whom come to work or pursue studies or research. Further details on such entrants are given in the next section.

Working visas, work permits and related programmes

In addition to maintaining systems to deal with permanent or long-duration immigration, most countries also have administrative arrangements for entry on a temporary basis. For the most part, these tend to be related to labour-market needs and involve working visas or work permits, to which certain conditions are attached. Such documents remain valid only for a specified period. Recipients may also be restricted to a particular occupation or industry, or indeed to a particular employer (in which case the onus is usually on the employer to obtain the visa or permit). In circumstances where the arrangements are employer-based, it may also be necessary to demonstrate that the vacancies in question cannot be filled on the national or local labour market.

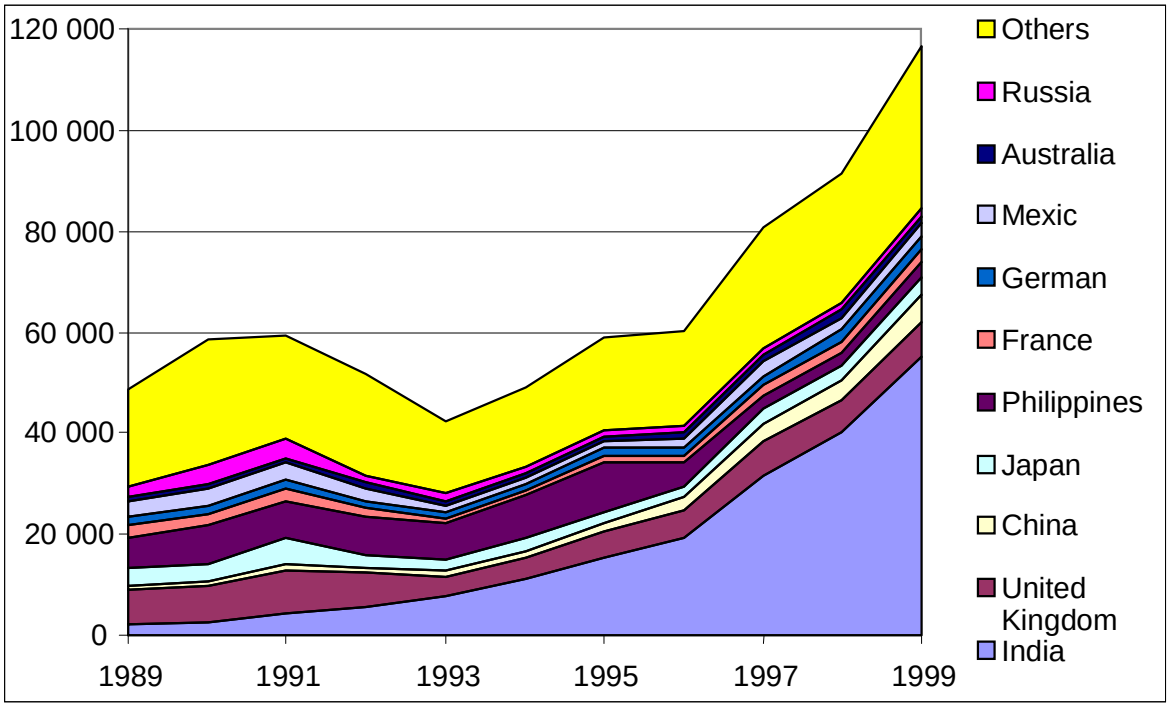
In many countries the inflows associated with these systems greatly exceed the numbers entering for employment reasons under permanent immigration procedures (Graphs 7 and 8). Figure 11 shows an indicator for the numbers of scientists and engineers who were permanent immigrants to the United States. Immigration peaks occurred in 1992 and 1993 following a statutory increase in the number of work-related permanent visas. The number of S&E immigrants who entered on a permanent basis has decreased since. Conversely, qualified immigrants allowed to enter on a temporary basis, as measured through H-1B visas (Graph 8), have steadily increased since 1993. In 1999, about 50% of these visas were delivered to Indian citizens. In Australia, nearly 93 300 non-nationals entered the country under long-term working visa arrangements in 1999/2000. Some 34 000 entered under the temporary business entry (long stay) system, and most were to take up professional or managerial jobs.

Graph 7. US Immigration and Naturalization Service counts of permanent visas with S&E occupations



Source: National Science Foundation, *Science and Engineering Indicators 2000*.

Graph 8. H-1B visas issued by country of origin, 1989-99



Source: OECD, adapted from Lowell, 2000.

In Europe, these systems are normally referred to as work permits. They tend to be restrictive in that a prospective employer is generally obliged to apply for a permit for a named person and a specified job. There are also significant exclusions. Many European countries have negotiated bilateral or multilateral agreements guaranteeing freedom of movement for workers to cross national boundaries between countries that are party to the agreements. Under these circumstances, fewer administrative procedures have to be followed, and, as a result, migration movements may not always be fully recorded. As a result, the usefulness of the system for providing comprehensive data on migration flows is significantly reduced. The EU constitutes the most obvious example, but even before the EU came into existence, a number of European arrangements allowed labour to move freely across national boundaries. The Nordic countries and the labour market arrangements between the United Kingdom and the Republic of Ireland are examples.

In Japan, one of the status of residence categories used to classify non-nationals is defined as "for the purpose of work". Bearing in mind that entertainers entering for a short-term stay are included, the inflow of such persons into Japan increased in recent years, from 82 000 in 1995 to 108 000 in 1999.[7] The aggregate inflow for the broad highly skilled group, covering researchers, engineers, those with occupations in the social sciences and education as well as intra-company transferees, rose from 15 000 in 1995 to 21 000 in 1998. The inward movement for these categories declined somewhat in 1999, presumably owing to the downturn in the Japanese economy, but this is probably a temporary phenomenon; the inward movement is likely to increase as the Japanese economy recovers. Population stock figures for the corresponding category of foreign workers in Japan increased from 88 000 in 1995 to nearly 126 000 in 1999. Interestingly, it continued to increase between 1998 and 1999, an indication that the outflow of such persons also declined somewhat during this period.

Basically, the main objective of governments in allowing temporary or fixed-term employment-related immigration is to meet the human resource needs of national economies. Thus, the great majority of such entries are generally restricted to workers whose skills are in short supply, and whose entry will not adversely affect employment opportunities for the resident population. It is inevitable, therefore, that the working visa and permit systems are strongly oriented towards admitting persons who possess skills and qualifications. In fact, such migrants increasingly receive more favourable treatment, as the global demand for professional and high-technology workers increases and countries compete for what is an increasingly scarce resource. German government sources in early 2000 announced an initiative to facilitate the recruitment of over 20 000 computer/software engineers from outside the EU. The French government enacted a decree in 1999 permitting companies to hire workers skilled in computer science if it can be demonstrated that the company is unable to fill the posts from the local labour market. Another example is provided by the recent enactment of the US Competitiveness in the Twenty First Century Act which substantially alters the terms under which foreign professionals and workers with special skills may obtain and continue to use H-1B visas. The Act increases the number of such visas available (to 195 000 per year starting in 2001), relaxes restrictions on the mobility of such workers and extends their potential duration of residence as H-1B non-immigrants. It actually facilitates a substantially larger number of H-1B admissions than the stated limit suggests, since it exempts from the quota employees of several major sponsors of H-1B workers, such as institutions of higher education, non-profit agencies and governmental research organisations. Basically, the allotment of H-1B visas is now a function of demand.

With regard to the availability of statistical information on working visa or work permit systems, the situation varies greatly between countries. In some, the data collected emphasises occupations or skills (*e.g.* United States, Canada, Australia, Japan) mainly in order to monitor the inflow and ensure that the entrants are restricted to the officially designated skill-based categories. Unlike the situation for permanent immigration, information on formal educational qualifications is rarely collected for these temporary immigrants. In European countries, while work permit systems are also usually designed to ensure that inflows are confined to highly skilled entrants, information on occupations is only exceptionally available. For the most part, tabulations according to sector are most frequently published. Even where different countries use the same classification variables, there is no uniformity in the use of nomenclature. Therefore it is difficult, if not impossible, to derive comparative data across countries.

Despite the inconsistencies and the general lack of coherence, an inspection of the existing data on temporary work-related immigration for different countries reveals a noticeable tendency towards an increasing level of international migration among the highly skilled. In the United States, for example, the number of admissions under the H-1B visa system rose from 106 000 in 1994 to over 240 000 in 1998. It should be noted, however, that admissions recorded under the different US visa systems include multiple entries by the same person over the period in question. Thus, these figures should not be interpreted as the number of individuals entering the United States under these arrangements. In the United Kingdom, the number of work permits issued to managers and scientific and technical professionals rose from less than 5 000 in 1996 to nearly 19 000 in 2000, a near doubling of the share of all work permits (from 13% to 25%). In Canada, for permanent skilled worker immigrants, the share with tertiary-level qualifications rose from 78% to 86% over the period 1997-99., and there is a similar trend for total permanent adult immigrants into Canada.

In Japan, the number of Japanese citizens recorded as leaving “to assume posts” (presumably mainly skilled) rose from 38 500 in 1992 to over 53 000 in 1998. In the same period, the number of Japanese citizens who left to engage in research, study or technical training abroad increased from 220 000 to nearly 280 000.[8]

In summary, the evidence points clearly to a rising level of high-skill migration in OECD countries. However, because of data problems, it is not possible at this point to use the sources described above to quantify movements in comparative or global terms, even on the basis of the very broad definitions of HRST.

Population registers

Population registers, where they exist, tend to include mainly demographic data, such as age, sex and nationality or citizenship and, with respect to migration, information such as date of entry into the country, intended duration of stay, etc. The main purpose is to provide basic information on the resident population in terms of its composition and associated migration movements. Population registers generally do not seek information on educational levels or labour market characteristics. However, in countries with well-developed register systems (such as the Nordic area) links can be made to other sources (*e.g.* social security registers) to obtain the required information. This opens up the possibility of classifying migration movements (including departures) according to sectors, occupations, etc.

Labour force surveys and censuses

Censuses and labour force surveys have the potential to provide more specific and comparable information on migration inflows of HRST for different countries. These sources have the advantage of being essentially statistical exercises specifically designed to facilitate economic and social analysis, and, increasingly (even in purely national circumstances), they tend to involve international comparisons. At the level of individual survey respondents, relevant information is usually collected on sector, occupation and educational levels, generally in a form that allows classification according to standard international definitions. Thus, at the data analysis stage, it may be possible to use definitions based on a combination of these data. However, much depends on the level of detail obtained at the data collection stage, even if not entirely reflected in the published results (*e.g.* because of sampling constraints). If the information on occupation, industry, etc., obtained from respondents is reasonably detailed, it can be aggregated in various ways with different objectives in mind, including the compilation of data according to HRST definitions.

Inevitably, however, there may be problems. Information on inward migration is usually obtained by seeking details of survey respondents' place of residence one year prior to the survey.[9] Migration is then defined on the basis of those who are residents in the country when the survey is taken, but who lived abroad one year earlier. Obviously, this approach excludes some short-term migrants. Those who entered the country during the preceding 12 months and left prior to the survey date are not included.[10] Furthermore, it is a well-known feature of "recall" questions that the derived information is less reliable than that relating to a respondent's current situation. In a significant number of instances, responses may fall into the "unstated" or "unknown" categories.

The sampling methods used in labour force surveys in particular limit the possibilities for presenting detailed information. This is especially true with respect to migrants, who tend to be small in number relative to the size of the national population or labour force. There may also be problems of differential response for various groups in the population. Non-response rates for migrants may be higher than for the general population for a number of reasons, including the nature of their accommodation and their level of proficiency in the national language. Some migrants live in hostels and institutions not usually covered in labour force surveys, which tend to be based on samples of private households. While these problems may not affect qualified or skilled migrants to the same

degree, they may cause them to be over-represented in the derived population and labour force estimates.

The main advantage of using census data is that they are usually based on a complete enumeration of the population so that problems arising from the use of sampling procedures do not arise. Censuses usually place legal requirements on respondents to co-operate and there should be less missing or unrecorded information. In theory, at any rate, all migration inflows, however small, should be identifiable. However, as census questions on migration are usually formulated on the same "recall" basis as in labour force surveys, many short-term migrants would again be excluded.

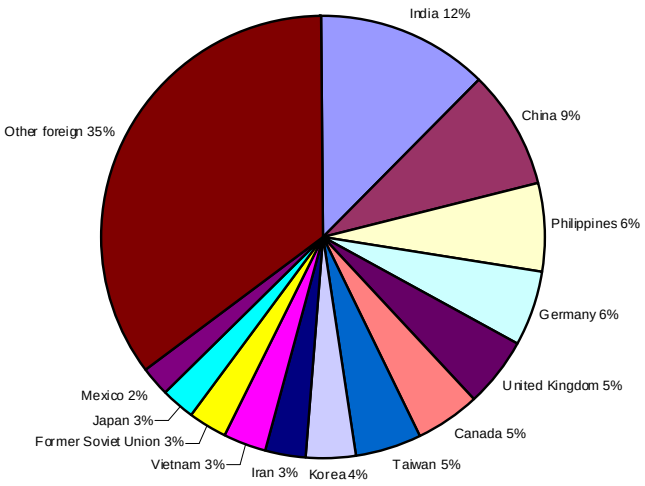
Censuses tend to be held infrequently – about every ten years in most countries. However, a set of UN recommendations[11] requested countries to hold a census as close as possible to the year 2000. Thus, it should be possible, as the relevant data become available, to assemble a body of useful information on migration from these sources. This should be facilitated by the fact that the recommendations for the UN Economic Commission for Europe specify the inclusion of a question on "residence one year earlier". Because the current ISCED and ISCO nomenclatures are likely to form the basis of the educational and occupational classifications used in different countries, it should be easier to derive HRST flows, even if on a rudimentary basis.

Other data sources

Perhaps the most important other source is the UK International Passenger Survey (IPS). This is a continuing sample survey of international travellers conducted by the Office of National Statistics which covers the principal air and sea routes between the United Kingdom and other countries (excluding travel between the United Kingdom and the Republic of Ireland). Most of those surveyed are short-term travellers, but a sub-sample of "migrants" is identified. The definition of migrant is that recommended by the United Nations, *i.e.* the concept of minimum duration (either in the United Kingdom or abroad) is based on a time span of one year or more. Data are available on basic demographic characteristics as well as nationality, country of origin, origins/destination and occupational status. However, the sample size for "migrants" is small, about 2 500 in all. Therefore, detailed analyses of migrant characteristics have to be considered with some caution as sampling errors can be high.

Certain countries conduct special surveys of potential relevance for measuring international mobility of the highly skilled, such as SESTAT, which captures the contribution of both foreign-born and non-US citizens to the US labour force in the science and engineering context. Most of the data derivable from this source relate to population stocks, but some broad inferences on migration flows can be drawn from observed changes in the stock of foreign-born graduates.[12] Graph 9 is an indicator, drawn from SESTAT, of the stock in 1997 of immigrant S&E degree holders according to place of birth. They numbered about 1.5 million (12% of the total stock) and countries contributing at least 30 000 are represented in the figure. Immigrant scientists appear to come from a wide variety of countries, none of which dominates.

Graph 9. Place of birth of foreign-born degree holders in science and engineering in the United States, 1997



Source: National Science Foundation, *Science and Engineering Indicators 2000*.

In addition, several OECD countries, including Denmark, Canada, France, Italy, Ireland, Japan and the United Kingdom, maintain annual graduate surveys that monitor the post-graduation labour market performance of recipients of higher-education degrees. In some cases, foreign and foreign-born graduates are distinguished.

Migration outflows

One feature that applies to most of the above-mentioned sources is that they only measure inflows. While many countries provide aggregate estimates for gross migration outflows, it is rarely possible (apart from Australia and Japan) to derive detailed information on emigration. The reasons are fairly obvious. In household surveys it is difficult, if not impossible, to obtain information on persons who have already left the country. As for administrative sources, while governments have cause, for various reasons, to give priority to monitoring and documenting migration inflows, most see little reason to record in any detail the outflow of persons for whom they no longer have responsibility.[13] There have been, from time to time, expressions of concern about "brain drain"; however, these have seldom prompted any structured response in the form of additional data on emigration.

Some estimates derived from labour force surveys

Table 4 shows employment estimates for EU countries for Spring 1998 classified by broad ISCO group and nationality. The nationality variable distinguishes "nationals" of each country as appropriate, "nationals of other EU countries and of other developed countries",[14] and, finally, citizens of all other countries, which are broadly defined as "developing". Classifications involving the employment stock of non-nationals do not, of course, necessarily bear a direct relationship to labour

force inflows, as these also include nationals returning from abroad. While they do not give a complete picture, they do provide a guide as to the size of an important component of total employment with which migrant flows are associated. If one defines HRST as broadly those with occupations associated with ISCO major groups 2 and 3, about 27% of those in employment in the EU in 1998 fell in this category. The proportion rises to over one-third if the definition is extended to cover "managers, executives, etc." (ISCO 1).

Table 5 shows the shares of all non-nationals in employment in each country for the broad occupational groups referred to above.

Table 4. Total employment in 14 EU countries in 1998 classified by nationality and occupational group

Thousands

Occupation	Austria	Belgium	Germany	Denmark	Spain	Finland	France	Greece	Italy	Luxembourg	Nether-lands	Portugal	Sweden	United Kingdom	Total
Nationals															
ISCO 1	267	381	1879	178	1 103	178	1 652	437	665	5	838	335	190	3 851	11 960
ISCO 2&3	822	1 070	11 193	795	2 649	723	6 017	759	4778	39	2 493	628	1 346	6 139	39 450
ISCO 4-9	2 194	2 132	19 640	1 639	9 272	1 262	13 590	2 626	14 721	58	3 834	3741	2 261	15 849	94 267
Total	3 282	3 583	32 712	2 612	13 024	2 163	21 260	3 822	20 165	102	7 165	4 703	3 797	25 839	145 677
Other EU and developed countries															
ISCO 1	12	38	120	(4)	13	-	47	(3)	(6)	4	15	(3)	4	136	408
ISCO 2&3	49	51	366	19	20	(4)	108	6	28	19	59	6	42	225	1 002
ISCO 4-9	208	137	1 376	27	34	7	520	122	66	43	69	13	86	387	3 143
Total	269	226	1 862	51	66	12	675	132	99	67	143	23	132	748	4 553
Developing countries															
ISCO 1	-	5	37	-	5	-	35	-	-	-	(6)	(2)	-	32	126
ISCO 2&3	4	5	95	-	6	-	54	-	(7)	-	(8)	(4)	-	65	254
ISCO 4-9	70	38	830	14	59	3	446	12	85	2	78	32	14	199	1 881
Total	75	48	963	15	70	4	534	13	94	2	92	38	17	296	2 261
All nationalities															
ISCO 1	280	424	2 037	183	1 120	179	1 735	441	672	9	860	340	195	4 019	12 493
ISCO 2&3	874	1 126	11 654	815	2 675	728	6 179	766	4 813	58	2 561	639	1 390	6 429	40 706
ISCO 4-9	2 472	2 307	21 846	1 680	9 365	1 273	14 555	2 760	14 872	103	3 980	3 786	2 361	16 435	99 291
Total	3 626	3 857	35 537	2 678	13 161	2 179	22 469	3 967	20 357	171	7 401	4 764	3 946	26 882	152 490

Source. EU Labour Force Survey. Special Tabulations provided by EUROSTAT.

Table 5. Share of non-nationals in employment in different occupations in EU countries, 1998

	Austria	Belgium	Germany	Denmark	Spain	Finland	France	Greece	Italy	Luxem-bourg	Netherlands	Portugal	Sweden	United Kingdom	Total
ISCO 1	5.0	10.1	7.7	2.7	1.5	0.4	4.7	0.9	1.1	44.7	2.5	1.4	2.3	4.2	4.3
ISCO 2&3	6.0	5.0	4.0	2.4	1.0	0.6	2.6	0.9	0.7	33.4	2.6	1.7	3.2	4.5	3.1
ISCO 4-9	11.3	7.6	10.1	2.5	1.0	0.8	6.6	4.8	1.0	43.6	3.7	1.2	4.3	3.6	5.1
Total	9.5	7.1	7.9	2.5	1.0	0.7	5.4	3.7	0.9	40.2	3.2	1.3	3.8	3.9	4.5

Source. EU Labour Force Survey. Special Tabulations provided by EUROSTAT.

Measuring HRST inflows

The EU Labour Force Survey data were to be used to compile estimates of the migration inflow into employment for individual countries for the three broad occupational groups previously used. This would have involved the compilation of tables somewhat similar to Tables 4 and 5, but relating to gross migration inflows rather than to employment stocks. However, in the course of the compilations, it became clear that it was not possible to do this, owing to the absence of full information on country of previous residence, since for significant numbers of respondents in many countries the entry "country of residence one year ago" was not recorded. This meant relatively large numbers of persons in the "not stated" or "blank" categories. There was no way to determine how they could be distributed between the "immigrant" and "non-immigrant" categories, even though, for some countries, the numbers involved suggested that many must have been resident in the country a year earlier.

However, it was still possible to use the available data to make some broad estimates of inflows. By using the subset of the Labour Force Survey data that involved identifiable inward movements, it was possible to estimate, for each country, the share of the partial population inflows which related to inflows into employment and, within the latter group, how these were distributed according to the three ISCO categories noted above.[15] These relationships were then associated with known, independently compiled gross population inflow figures to give estimates of occupation-based migration movements into employment. While these estimates were compiled for individual EU member countries, the country-specific estimates must be regarded as tentative; it was considered prudent to show the estimated flow data at total EU level only (Table 6). Indeed, even at that level, given the nature of the estimation procedure and the possibility of bias, the estimates can only be regarded as giving a broad indication of the size of the aggregates involved.

Table 6. Estimated employment stocks and gross migration inflows for EU countries

Occupation	Total employment, 1998	Migration employment inflow, 1997	Inward migration
	Thousands		Percentage
ISCO 1	12 493	57	0.5
ISCO 2&3	40 706	213	0.5
ISCO 4-9	99 291	436	0.4
Total	152 490	705	0.5

Source: Estimates based on the EU Labour Force Survey and Demographic Statistics.

These combined figures for the 14 EU countries covered put the estimated migration inflow into employment in 1997 at just over 700 000. Some 57 000 (8%) of these migrants were classified in ISCO 1 (managers, etc.), 213 000 or just over 30% were professionals or associate professionals (ISCO 2 and 3) and the remaining 436 000 (or 62%) were associated with other less skilled occupations.

If these figures are compared with employment stock estimates (for 1998), they indicate that the total migration inflow into employment represented about 0.5% of the total number of persons at work in the EU *(i.e.* 152.5 million in 1998). The corresponding proportions for three occupational groups distinguished did not vary very much from this figure.

It is of interest to conclude by considering similar estimates from the US Current Population Survey (CPS). Table 7 contains estimates of inward mobility to the United States from abroad for adult employed civilians for the years ended in March of 1996 and 1999.[16] These data, which at

respondent level, are derived in much the same way as in the EU Labour Force Survey, indicate that inflows were 623 000 in 1999, significantly higher than in 1996 (just over 480 000). If the first three occupations shown (managers, professionals, technical support etc.) are regarded as broadly representing HRST, the related inflow in 1999 was 184 000, or just under 30% of the total. The corresponding share in 1996 was only marginally smaller.

Table 7. Inward mobility to the United States of employed civilians aged 16 years and over, by occupation

Occupation	1995/96	1998/99	1995/96	1998/99
	Thousands		Percentages	
Executive, managerial	39	66	8.1	10.6
Professional, specialist workers	92	111	19.0	17.8
Technical support etc.	7	7	1.4	1.1
Sales	53	54	11.0	8.7
Administrative support, clerical	25	48	5.2	7.7
Personal services	9	6	1.9	1.0
Protective service	1	8	0.2	1.3
Other services	103	99	21.3	15.9
Precision production, craft workers	35	53	7.2	8.5
Machine operatives, testers etc.	45	34	9.3	5.5
Transport, material movers	6	17	1.2	2.7
Unskilled labourers, cleaners etc.	23	58	4.8	9.3
Farmers, forestry, fishing	45	62	9.3	10.0
Total	483	623	100.0	100.0

Note. The periods covered relate to the year ended in March.
Source. US Current Population Census.

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NOTES

1. This paper summarises the results of work presented by the authors in two previous papers (2001b; 2001c) prepared for the Seminar on International Mobility of Highly Skilled Workers, held in Paris, 11-12 June 2001. This paper will be the first chapter of the proceedings of the conference, which will be published shortly. Interested people should contact Martin Schaaper.

2. ISCED was revised after the release of the "Canberra Manual". According to research conducted by Eurostat and UNESCO, categories 5b, 5a and 6 of the new ISCED-97 may be considered as the new equivalent of the former categories 5, 6 and 7.

3. The new ISCED offers some interesting developments in the description of these emerging fields. Life sciences are described as: biology, botany, bacteriology, toxicology, microbiology, zoology, entomology, ornithology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences. Computer sciences includes system design, computer programming, data processing, networks, operating systems – software development only (hardware development is classified with the engineering fields).

4. The country where a person lives, that is to say, the country in which the person has a place to live and where he or she normally spends the daily rest period.

5. Reference should be made to the Statistical Appendix in the 1999 edition of the OECD publication *Trends in International Migration* (OECD, 1999) for a more detailed overview of data sources on international migration.

6. Some countries distinguish these groups. In the Australian immigration statistics, they are categorised under the heading of "category jumpers".

7. For detailed data on Japan, see the chapter by Kobayashi in the present volume.

8. These data are unique in that Japan is one of the few countries that comprehensively documents departures (Australia is another). There have been studies of the outward migration of skilled Japanese workers in the context of Japanese foreign direct investment (FDI). See, for example, OECD, 1997.

9. One can also attempt to derive information on migration inflows from questions that record "duration of residence in the country".

10. In this regard, see Koser and Salt, 1997. This study argues that short-term movements (including business trips) of qualified workers may become more important as use of new technologies and greater international networking reduces the need for longer-term visits by professional personnel.

11. See UN, 1998b. This publication was prepared jointly by the UN Commission for Europe and Eurostat.

12. One significant limitation of this source is that persons whose only S&E degree is from a foreign institution are counted only if that person was in the United States with that degree at the time of the April 1990 census.

13. In the Nordic countries, population registers (sometimes in association with other sources) are used to provide data on gross population outflows.

14. The category “other developed countries” covers the EEA, central and eastern Europe, other European countries (except Turkey), the United States, Canada, Japan, Australia and New Zealand. This categorisation is used in the annual series of Eurostat Reports on Migration Statistics.

15. This relates to that subgroup of Labour Force Survey respondents for which the country of residence one year prior to the survey date was identified.

16. It should be noted, however, that the data for the EU are obtained by aggregating the inflows for individual member states, which include inward movements from other EU countries. The total inflow from outside the borders of the EU would be smaller.