

# **Executive Summary**

## **And**

### **Conclusions**

This paper draws upon the results and findings of the activities carried out under a feasibility study on outflows of European scientists and engineers, ‘Brain Drain — Emigration Flows for Qualified Scientists’ for the European Commission. The project was coordinated by MERIT (Wendy Hansen); subject matter experts and researchers contributed through MERIT and two subcontractors on the project: CNR (Rome) under Sveva Avveduto and IKU (Budapest) under Dr. Annamaria Inzelt. Wendy Hansen prepared this draft with input from Sveva Avveduto; all of the material(s) are drawn from the series of activities and studies carried out under this project; full details of authors and contributors are indicated on the individual reports. All misrepresentations and errors in this summary document are the responsibility of Wendy Hansen.

MERIT, October 2003.

# Introduction

Improving the mobility of scientists and engineers has been a focus of S&T policy in Europe for a number of years. Yet, the ability to assess and evaluate the impact of the policies let alone measure the end sum gain remains a challenge. Despite progress at the international such as the *Canberra Manual on Measurement of Human Resources in Science and Technology* (a joint initiative of the EC, Eurostat and the OECD), guidelines for defining and measuring human resources in science and technology mobility and empirical evidence are inadequate.

Research on the international mobility of European-born scientists and engineers, and of more importance, the loss of numbers of scientists and engineers, often has to rely upon limited domestic information sources such as the labour force survey. These surveys' quality varies and reliance upon this source for information on internationally mobile scientists and engineers is a risky undertaking. There are other sources of information on highly qualified persons crossing borders to study and work such as study permits and labour permits, administrative registers and census figures, but they too can be notorious for lack of timeliness and comparability, if available at all. Mobility measures, the inflows and outflows, the net gains and losses, the impact domestic and foreign policy on the flows of highly skilled scientists and engineers are, by and large, left to the ingenuity of individual researchers.

This study was supported by the *Competitiveness, economic analysis and indicators unit* of the Directorate for the Knowledge-based economy and society of the Directorate General for Research to investigate the feasibility of measuring the brain drain/brain gain phenomenon. The study's scope included gathering information on the international mobility of European scientists and engineers as well as the challenge to develop new methods to gather information on internationally mobile scientists and engineers. The outputs of the study provide information on the current situation and suggest avenues to pursue to advance measurement and understanding of the international mobility of European scientists and engineers.

## ***Methodology — in brief***

This project is composed of a number of different activities. Two papers were prepared to contribute to discussions on defining brain drain: one entitled *Human, Brain and Knowledge Mobility* (Todisco) and one entitled *The Evolution of Theories of Brain Drain and the Migration of Skilled personnel* (Avveduto, Brandi). A paper was prepared on east-west migration entitled *Historic East-West Migration in Central and Eastern Europe* (Hars and Inzelt). A discussion paper *International Mobility of European Scientists and Engineers — Moving Policy from a Reactive Role to a Proactive Position* was prepared to put the issue and results of the study in a European policy perspective.

A series of country 'vignettes' were prepared to identify key information sources, present data as available and inform on recent trends. Not surprisingly, there was tremendous variance in terms of availability of data. For a few countries, little or no information on international mobility is available and data is limited to macro-immigration statistics; in others, the labour force and Census surveys were helpful. In some countries, timely and rich data sets were available. Even so, the data presented

challenges at the international level of analyses. That said, the research shows the ‘issue’ of brain drain and brain gain was clearly high on the agendas of many countries and the vignettes include discussion of the issues of brain drain and international mobility as raised by national experts.

A second and key element of the study involved the design and piloting of three surveys to consider international mobility. The surveys were designed to provide information on international mobility and in particular, factors affecting flows, the ‘push’ and ‘pull’ factors. The surveys were piloted in three sectors: public funded research institutes, private enterprise, and a non-profit professional association. The surveys were piloted in the EU (Italy), the CEEC (Hungary) and internationally (a US association with members around the world). As well as gathering information on internationally mobile European scientists and engineers, the experience of the piloted surveys were documented and can be used to inform on the feasibility and practicality of further developing and advancing surveys of this type for regular information gathering activities.

## European Movers

### Flows and Europe

Regional accords like the EU and NAFTA are making it easier for researchers and scientific and engineering personnel in general to take advantage of opportunities offered outside of their own national borders. Policy and decision makers from Ministries of Labour to universities to the private sector are all realizing the growing value in the ‘foreign’ stock of HRST. Not all countries however, are realizing the benefit of flows of HRST. Some countries have moved ahead quickly to remove barriers of entry while others are trying to balance the needs of labour markets and their own workers. More and more countries are devising ways and means to draw upon the international supply for highly qualified personnel to (i) meet short and medium term demands (e.g. the IT and biotech sectors) and (ii) make up for the lack of supply in general in the home country (e.g. lack of young people entering fields in science(s)).

Some country findings:

Immigration in **Finland** continues to expand with the year 2001 the 7<sup>th</sup> consecutive increase. Between 1995 and 2001, the number of foreign citizens emigrating to Finland grew by one third to surpass 11,000. Among the immigrants, that largest contingent was from Russia (almost one quarter) followed by Estonia (about one in ten) and Sweden (about one in twenty). In the other direction, while most Finns

who leave choose Sweden, other destination countries include Germany, Norway, the US, Spain, the UK and Denmark. The number of work permits to foreign workers issued each year is on the rise: in 2001, more than 21,000 work permits were issued and this was double the average issued each year during the mid 1990s. In a 10-month period in 2002, 768 work permits were issued to foreign IT software workers

and 658 to foreign IT hardware workers.

In 2000, there were some 184,300 foreigners registered in **Norway**; this represented an increase of 29% compared with 1990; as the presence of foreign population increased over the decade, the contribution of the EU rose from 39% to 43%. In the 1990s, Denmark was the main supplier but in 2000 Sweden ranked as the lead supplier. In 2001, there were 43,000 people employed as IT professionals and another 20,000 or so as other IT specialists and 4.3% of these workers were foreign. Among the more than 16,000 teachers, about one in ten were foreign citizens; among the 121,000 or so health professionals (including nursing), 5.7% were foreign citizens.

In 2002, Sweden realized the greatest net gain in migration since the mid-1990s. Many of these movers were Swedish born or from other Nordic countries. If the Swedes are discounted, the largest share came from Iraq and then Norway, Finland and Denmark. Persons from Asia and non-EU countries drove immigration. Since the late 1990s, the representation of foreigners in the population has been between 5% and 6%. In 2000, there were more than 19,000 temporary work permits granted but most of them were seasonal workers. The number for highly skilled workers was very small — only some 400.

In 2002 there were 266,729 foreign citizens in **Denmark**, and more than one third higher than the figure in the mid-1990s. In 2002, 30% of the foreign citizens were from countries within Scandinavia, the EU and North America; in 1980 more than half of the foreign citizens came from these regions. In 2001, among the 38,591 residence permits granted, 13% were for work and business. In July of 2002, special legislation to fast track high

demand skills (e.g. IT) was put in place. In the second half of 2002 since the legislation was put in place, among the 805 job-card permits, most were IT specialists (47%) followed by doctors (35%); overall one in five were brought in for occupations in natural sciences and technology.

The **UK** has a proven record of drawing on foreign talent to meet labour market demands and also sending many qualified scientists and engineers overseas. In fact, in receptor countries like the US and Canada, the largest contingent from Europe is from the UK. For almost all of 1980s and the 1990s, the UK enjoyed net gain in EU flows. In 2000, the UK granted 64,574 work permits/first permissions: more than half of them were in associate professionals/technical occupations, almost one quarter in professional occupations in natural/applied sciences and teaching and at least one in five in management/administration. One in five permits were in IT. Some one in five of the permit recipients were from the US or India: most inflow from the US (43%) were in associate professional/technical occupations including computer analysts, programmers, business and finance professionals with the second largest share of 41% in management/administration; among those from India, almost two thirds were in associate professional/technical occupations and one quarter or so in professional occupations including engineer. At least one in ten work permits were for people from the Philippines and almost all of them were in health professions. In 2001, foreign citizens accounted for 6.4% of IT employment and a high share of 7.8% in health.

**Ireland's** work permit system and the changing social and political environment in Europe has brought about some significant shifts in Ireland's option to turn to foreign workers to meet

domestic needs. In 2000, some 18,000 work permits were issued (or renewed) compared with only 5,700 or so two years earlier; the increase was driven by people from Central and Eastern Europe — between 1999 and 2000, the number of work permits issued to persons from this region jumped from less than 500 to 8,000. As this took place the share from the EU and the US. It was the services sector that drove growth: of the work permits issued in 2001, three quarters were for work in the services sector.

Between 1996 and 2000, **Austria** realized a net migration of almost 51,000; While the total number of Austrian citizens saw a net a net loss in the population of some 25,000, the population with EEA/Switzerland (CH) citizenship had a net gain of more than 24,000; the largest net gain was among citizens from other countries (more than 52,000). Labour data reveals that between 1995 and 2001, the number of Austrian citizens with tertiary education grew by 24%, about the same as the growth of the population with EEA/CH citizenship. The largest of the gross gains from migration of working age population with tertiary education was due to the arrival of EEA/CH citizens from other EEA/CH countries (around three quarters) and one-fifth from third countries. In 2000, foreigners accounted for one in ten of total employment; most of the foreign workers were from the former Yugoslavia (almost half), somewhat fewer than one in five from Turkey and about one in ten from the EU. In the year 2000, 100,000 work permits were issued, typically in sectors of agriculture/forestry, tourism and textiles.

In **France**, as in other countries, doctorate and post doctorate university courses bring in (if even for a short term) foreign-born talent. In 1999/2000, there were some 129,000

foreign students in French universities; a rise of 6% in just one year and it meant that foreign students accounted for 9% (and lower than the 13% seen in the mid-1980s). At the same time the number of French students dropped by 1%. Students from North Africa dominated the foreign student body (49% in 2000), but their share is declining as being offset by students from non-EU European countries. In 2000, the EU share of total foreign enrolment was 21%, the non-EU European share was 9%, 13% were from Asia and 7% from the Americas. Among the EU foreign students, Germany was the dominant supplier and among the other European countries it was Romania. Overall, Europeans had less tendency to be in science faculties but within the European contingent, a higher share of students from the CEEC were in science compared with EU students. The Ministry of Foreign Affairs estimates nearly 1.8 million French citizens were residing abroad and in 1998 and most of them have a graduate degree, PhD or other postsecondary qualification. A recent study tells the main reason for post doctorate French researchers emigrating to the US is because of the absence of adequate opportunities in France and the fact that the acquisition of a post-doctorate qualification in the US is a prerequisite to a high level career in research in France.

Between 1992 and 1994, Eastern Europe lost a considerable amount in terms of human capital and seemingly some was to the benefit of **Germany**: estimates are that some 82,000 highly skilled Eastern Europeans arrived in Germany. However, not unlike other countries in Europe, Germany finds it difficult to attract foreign intellectual capital and despite such efforts such as the introduction of 'green cards' to foster recruitment of specialists to IT. The share of foreign workers in Germany's

labour force hovers around 9%; typically foreign workers are in lower skill jobs. Some 2% of German students enroll in foreign universities but few foreign students come to Germany. Germany students who went to the US indicated a postdoctoral appointment as the reason for their move, and most reported that his/her experience in a US laboratory as a very positive experience (Germany remains one of the top suppliers of foreign students to the US). A survey of firms that employ foreign highly qualified employees show it was R&D firms that reported the highest share of foreign highly skilled workers followed by the IT industry. When German employers of highly skilled foreign workers were asked about the reasons for hiring foreign workers, the importance of knowledge of foreign languages, knowledge of English and a knowledge of foreign markets scored high — it seems foreign workers were brought in for the skills not available through the German education system and before anything else, German employers seek them because they can provide intelligence on foreign markets.

In 2000, four EU countries (Germany, Belgium, UK and Spain) ranked in the top 15 suppliers of foreign-born population for the **Netherlands** and accounted for 14% of the foreign-born population; ten years earlier these four countries had supplied 19% of the foreign-born to the Netherlands. In 1987, there were some 176,000 foreign workers in the Netherlands, of which about half (47%) were from the EU; eight years or so later in 1995, there were 221,000 foreign workers in the Netherlands but the share from the EU had diminished to 43%. In 1995, 36,000 (or 16% of the total) foreign workers were in occupations of scientist (includes artists); in these occupations the EU supplied the lion's share — more than three quarters. 2001 data

illustrate the low representation of foreign citizens in the Dutch work force: only 2.8% of the IT professionals and 1.4% of health professionals were foreign citizens. That said, despite a tightening of the labour market in recent years, the share of work permits granted of those requested was on the rise (e.g. comparing 2000 with 1999) and most of the permits were in IT.

Total employment in **Belgium** numbered some 3.8 million in 1998. Occupations in management stood at 424,000 and among them, just under one in ten were non-nationals; almost all of them (88%) were from the EU and other developed countries. There were 1.1 million in professional occupations; only 5% were non-nationals. Most of the non-nationals in professional occupations came from the EU and other developed countries (at least nine in ten). In 2000, almost 7,500 work permits were issued, a slight drop over the previous year. Belgium did recruit for high demand occupations: for example, in 2001 6% of the IT professionals were foreign citizens and this was one of the highest shares reported in the EU. Belgium also counted on foreign citizens to some extent for university teachers: in 2001, 2.4% of postsecondary teachers were foreign citizens.

Foreigners' numbers remain less than 2% of the labour force in **Spain**. The role of the EU in supplying Spain is falling: in 1987, 50% were from the EU and in 2001 only 25% (this was partially offset by the rise in the number of persons coming from the CEEC). When the labour force with a higher education is examined, the rate of foreigners with a university degree was 30% (in 2001) and similar to the representation of higher education in the total labour force. The main regions of origin for foreigners with a university degree are the EU and Latin

America, with the contribution of the former decreasing as the latter is increasing.

Until 1998, in **Greece**, the number of work permits issued to foreigners had been restricted to between 25,000 and 34,000. During the 1980s and 1990s, the largest share went to scientists and professionals (some one third in the mid 1990s). Most of the permits went to persons from Europe of which most were from the EEC region. In 1995, there were more than 27,435 foreigners with valid work permits in Greece, of which 8,826 were in the scientist, professional, business, executive category and another 5,110 in the technician category. In 1998, about one in ten of the legalized foreign immigrants had tertiary education but only a small share was working in jobs commensurate with their education.

In 1998, there were a total of 88,605 foreigners working in **Portugal**. Thirty percent of the professional, managerial and technical occupations were foreign; the remaining 70% were in medium and low skilled occupations. The contribution of the EU for highly skilled workers in Portugal is evident. In 1998, more than half (52%) of the foreign highly skilled workers were from the EU (people from Brazil were the second largest contingent). Among the foreigners arriving in Portugal in 1999 and 2000, the most skilled group continued to be made up of Europeans. In 2000, 46% of the foreign labour force from the EU had higher education compared with only 23% of those from Brazil. The EU also supplies the bulk of foreign researchers: in 1999, the EU accounted for 43% of the foreign researchers and other European countries another 10% or so. Data sug-

gests Portugal is enjoying inflow of a more permanent nature while outflows tend to be temporary. Among the EU-born persons, it was persons from the UK, Germany and Spain who dominated. That said, there are fears that the supply of highly skilled HRST from Europe can be fickle and Portugal can quickly lose the EU as a key contributor.

**Italy** is a country that supplies talent to Europe and the Americas: in the 1960s, Switzerland attracted a significant share of Italian professionals — in 1966 alone, some 2,000 engineers and 540 physicians obtained a Swiss passport; in the late 1960s they went to the Americas. At the end of the 1990s, Italy was suffering a ‘drain’ of its graduates – between 1996 and 1999, more than 2,300 graduates. In 2002, a sample survey carried out on Italian researchers abroad showed departures were in part due to difficulties experienced in access to and progression in scientific careers in the Italian scientific environment. Data also reveals that although the flow of Italian migration fluctuates from year to year (number of skilled Italians entering and leaving Italy), and until the end of the 1990s, it was always a negative sum for Italy. The presence of foreign students in Italy remains relatively low: a peak of 3% was reached in the 1980s and a decade later was at about the same level. Over the last decade, the structure of the higher education system has undergone significant changes and laws concerning immigration have become more restrictive. At the same time, reprioritizing of policies has seen declines in enrolment (e.g. in medicine).

## Flows and the CEEC

The trends in flows of persons from CEE countries, among European countries and out of Europe reflect the policy restrictions of the past and the recent and rapid changes in the economic, social and political culture to engage in the global knowledge based marketplace today. The opening of economic and geographic borders brings tremendous potential for economic and social change, but it also brings pressure to bear on the nations' supply of highly skilled human capital, human capital in growing demand around the world.

Brain drain has been a concern in **Bulgaria** since 1990. Recent evaluations suggest as many as 55,000 to 60,000 highly educated persons leave each year. Their typical destination is the US, Canada, Germany, the UK and Scandinavia. Bulgaria does not yet see inflows of highly educated immigrants from countries like the US, Russia, the UK and Greece. The main sectors that suffer losses are chemistry, biology, medicine and physics. It has also been suggested that as many as half of the students above the age of 18 are potential emigrants. For example, the US data tells of 898 Bulgarian university students in 1993 and in 2001, more than triple the number at 3,270. Between 1994 and 2000, 597 entry permissions were granted to foreigners. According to a 2000 survey, most of the highly educated immigrants in Bulgaria are from the US, with the next largest shares coming from Russia, Greece, Germany, France and the Ukraine

During the transition period in **Estonia**, there was intensive mobility brought about by the restructuring process uniting basic research and higher education between scientific institutions within Estonia. At the same time, scientific personnel left to continue their work in other countries: 65% are continuing their scientific work and as high as 81% in engineering and technical sciences. Estimates

are that during the transition, research personnel numbers were reduced by 30%. Estonia is third behind Romania and Poland in terms of the high proportion of researchers who left their country to take up a job in a foreign country. Current data suggests that the researchers in Estonia today may have a low propensity for international mobility given their age structure.

Between 1995 and 1999, most of the highly skilled immigrants that arrived in **Hungary** were from former socialist countries; inflow from the EU was some 500 to 650 annually. In terms of share of total immigration, the proportion of highly skilled immigrants was considerably higher in 1995 than in 1999: 34% of total immigrants were highly skilled in 1995 but only 24% in 1999. As mass privatization ended and economic recovery began (1997/97), the inflow of experts slowed. Although Hungary receives talent from neighbouring as well as more distant socialist countries, Hungary is not active in sending people in those directions. Most Hungarians go to Germany, followed by Austria, the UK, Sweden, Italy and the Netherlands. With the 'green card' initiative of Germany, statistics shows between 5,000 to 6,000 Hungarian IT experts were granted a permit.

In 1991, with the independence of **Lithuania** restored, foreign capital be-

came interested in Lithuania's market and the flow of skilled foreigners became notable. Recent data shows most are in the IT sector followed by education. Directors, instructors, professors and researchers dominated inflow of foreign-born talent. Higher educated specialists from the EU compose about 35% of the brain gain; most came from Finland and Sweden; a large share came from the US and Canada as well. In terms of emigration, estimates are that between 1991 and 1993, more than 12,000 higher educated Lithuanians left. During the second half of the 1990s the number of emigrants declined to just 240 in 1999; in 2000, the figure was back up to 436. There is almost equal representation of men and women among the leavers. More recently, Lithuania has become concerned with outside pressures, such as the IT quotas in countries like Germany and the US that could further drain their highly educated capital resources.

Over the years, the education level of **Poland** has been rising and the recognition of the skills of Poles is growing. In 1996/97, almost 20,000 Poles were working in Germany on a contractual basis; 3,000 or so were employed in the UK as specialists (mostly in companies with a trade relationship); the main destinations of Poles are the Germany, the US, Italy, the UK and France. In 2000 the outflow from Poland was almost 27,000. The share of researchers from the Polish Academy of Science institutes among emigrants is much higher than their share in total research in Poland. Highly skilled Poles tend to be underemployed in a foreign country and brain wastage is a danger. A large share of immigrants to Poland in the 1990s were educated and experienced professionals. In 2000, regional labour offices issued 10,031 work permits for persons with a higher education degree: 73% were from

Europe including 42% from the EU; 18% were from Asia and 7% from the US.

The new social and political order in **Romania** has brought about an increase in the number of skilled Romanians seeking work elsewhere. Even without bilateral agreements like this, Romanians can be found employed elsewhere such as those with Nokia in Finland. At the same time, other countries like the US and Canada are recognizing the talents of Romanian IT engineers and using them to fill demand. In 2001, more than one quarter of the emigrants were professionals including engineers, architects, physicians and economists. Between 1990 and 2000, more than one third of the higher educated emigrants went to Germany, and about one in ten to the US or France. Of the total of 9,921 emigrants in 2001, 15% of them were engineers/architects, 5% were teachers and 5% were economists. It appears that highly educated women have a greater propensity to work in a foreign country than men albeit by a slight margin; between 1990 and 2000, 53% of the higher educated emigrants were women.

Official statistics tell of more than 5,000 **Ukrainian** scientists leaving in the 1990s and suspicions are this figure is low. As recent as 1997, more than 500 scientists left to work abroad were reported. In 2000, there were 15,132 emigrants with a university degree; most were bound for Europe (9,248) and a large share went to Israel (3,817) and the US (1,332); among the destination countries it was Canada that received the highest share of persons with a higher education degree (e.g. 41% emigrants to Canada had a higher education degree compared with 22% of the emigrants to Israel and 14% of the emigrants to the US). There is a fear the exit of experienced scientists

and engineers may grow given the share of young persons who are voic-

ing interest to pursue research and science and engineering careers abroad.

## European Flows Across the Atlantic

Flows within Europe can, on the one hand, can have negative consequences for the supplying country. On the other hand, flows and exchange of human capital and consequently suggest brain circulation within Europe, a positive net effect. The extent to which Europe and the European Research Area benefits from this exchange is an important measure but not a subject of this study. However, the volume and type of talent potentially draining outside of Europe's borders is important. Although trends are changing, Europe continues to supply regions like the Americas and Australia with highly skilled scientists and engineers.

### *European flows to the United States*

Overall, Europe's role as a supply line for the US population has been slowing: in 1970, the EU had five countries in the top ten 'sending' countries (e.g. foreign-born population) with Italy and Germany ranking one and two; by the 1990 Census, the EU had only three countries ranked in the top ten, with Germany now ranking six, followed by the UK and Italy.

In 2001, almost 50,000 of the more than one million immigrants admitted to the US were from the EU; the UK was the key supplier and Germany and France were also important sources. About 33,000 were from the CEEC and Poland and Bulgaria were the dominant sources.

Although the numbers are declining, the US continues to rely upon Europe for foreign skilled workers to meet short-term labour market demands. In 2001, the EU supplied more than 400,000 and the CEEC some 67,000 of the 1.3 million non-immigrants admitted to the US on a temporary basis. Most of the EU persons went on intra-company transfers and exchange visits, followed by H-1B visas although this

varied across the EU. For example, most of the UK non-immigrants admitted were on intra-company transfers followed by H-1B visas whereas among the Germans, it was typically under exchange visits followed by intra-company transfers. Most of the CEEC temporary workers entered the US on H-1B visas. (The H-1B visa is the visa for workers with specialty occupations, e.g. special skills, skills in demand such as IT).

In 2000, among the top fifteen countries supplying the 257,640 skilled workers (H1-B beneficiaries), the UK ranked 4<sup>th</sup> sending almost 7,937, followed by Germany in 11<sup>th</sup> position (3,534) and France in 12<sup>th</sup> position (3,415).

The age of temporary workers from the UK and German at 32 was above the overall median age of 29; the median age of those from France matched the 29 median age of the overall total.

In 2000, the UK temporary workers reported a median income of \$70,000, the highest median income of the top 15 supplying countries; and the median

income of persons from Germany (\$55,412) and France (\$57,000) was also well above the median reported for all countries (\$52,800).

More than half of the temporary workers went into 'hot' occupations such as computer and other IT related activities. In 2001, 22% of the EU H1-B beneficiaries were in computer and related occupations and 17% in engineer-

ing/architecture occupations; at least one in ten were in management. Although occupation choices varied across the EU countries, most of the temporary workers were in computer/related occupations; it was the Dutch that showed the highest share of 16% in management occupations, about one in five.

## ***Europeans earning US doctorates — drain or gain for Europe?***

### **Some statistics on European US doctorate recipients**

In 2000, EU-born persons earned 1,493 of the 41,638 doctorates awarded in the US. Two thirds of the EU-born doctorate earners were from only four countries: Germany, the UK, France and Italy. More than half of the EU-born US doctorate recipients were in the US on a temporary visa (e.g. student visa) and one in five had a permanent visa. Among the major EU countries, Italy had the highest share in the US on a temporary visa (63%) and the UK the lowest (44%); almost three quarters of the CEEC US doctorate recipients were in the US on a temporary visa.

Since the 1990s, at least two thirds of the doctorates earned by EU-born persons were in fields of S&E. It was among persons from the UK the representation of S&E fields tended to be the weakest among the four countries examined <sup>1</sup> — in 2000, 73% of the doctorates earned by Germans were in S&E compared with 55% of those earned by UK citizens. CEEC persons showed clear preference for S&E studies — eight in ten of the doctorates earned by CEEC citizens were in S&E.

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<sup>1</sup> Data sets for UK, Germany, France and Italy were sufficient to allow individual analysis.

In 2000, among the EU-born, women earned 37% of the doctorates which was lower representation than the 44% in the total number of doctorates earned by women in that year. Among the CEEC-born, women earned a lower share of 32%. Among the EU 'big four', France showed the highest representation of women (43%).

Between 1991 and 2000, the median age of US doctorate recipients fell from 33.8 to 33.1. In 2000, the median age for the EU-born was lower at 32.0 and for the CEEC-born it was only 31.3.

Among the EU-born, the share reporting financial support of foreign government sources rose dramatically over the ten-year period 1991 to 2000 from only 8% to 23%.

The EU-born tended to complete their degree in a shorter time than the average. In 2000, the median number of years from Bachelor completion to doctorate was 9.4 overall, but for the EU-born it was only 7.8 years.

### **Plans after earning the US doctorate**

Seven in ten of the EU-born doctorate recipients over the decade 1991 to 2000 reported they planned to stay in

the US after graduation. This translated to almost 11,000 of the 15,600 or so EU-born US doctorate recipients telling of plans to stay in the US. The trend was similar for the CEEC; some seven in ten reported plans to stay in the US.

Between 1996 and 2000, EU-born earned 7,728 US doctorates; 46% of those with plans to stay in the US had a firm employment offer compared with 41% of those with plans for a foreign location. It was among those from the UK with plans to stay in the US, the highest share reported a firm employment offer in the US and France and Germany were not far behind. Among the CEEC-born who reported plans to stay in the US, 38% reported a firm employment offer

Although most of the firm employment offers in the US reported by EU-born were in the education sector, things were changing. In the first half of the decade, 62% of the firm offers in the US were in education but by the second half of the decade it was down to 57%; at the same time, the share reporting firm employment offers in the business sector grew from 19% to

25%. For those choosing overseas destinations, the share in education fell slightly from 54% to 52%. For the CEEC, the shift was drastic: the first half of the decade with the second shows the share with an offer in the education sector dropping from 54% to 39% as the share in the business sector jumped from 31% to 51%.

Over the decade of the 1990s, the overall share of doctorate graduates saying they would be engaged in R&D activities expanded from 26% in the first half of the decade to 30% in the second half. The trend among the EU-born staying in the US with firm employment plans showed the opposite: the share in R&D activities dropped from 36% to 33% while the share reporting teaching occupations rose from 37% to 42%. Among the CEEC-born, the shared planning R&D activities expanded from 46% to 56% and the share in teaching fell from 30% to 25%. Among the four EU countries of France, the UK, Germany and Italy, it was Italy that reported the largest share with plans for R&D employment (38% to 39%) over the decade.

### *European flows to Canada*

In 2001, the EU-born accounted for 30% of Canada's 5.4 million immigrant population, most from the UK, Italy, Germany and Portugal. Almost 400,000 were from the CEEC, notably Poland, Romania and Hungary. Most had emigrated prior to 1961; fewer than one in ten arrived after 1991. France went against the EU trend — 32% arrived after 1991. Not surprisingly, the flow of East Europeans to Canada followed the economic and social restructuring in Europe and more recent years saw the heaviest mi-

gration from countries of Bulgaria, Poland and Slovenia.

It is estimated that at least one in five of the EU-born Bachelor-qualified HRST arrived in Canada with their degree. In 1996, there were more than 12,000 EU-born doctorate degree holders in Canada's work force.

Since 1995, some 117,000 EU-born were granted landed immigrant status although recent years see the number falling. The UK dominated the EU contingent (about one third) with the

share from France growing from one quarter in the late 1980s to almost one third in 2002. Germany is the other key supplier.

Recent years show some 13,000 to 15,000 from the EU admitted each year, down from the levels in the 1980s and early 1990s. As this took place, the number from the CEE region was on the rise — in 2002, the CEEC sourced 11,551; Romania supplied most of the CEEC emigrants.

Fewer than half of the permanent residents from the EU were women (46%) whereas more than half of the CEEC emigrants (52%) were women; recent years saw little change in the representation of women. This puts the EU below the overall total where 51% of the permanent residents admitted in 2002 were women, and the CEEC women's share above.

The EU is accounting for diminishing shares of highly skilled persons obtaining permanent residence in Canada: in 1980, the EU accounted for 18% of those with a Bachelor degree and 23% of those with a Doctorate were from the EU; in 2002, only 3% of those with a Bachelor degree and 18% of those with a Doctorate. The UK dominates the EU contingent although the share from France is approaching that of the UK; Germany accounts for the third largest share. Since the mid-1990s, the CEEC accounts for 4% to 5% of permanent residents admitted with a Bachelor degree and 2% to 4% of those with a Doctorate; Romania and Poland dominate the CEEC contingent.

Although Europe's role is lessening in terms of share of total persons admitted annually, it continues to supply Canada with highly skilled persons for occupations in the natural sciences and engineering. For example, recent years

see some 1,400 to 1,700 permanent residents admitted annually in occupations in natural science/engineering from the EU and a similar figure from the CEEC.

Europe also fills short-term labour market needs for Canada. Since the mid 1990s, the EU has supplied 14%-15% of the temporary foreign workers each year and the CEEC sent some 2% to 3% each year. As few as six EU countries provide nine in ten of Canada's temporary workers: the UK, France, Germany, Italy, Ireland and the Netherlands.

In 2002, the representation of women among EU temporary workers in Canada has risen to 31% compared with 29% for total countries. The representation of women varied across the EU with Ireland showing the highest share (45%) and Italy the lowest (15%). The small contingent of temporary workers from the CEEC showed higher representation of women (in 2002, 38%); among the CEEC countries, Slovakia had the highest representation of women by far (60%) and Slovenia with 17%, the lowest.

In 2002, most of the 22,000 from the EU were in S&T occupations including management, natural sciences, social sciences and education. For example, in 2002, the EU supplied 16% of the 12,545 temporary workers in management/administration, 28% of the 16,422 in natural/applied sciences, 28% of the 2,625 in engineering, 14% of the 2,104 in computer systems analysis, and 36% of the 6,443 in technician/technologist occupations. The EU also supplied 16% of the 2,143 temporary workers in occupations of university professor and 9% of the 2,113 in college teaching occupations.

## ***European flows to Australia***

Australia has traditionally attracted permanent settlers from abroad and actively pursued pro-immigration policies throughout its history. Since the end of the 1990s, more than half of the visas granted each year are 'skill' visas.

In 2001/02, the EU supplied 11,689 of a total 88,900 settlers arriving in Australia (13%); three quarters were UK-born.

During the three year period 1997/98 to 1999/00, the EU supplied 16% of the almost 121,000, again three quarters of them were from the UK. Australia also received some 1,800 from the CEEC over the three-year period.

The EU supplied a range of S&T occupations and typically accounted for 14% to 19% of the settlers arriving in S&T occupations. For example, the EU provide 17% of the 334 IT managers, 16% of the 480 chemists, 18% of the 462 life scientists, 19% of the 474 environment/agriculture scientists, 17% of the 3,738 engineers, 15% of the 184 mathematicians, and 19% of the 4,293 computing professionals; the exception was the much higher share from the EU in geology: 26% of 437.

The EU also sent Australia teachers over the three-year period. Among the 4,900 teachers who arrived in the settler category, 14% were from the EU as well as one in ten or so of the 1,500 university lecturers/tutors.

## ***European flows to New Zealand***

Historically, New Zealand has been a country of immigration. After the Second World War, immigration schemes focused on bringing Europeans to fill demands for skilled workers; in 1974 this flow was interrupted as the government brought UK and Irish immigration criteria into line with all immigrants. For the last twenty years the supply from the UK has been on the decline.

The most common field of study for Pacific Peoples and Asians who had post-school qualifications was 'man-

agement and commerce'. In 2001, among the population with postsecondary education, the most common field of study for New Zealand persons of European descent was 'engineering and related technologies' and 'society and culture' studies.

According to a recent survey of 900 expatriates (mostly active in IT occupations), the focus of policy is on brain drain whereas attention should be focused on how to foster the return of skilled New Zealanders overseas.

## **Striking a New Path for Measurement of Internationally Mobile HRST**

Three surveys were developed. Each survey targeted a specific group of internationally mobile scientists and engineers (movers); each brought a unique methodological approach.

Two surveys were developed specifically to gather information on internationally mobile scientists and engineers. Consiglio Nazionale delle Ricerche (CNR) developed a survey to pose questions to foreign researchers working in public funded research institutes and was piloted in Italy. The Maastricht Economic Research Institute on Innovation and Technology (MERIT) developed a survey to pose questions to scientists and engineers known to be working (or had worked) abroad and was piloted through a professional organization (private non-profit).

A third survey was developed by the IKU Innovation Research Centre to take into account some of the unique challenges of countries in Eastern Europe soon to join the EU. The pilot was carried out in Hungary, a country where the inflow of foreign-born scientists and engineers is a relatively new phenomenon, as is the case in much of the CEE region. This survey collected data to examine the role of foreign direct investment in attracting foreign-born scientists and engineers and was carried out across a sample of small, medium and large sized companies.

### ***A pilot survey of foreign researchers in Italy***

Italy is a country where high tech products account for only 6% of GDP (2000); public research spending far outweighs the private sector. Italy has a lower than average ratio of R&D workers in the labour force compared with other EU countries. Italy has no specific legislation in place to attract foreign workers.

The CNR questionnaire targeted public funded research institutes in Italy. It consisted of three sections: demographic data; work activity information (e.g. employment conditions in Italy and home country); and, questions to uncover 'push' and 'pull' factors of international migration of research scientists and engineers. It also provided for the respondents to make general observations about their stay abroad.

A total of 459 research institutes were contacted and more than one quarter of them had foreign researchers on board. The majority of responses came from institutes that accounted for some 80% of public research activity.

**Age is a factor of length of stay:** 44% of persons under the age of 30 planned to stay for one year or less and 36% for one to three years. Almost all of the foreign researchers under the age of 30 regarded their stay in Italy as temporary whereas the older the age group, the greater the percentage of foreign

researchers told of intentions to stay in Italy for a long period.

**Women tend to stay in Italy less than men:** 48% planned to remain for only one year compared with 32% of the men.

The majority of scholarship researchers told of plans to stay in Italy for one

year, or at most 2-3 years, the typical length of a fellowship or scholarship; most visiting professors planned for a one-year stay (typical of sabbatical term). Among those with contracts of employment, more than one quarter said they would be in Italy for ten years and more. **The provision of a suitable contract of employment in Italy is an effective means of securing long-term presence of foreign scientists and engineers.**

**Scientific discipline** was a factor of length of stay: a higher proportion of long term stays (five years and more) was reported by persons in physics and biology compared with chemistry. Among those in chemistry, almost all of the researchers (94%) expected to remain in Italy no more than four years and no one more than ten years; among the biologists, 15% anticipated a stay of more than ten years as did 13% of the physicists.

**A desire to institute contacts** was reported as an important motivation for relocating by more than half of the respondents. A significant share also told of ambition to specialize in a field not sufficiently developed at home. Greater freedom in work life and social life was also important for more than half of the respondents.

**Economic conditions** in Italy (e.g. salary) were well down on the 'push' scale of priorities and few cited difficulties in finding work adequate to their qualifications at home as a reason to go to Italy.

Many foreign researchers chose Italy because of the **opportunities for study and the scientific and training reputation of the institute(s)**; many felt Italy was at the forefront of research in his/her field. These are clear 'pull' factors for Italy.

**Availability of scientific equipment** was identified as an important 'pull' factor.

In general, the possibility of obtaining a more stable post of employment was not a significant 'pull' factor. The existence of bilateral agreements between Italy and the researcher's home country had little influence on the decision to work in Italy.

Beyond professional factors, a sense of **cultural affinity** was identified as a 'pull' factor of some importance.

**Foreign researchers tended to hear of their opportunity in Italy by one of two ways:** an invitation from the institute or through information received by colleagues and friends. Job notices published in professional journals were also cited. EU-born researchers cited the Internet and transfer programmes, both of which were cited significantly less by non-EU born foreign researchers; the latter group showed a tendency to discover the opportunity in journals and more so than their EU-born colleagues.

**Many respondents told of 'paperwork' barriers encountered in obtaining work permits and papers.** This was particularly the case for non-EU born researchers.

**Housing availability and costs** was identified as a problem by two thirds of the respondents; for workers from the EU it was the most frequently cited difficulty.

Half of the respondents reported they had **no problems with language barriers**; this may be partially explained by the use of English in the international scientific community.

**Reasons for returning home vary by duration of time spent** in Italy. Typically, those with a short-term stay have a predetermined length of visit and so

the accomplishment of a predefined scientific goal is a major factor.

For those in Italy over a medium to long-term stay, **employment opportunities arising in the home country were cited as important.** Among those who had no plans to return their home country, more than half had a desire to remain in Italy while others planned to move to a country offering higher salaries.

**Two thirds of the respondents felt their stay in Italy was advantageous for their home country,** regardless of country of origin; the share of those

who believe this decreases as the length of stay in Italy increases.

The foreign researchers were probed about the issue of brain drain: **69% said brain drain was a problem in their home country.** Responses from British, French and Dutch researchers were divided between those who believe factors relating to work and economics in the home country prompt researchers to go to the US and those who believe extensive international mobility is necessary for science; only the Germans believed their national research system was so good as to prevent brain drain.

### ***A pilot e-survey of internationally mobile scientists and engineers***

The MERIT survey was conducted through an intermediary organization, the American Association for the Advancement of Science (AAAS), a professional association of scientists and engineers first established by Benjamin Franklin. Members were invited to complete the survey if he/she was working in a country other than his/her country of birth or if he/she had worked outside of his/her country of birth previously. This was designed to provide information about EU-born working abroad as well as non-EU-born that were working (or had worked) in Europe. Although the EU-born scientists and engineers of the AAAS membership may not be typical of mobile EU-born scientists and engineers, this presented an opportunity to pilot a questionnaire among highly skilled scientists and engineers with international experience. At the same time, there was an opportunity to explore other dimensions of international mobility such as differences between EU and US countries and cultures. There were more than 1,100 eligible respondents: one third EU-born, more than one third in the US and slightly fewer than one in ten in CEEC; there was also significant representation of women (one in five).

Some key findings include:

**A stereotype of women choosing between a family and a career may still exist:** a higher share of women than men is single; fewer of the women have children compared with men (although this can be partly explained for the under age 50 cohort, there is no such explanation for those over 50); the findings were similar for EU-born

and US-born, whether they were working abroad or at home.

The PhD of the EU-born is more likely to be taken abroad than the Bachelor or Master's degree: 36% of the EU-born earned their PhD outside of the EU, but only 20% or so earned their Bachelor or Master's degree outside of the EU.

At the time of the survey, 70% of the EU-born were working outside of their home country (81% in the US, 10% in the EU and 10% in other); about half of the movers were working in the education sector.

EU-born persons who only worked outside of the EU are much more likely to be working in the EU compared with those who only studied outside the EU; this is also true for the US-born although the effect is less compared with the EU-born (one explanation may be that as students, persons are learning to adapt to the host country). **The results suggest that studying abroad increases the risk of EU-born remaining abroad** much more than for those who only work abroad.

In the under 50-age cohort, **men earned significantly more than women**; in the over 50 age cohort there is no significant difference. There is **no significant difference in income of EU-born and US-born working abroad, but large observable differences among those working at home**, with the US-born earning significantly more than the EU-born. Europeans working abroad earn significantly more than those working at home (this could be partially explained by factors of quality and sector of work such as IT but not when all disciplines are examined).

**One in three EU-born at home planned to move abroad**; only **one in ten of the EU-born HRST planned to return home**. EU-born are far less likely to return home compared with the US-born: 13% of the EU-born compared with 52% of the US-born planned to return home. At the same time, EU-born are more likely to plan to move abroad than US-born (33% versus 18%). Given that nine in ten of the EU-born scientists and engineers working abroad were in the US; the 'pull' of the US as a place to live and

work seems stronger than the 'pull' of the EU.

**Having children does not appear to increase the desire of the EU-born to stay home or return home**: 59% of the EU-born respondents with children and working abroad had no plans to return to the EU; 36% of the EU-born with children and working in the EU had plans to go abroad.

Although intentions to move decline with age, the results suggest **the effect of age on discouraging plans to leave the EU is not as strong as might be expected**: among those aged 55-64, 38% reported no plans to go abroad and 31% responded with yes to plans to go abroad.

**Neither of the two leading factors identified by EU-born with plans to stay in the EU have anything to do with quality of work or access to R&D and leading technologies** — family responsibilities and better living conditions in the EU were identified as most important factors among EU-born with no plans to leave the EU. Although the US-born in the US also cite family responsibilities, a higher share consider work factors such as career advancement, access to leading edge technologies and R&D funding as important factors.

**The most important reasons cited for keeping EU-born scientists and engineers abroad relate to work quality**: better career advancement opportunities, broader scope of activities; better access to R&D funding; broader job opportunities and access to leading edge technologies.

**The most important factors cited for EU-born planning to move from their home country** are broader scope of activities, better access to leading edge technologies, career advancement opportunities and better access to R&D funding.

**Salary is an important consideration, but most often it was not identified as the key or deciding factor in the decision to go abroad.** Better earnings and wages were cited as very important by 31% of EU-born working abroad as a factor in their decision to not return and by 26% of those working at home as a factor in their decision to go abroad

For the EU-born movers, **the most cited reason for returning was family responsibilities** followed by living conditions and for the US-born returning home it was contract ending, broader scope in activities and better access to R&D funding.

EU-born movers cited **acquaintances as the most important source for finding work abroad** while **employer recruitment is the major source of finding employment back in EU.**

**The most common way of obtaining current employment was by respondent's own initiative.** That said, it is important to note the data indicate that post graduate positions are a key mechanism for Europeans finding employment abroad while exchange programmes and national research centers are frequently cited as the mechanism to return to Europe.

The importance of **communication, leadership and language skills are cited more frequently than computer skills.** Men cite higher rates than women but the order of ranking is the same (e.g. 80% of men rank communication skills as important compared with 72% of the women).

**Women were more likely than men to give a higher level of importance to the existence of a specific job before moving abroad.**

**There was little difference among men and women when asked about satisfaction with work abroad.** Factors assessed included practical work/research experience, theoretical work/research experience, R&D resources, acquisition of new skills and knowledge, expansion of network, career advancement and earnings.

In the past, a lower percentage of men than women reported problems such as lack of information provided prior to move, problems in acquiring visa; language, cost/availability of house; and, social system in the foreign country. Today, a larger share of men report problems with lack of information and language. This could suggest **women may have become more adaptable for international mobility over time than men.**

### ***A pilot survey on foreign direct investment and foreign-born scientists and engineers in Hungary***

Changes in political environments as well as improvements in economic and social conditions have begun to break down the barriers to highly skilled foreign-born HRST moving to CEE countries to work and teach. The survey was designed to examine the relationship between foreign direct investment (FDI) and the entry of highly skilled foreign-born scientists and engineers to the CEE countries. In particular, information was being sought on whether foreign investors bring in highly skilled people to Eastern Europe to upgrade the knowledge in a number of fields and does this mean the

economies are involved in brain circulation? The pilot survey was carried out in Hungary. Investigations as to the viability and practicality of conducting this survey in other CEE countries were also carried out as part of this feasibility study.

A register was prepared to identify potential employers of foreign-born scientists and engineers. Human resources managers identified respondents (or similar post depending on company size and hierarchy). Results were received from 39 companies that employed highly skilled immigrants in year 2000. The companies were made up of investors from major, medium and small economies; the most common foreign ownership was German, Austrian and French; the companies were active in the manufacture of chemicals, chemical products and rubber/plastics sector, manufacture of metal fabrications, manufacture of electrical and non-electrical machinery, construction and high-tech services. Among the almost 200 respondents, about one quarter were Romanian citizens and half bore EU citizenship; about one in ten were women.

Some key findings:

**Professional women seem less inclined to engage in intra-firm mobility than men.**

**Age is a factor:** 63% of the respondents were under the age of 40 and only 14% were above the age of 50. On average, the women were younger than the men: 73% of the women compared with 66% of the men were under the age of 40.

**The majority of the foreign scientists and engineers reported a university degree;** two thirds were in engineering and about half of them in ICT related fields such as electrical engineering and informatics. The share with an engineering degree was significant among those from advanced economies as well as former socialist countries. About one in ten of the respondents had a degree in social sciences (business/marketing/commerce) and most of them came from the EU.

**Highly skilled workers from advanced economies have stronger mobility tendencies than others.** Young west Europeans and Americans take up positions in Hungary as a stepping-stone in their career; more mature western scientists and engineers are given opportunities to work in Hungary as a pre-retirement experience or as a 'winding-down' position. It is the

persons from candidate and developing countries who are the more 'typical' immigrants — their move to Hungary might be a final destination for employment or a stopover on the way to gaining employment in more advanced countries.

**Highly skilled immigrants were employed in highly skilled positions and often assumed management responsibilities.** Forty three percent of the immigrants were in 'leader' positions even though most of those in production and functional managerial positions arrived without management experience; the other 57% were classified as professional and associates. Within the group of professional and associates, the largest contingent was engineers/architects followed by computer specialists. One third of those reported as senior officials and administrators were graduates from the faculties of social and behavioural sciences or law while others in management positions reported an engineering degree. The results suggest **a strong correspondence between field of the degree of the foreign scientist and engineer and his/her occupation.**

**Most of the immigrants were employed in sectors related to ICT (one third).** Hungary is turning to foreign sources for ICT skills and matches the contemporary 'immigrant' job pattern.

The ICT sector was the top employer of persons from advanced countries, former socialist countries and developing countries, although a higher share (58%) were sourced from the former socialist region and developing coun-

tries compared with advanced countries; this shows once again the former socialist countries competing on a world scale for scarce resources such as those driven by IT.

## Key Findings and Conclusions

Research on the development of measurement of international mobility of human resources in science and technology (HRST), collection of data and insight into the factors of international mobility remains one of the weakest areas of research in S&T statistics and indicator development. International mobility is critical to economic and societal growth clearly to ensure an adequate supply of highly skilled HRST for a nation's economic and social development in a global economy. Changes are underway.

A number of EU countries have taken a proactive role, from enacting legislation to facilitate foreign researcher entry to streamlining administrative burdens for intra-company transfers. For example,

- The UK permit system has responded successfully to bring in health and medical services workers. The UK continues to be active in encouraging 'brain worker' exchange as barriers for foreign scientists and engineers continue to fall and UK researchers continue to venture out, with a net gain for the UK in the end.
- The Irish government is providing fast tracking of skilled workers in designated sectors (a 5-year programme to attract IT and biotech persons to Ireland); it has reduced the administrative burden of intra-company transfers. It also has an initiative to attract Irish researchers home for tenure positions.
- Since the 1990s, Portugal has had a policy of advancing training of human resources and supports granting of scholarships to support postdoctoral research by foreigners in Portugal.
- Germany introduced 'green' cards to foster the recruitment of IT specialists; Denmark introduced fast tracking of IT skilled persons as part of 'job-card' initiative in July 2002.
- Between 1991 and 2000, Hungary eased the entry of higher educated foreign citizens by exempting them from regular work permission procedures (this ended in January 2000).

At the same time, there are countries that still have restrictions and challenges. For example,

- The Netherlands and Belgium continue with restrictive employment policy, although there are special considerations for highly skilled workers that are in demand (e.g. IT). Procedures for R&D workers and IT specialists are accelerated. although it does allow for a large share of permits going to highly skilled workers. As well, while all must meet the same conditions, the procedure for R&D workers has been accelerated. IT specialists have also been fast tracked.

- France seems unable to attract highly skilled persons anywhere the near the success of countries like the UK or the US and a recent a study carried out for the French Senate tells of a “discouraging landscape of administrative convolution, heavy taxes and inflexible labour legislation.” Some might observe that overall, Europe has yet to successfully market the ERA as a challenging venue to attract the brightest and best from outside of its borders.
- Yet others like Spain and Italy are producing highly skilled personnel that leave to pursue research abroad because of lack of research opportunities at home and more generally, a mismatch of supply and demand.
- The US, Canada and Australia continue to draw talent from the ERA environs. Moreover, not only are experienced researchers going overseas but also the incidence of doctorate graduates students choosing to stay abroad is high. We have the example of the US data that tells of at least 11,000 EU-born US doctorate recipients who graduated between 1991 and 2000 had no specific plans to return to the EU and the tendency to stay in the US is on the rise. All three of these countries have made tremendous advances in taking down barriers for high skill demand occupations.

The most exciting opportunity this study presented was the chance to move the measurement of internationally mobile HRST forward. The developmental surveys have proved to be key tools to uncover some of the clear messages from internationally mobile highly skilled people in Europe and those persons from Europe located around the world. At this point, it is important to remind the reader that although both the CNR and MERIT surveys of internationally mobile scientists and engineers set out to gather information on socio-economic characteristics and factors influencing the move(s) — push and pull factors, the sample sets were quite different: CNR targeted foreign researchers in public research institutes in Italy and the MERIT survey targeted known international ‘movers’ regardless of location and occupation (e.g. not limited to research pursuits). Yet the ‘push’ and ‘pull’ factors that were identified were quite similar. At the same time, IKU conducted a survey through firms who had foreign researchers on staff with the intention of exploring the relationship of foreign direct investment and foreign researchers and even from this source similar messages came through, such as the under representation of women on the international research circuit.

What are some of the messages that came out loud and clear?

- Women are underrepresented in international mobility and tend to take a lesser advantage of the international circuit from number of opportunities taken to duration of stay. They are less engaged in international mobility. This then suggests additional pressure on policy to bring women into science and engineering.
- Push and pull factors are diverse and varied among disciplines of science and engineering, among countries and between men and women. Yet, there are some clear and consistent messages:
  - Salary is of course an important consideration, but most often economic factors were not the decisive factor in the decision making process.
  - Paperwork barriers in Europe continue to be problematic for foreign researchers and their employers; they are problematic for mobile scien-

tists and engineers within Europe and especially for foreign scientists and engineers coming to Europe.

- Availability of scientific equipment and access to technology are high on the ‘attractiveness’ scale and brought foreign researchers to Italy and sent EU-born to the US.
- Networking and informal information sources are key sources of information for persons finding working abroad. ‘Informal marketing’ of Europe may have far more impact on its ability to draw foreign researchers than thought.

The surveys piloted in this study, albeit in a primitive stage of development, have proven to be viable instruments and need to be further developed. In some ways, the study confirmed what was known about empirical evidence of international mobility and brain drain/brain gain effects — very little comparable information exists. The strategic importance of highly skilled scientists and engineers will only increase, whether one considers the demographics of western economies or the constant appetite for mobile knowledge workers in a knowledge based economy.

At the international level, a number of activities are underway to development measurement tools and to produce the capabilities to measure international mobility of HRST. However, in the meantime, surveys such as the three pilot surveys carried out under this project could be fine tuned and carried out on targeted audiences to provide policy with short and medium term intelligence.

Finally, resources must be directed to measuring or assessing the impact of international mobility related policies. We could suggest, for example, adapting and adopting the surveys tested in this study to pose questions to foreign researchers as they arrive to take up their new position in Europe. This would not be additional burden for the researcher but a means of providing policy with feedback, and from our survey experience, we project a high response rate. What do we know about the success of the schemes in place? Without these measures of change, how can policy be used to improve the conditions to ensure Europe can successfully compete for highly skilled scientists and engineers at an international level?

Policy and decision makers find themselves in a particularly tenuous position of having to address critical areas of policy (e.g. international mobility issues crosscut immigration, labour, education, science and technology, tax policy) with little empirical evidence or research guidance. This study has not cleared the muddy HRST mobility measurement waters, but the research team would argue it has certainly moved measurement and understanding of HRST international mobility forward.