PART 8 — LOOKING AHEAD

1. Recent Developments in Measurement of International Mobility[1]

Migration of highly skilled labour has been one of the most characteristic features of global development for centuries. From the Renaissance onwards, the emigration of skilled labour from European countries to North America and other overseas territories was a major feature of the process of colonisation. The international transfer of knowledge – whether in the form of practical technical expertise or in the form of more tacit, brain knowledge – which accompanied such international migration patterns became a major factor behind international growth and development patterns. The foreign environment often provided new alternative, possibilities for initiative taking and entrepreneurship (Scoville, 1951), providing new dynamism to what had remained up to then relatively closed societies. At the same time, the opportunities for "green field" institutional and organisational experimentation brought about the creation of sometimes radically alternative, sometimes carefully imitated institutional set-ups of higher education systems; communities of craftsmen, engineers and scientists; the private and public organisation of research.

The potential growth advantages of "backwardness", emphasised in the early empirical growth literature by economic historians such as Gerschenkron and Abramowitz, and empirically highlighted later on by authors such as Cornwall and Maddison highlighted not only the contribution of the formal and informal international knowledge flows embodied in the import of capital goods, foreign direct investment or licences but also the particular contribution of the informal and formal technology transfer flows embodied in the international mobility of engineers, craftsmen and technicians and scientists. The two appeared often the essential complementary assets for successful catching-up growth strategies.

As trade theory would predict, throughout medieval history the existence of trade barriers had been a major factor behind the international transfer of technology through the international mobility of skilled labour from craftsmen to technicians and inventors. Thus, most of continental Europe's early industrialisation pattern which coincided with the Napoleonic blockade became heavily dependent whether in sectors such as textiles, iron ore or steel resulted from the international mobility (sometimes theft see e.g. the statue in Ghent for Lieven Bauwens for the "transfer" of spinning wheel technology having laid the basis for the Flemish textile industry) of entrepreneurs, craftsmen and inventors from Britain to continental Europe. In fact, the 15th Century patent system had its origin in the need for the national "local" protection of the technological knowledge of internationally mobile craftsmen and inventors (David). In short, the international mobility of highly skilled labour has been a major and intrinsic feature of economic development and the international spread of knowledge for centuries.

One of the main reasons for the decline in interest in the phenomenon of the international migration of highly skilled labour, and of scientists and engineers in particular, as reflected for example, in the first attempts by UNESCO and the OECD in the 1960s at defining "Research and Development" and its main investment compositions (see in particular the Frascati manual), is undoubtedly related to the vision that with the further opening up of world-wide trade and investment, the international transfer of technology and knowledge would be first and foremost embodied in traded goods, foreign direct investment and the

[1] This report was prepared by Hansen W. and Soete L., MERIT, for the project *The Brain Drain — Emigration of Qualified Scientists.*

formal associated payments for licences, trademarks and copyrights. Such a vision benefited of course from the availability at central banks and/or other government agencies of readily available statistics on formal technology payments and receipts. Gradually the role and importance of international mobility of human resources in science and technology (HRST) became an under-researched field with major lacunae with respect to the underlying statistical evidence on the phenomenon.

The late 1980s saw a shift towards broadening S&T indicators to include, in a more systematic way, output indicators (as in the case of the OECD's Oslo manual) and this further exacerbated the weak situation of measurement of HRST. The focus of research shifted further to the problems involved in the measurement of the output side of research. Only over the last decade did a shift occur with the OECD Canberra Manual (1995) attempting to harmonise indicators on HRST and define HRST as individuals having successfully completed third level education in a S&T field (HRSTE) or employed in a S&T occupation (HRSTO). The manual represented a significant step forward in HRST measurement. That said, one should be reminded the manual was drafted with a view to revision of scope and content in the short term (e.g. once it had been tested in the field). This review and redrafting has yet to be carried out. At an OECD meeting in June 2002, questions about what to do about the Canberra manual were raised, and while there was no commitment to begin work on the manual in the short term, there was agreement reached on the need for the work to be done.

More generally, the coverage and quality of statistics on the deployment of HRST on the labour market can be said to have remained particularly poor. International harmonisation at the European Union level was only achieved in 2001 by EUROSTAT, and the level of disaggregation (e.g. by occupation and skills, school-to-work transition, career path information, etc.,) remains relatively limited. While the OECD has taken the lead in organising a workshop(s) on the international mobility of the highly skilled (e.g. Paris, June 2001, June 2002), statistical evidence on the international mobility of HRST remains an area that suffers dramatically from lack of data.

All this has been unfortunate as there is little doubt that major changes did occur with respect to the international migration of highly skilled labour, and in particular scientists and engineers over the last thirty to forty years. Such changes relate both to the aggregate migration flows of HRST with some countries having moved from a situation of predominantly emigrating countries to predominantly immigrating countries, and to the origin of the immigrants and country of emigration of the migrants. Such changes appear also very different in Europe as compared to the United States and Canada. The United States and Canada have always been countries of immigration drawing both low and high skilled labour, including S&E personnel from around the world. While the growing emigration of Canadian-born S&E person flow to the US might resemble, at first blush, the case of Europe's drain to the US, Canada remains, contrary to most European countries, a country reliant upon immigration for HRST. In 2002, Canada admitted almost 28,000 foreigners in the economic category destined for jobs in the natural sciences, engineering and mathematics and more than 4,000 for occupations as technicians and technologists. In Europe with the process of economic integration, it has become important to distinguish more carefully external and internal European migration flows. The latter have undoubtedly been strongly affected by the economic integration and harmonisation process linked to the establishment of the Single Market (1992) and the Economic and Monetary Union (1999), the various enlargement processes from the EU6 in the 1970s to the current EU15 and the EU25 in 2004, and the change in economic regime in the East European communist countries and Russia. Finally, the new European policy emphasis on the need for a European Research Area dramatically accentuates the need for detailed information on both internal and external migration flows of HRST. It is important then to understand the movement within the European Research Area; it is essential to be informed about the drain from the European Research Area.

These needs, as the present study illustrates, transcend by far the traditional aggregate national human capital and education indicators as collected up to now by the OECD, EUROSTAT and the various national statistical agencies. As in other areas of social sciences research, there is now an increased demand for micro-based data providing detailed information on the individual international migration flows of scientists and engineers, the underlying motivation of the migrants, their gender and family conditions, their personal experience, the income and wage differentials between the home country and the country of immigration, the past and new working environment, and so on.

There is no argument the widespread availability of such harmonised survey data is an essential condition for analytical empirically based research that might better inform policy makers in a more rigorous and scientific way. In fact, there has been a significant development which deserves some elaboration.

Canada (Statistics Canada) and the US (The National Science Foundation (NSF)) have been working together to carry out a 'cross border' survey of earned doctorates. Modelled on the NSF survey of earned doctorates, the two agencies are working together to track doctorate graduates who cross the border between Canada and US to carry out post graduate work or take up employment. The example of international co-operation between Canada and the US can serve as a model for similar work to be carried out with EU member states. Statistics Canada has held preliminary discussions with CNR in Rome inviting them to consider participating in a pilot; this could see survey co-operation and information exchange stretch across the Atlantic.

That said, it is clear that for the short to medium terms, the new possibilities offered by timely and readily accessible surveys, as the 'pilot' e-survey illustrates, hint at the fact that this particular research area might today, and maybe paradoxically, benefit from the past backwardness and sluggishness of HRST statistics and information gathering at the international level. The current urgency felt at the policy making side for such data could indeed lead to truly leap frogging in the international collaboration in the development of harmonised e-surveys on HRST international mobility.

The experience and knowledge gained from the CNR pilot survey of foreign researchers in publicly funded research institutes in Italy, the MERIT e-survey questioning scientists and engineers with international mobility experience found around the world might provide the impetus for such a leap frogging. Although the extent to which we can draw general conclusions is limited by the scope and coverage of the pilot surveys, some clear indicators of factors of HRST international mobility and its measurement have already come to light. Below we remind the reader of some of the more important findings:

We learned —

- First and foremost, scientists and engineers are willing to share their experiences and inform on a range of variables and factors.

- The use of an intermediary provides key access to a target group, and enhances the potential of the survey (e.g. vested interest of the intermediary).
- The e-survey is amenable to a range of intermediaries (e.g. all publicly funded research institutes in the EU zone; private enterprise; universities, etc.).
- The e-survey is readily adaptable for short term ad hoc policy information demands.

From the responses, we learned —

- International mobility is typically motivated by a desire to engage in quality work with better access to R&D funding and access to leading technology; salary is but one consideration.
- Highly qualified scientists and engineers go abroad for better career advancement, broader scope of activities on the job.
- Family responsibilities and living conditions are both deterrents and drivers of international mobility.
- Post graduate positions are key for finding work abroad (e.g. in that country).
- A higher percentage of EU-born moving abroad were more satisfied with their experience than expected. This is particularly relevant when we consider this with the finding that acquaintances were important sources for EU persons finding work abroad.
- Past study and work experience has a bearing on future international mobility — there is a high 'risk' of EU-born persons staying in the US if they studied in the US compared with those who only worked outside of the EU.
- Financial incentive is a factor but it is stronger for the EU to go to the US than for the EU to attract foreign-born.

The results of the 'pilot' surveys support the notion of the viability of the ad hoc surveys of this nature to meet the short and medium term needs of policy demands. The information from this type of survey can, in the short and medium term, fill in the gaps as developmental work is underway at the national and international level such as the case with the survey of earned doctorates described earlier. In fact, it is not unreasonable to assume the role and contribution of this type of survey instrument will continue and take on a complimentary role for the national and international level surveys. The 'micro' survey such as tested at CNR and MERIT have a clear role to play in reaching targeted audiences and providing information in a short turn around time on types and factors of international mobility of highly qualified scientists and engineers.

At the same time, the experience and knowledge gained 'leap frogs' across the more formidable barriers the international surveys and statistical agencies must overcome, and can provide valuable feedback and useful insight to the longer term survey work.

2. Policy Implications for the European Union and Community Policies

The long history of the international migration of highly skilled labour, highlighted above, and its particular contribution to growth and development, raises first and foremost the question as to what is currently new with respect to the phenomenon of the international mobility of HRST, so as to raise so many policy concerns and international policy action. A second question relates then to the particular challenges the European Union might be confronted with and how Community Policies could address those.

2.1. International Migration of the Highly Skilled in the 21st Century

The renewed policy interest in the international migration of highly skilled labour runs practically in parallel with the renewed policy interest in knowledge activities and the emergence of a knowledge-based or knowledge-driven economy. And, just as in the case of the international mobility of highly skilled labour, knowledge is neither a new concept. Its importance for economic growth was at the core of economic thinking of the late 18th and 19th century, a period also characterised, as highlighted in the previous section, by the international migration of inventors and entrepreneurs.

Ultimately, what is new appears closely related to some familiar aspects of current knowledge creation and distribution:

- the internationalisation of codified knowledge linked to the emergence of ICTs and the Internet;
- the resulting increased phenomenon of global networking of scientific and technological communities; and,
- last but not least, the changing demographics and changing study incentives affecting directly the domestic outflow of potentially new HRST.

First, the economic and policy consensus over the last decade on the importance of knowledge for industrial competitiveness is without a doubt related to the emergence of the cluster of new information and communication technologies (ICTs). This resulted in a dramatic decline in the price of information processing; in a technological driven digital convergence between communication and computer technology; and last but not least a rapid growth in international electronic networking.

ICTs are of course and in the real sense of the word information technologies, the essence of which consists of the increased memorisation and storage, speed, manipulation and interpretation of data and information: in short, what has been characterised as the codification of information and knowledge. Combined with the communication technologies transformation, as reflected in the Internet, ICTs have made codified knowledge, data and information much more accessible, nationally and internationally to firms and individuals whether they are professional scientists, interested users or self-educated “amateurs”. Crucial, is that they are linked to information networks and have the knowledge to understand the scientific community language as expressed in the bits and pieces of codified knowledge. Contrary to what one might have concluded in first instance this codification process does not reduce the importance of the other parts of knowledge which have not become codified, generally referred to as “tacit” knowledge, call it brain knowledge. Rather the opposite, as more and more knowledge becomes codifiable, the availability, quality and networking of the “tacit knowledge” factor becomes an essential complementary asset.

It is in this sense that the possibilities to codify information and knowledge over both distance and time, has brought about more global access. ICTs, in other words, like in other economic areas, has indeed brought to the forefront the potential for catching-up, based this time upon codified knowledge transparency, while highlighting at the same time the importance of tacit, human capital knowledge in order to access, understand and participate in such global knowledge development. Ultimately, it is the crucial importance of this complementary brain knowledge in relation to world-wide available codified knowledge which has dramatically increased the demand and international competition for the most talented “brains” and highly skilled scientists and engineers. The paradox of the impact of ICTs on R&D is hence that while it makes the codified knowledge bits and pieces much more easily and readily accessible and has, as a consequence, led to intensified international networking in practically all scientific and technological communities, it has also led to a concentration of top quality research in the core nodes of such networks. The co-location of brain knowledge in such excellent-graded environments with outstanding funding, physical and networking facilities appears today an even more dominant attraction factor for top level research talent.

Second, and somewhat as a mirror point with respect to the previous point, many authors in the innovation literature (David and Foray, Cowan) have argued that the perception of the nature of innovation processes has also changed significantly over the last decade. Broadly speaking, innovation capability is today seen less in terms of the ability to discover new technological principles, but more in terms of the ability to exploit systematically the effects produced by new combinations and use of pieces in the existing stock of knowledge, sometimes referred to as 'innovation without research'. This new model implies to some extent more routine use of a technological base allowing innovation without the need for leaps in technology. This mode of knowledge generation — based on the recombination and reuse of known practices - raises of course more information-search problems[2] and is also more directly confronted with problems having to do with impediments to accessing the existing stock of information that are created by intellectual property right laws.

The science and technology system is in other words shifting towards a much more complex socially distributed structure of knowledge production activities, involving in particular a great diversity of organizations having an explicit goal of producing knowledge (learning entities). The old system was based on a simple dichotomy between deliberate learning and knowledge generation (R&D laboratories, private, public and in universities) and activities of production and consumption where the motivation for acting was not to acquire new knowledge but rather to produce or use effective outputs. The collapse (or partial collapse) of this dichotomy conducts to a proliferation of new places having the explicit goal of producing knowledge and undertaking deliberate research activities.

Underlying this trend, most of the rich Western societies have witnessed a proliferation of a more intensive use of human capital throughout all parts of their society, not just the high-tech or R&D sectors of the economy — one may think of services, the non profit sector, user communities, etc. It is in this sense that the knowledge economy relies ultimately on a more qualified and more highly skilled labour force. As a result, some of the traditional immigration countries such as the US, Canada or Australia have started to focus more explicitly in their migration policies on the immigration of highly skilled labour as a long term competitiveness strategy. In short, given the growing demand for highly skilled labour, international competition amongst developed countries appears to have broadened to include today also competition for highly skilled labour.

[2] Problems raised by the increasing costs induced by the functions of storing, retrieving, evaluating and using knowledge.

Third, on the supply side, most developed countries are today confronted with rapidly growing shortages of S&E personnel due to the general demographic trend of insufficient renewal of the domestic population and a declining interest in S&T and in research studies more generally. In the ageing countries such as Japan, Germany, France and Italy the increasing shortage of highly qualified researchers, particularly science and engineering, is becoming a worrying trend and likely to undermine, in the long term, the welfare and income levels of those countries. An ageing society does not profit to the same extent from the emerging knowledge-driven society; on the contrary it might in the long term not be able to keep up its levels of competitiveness. It remains remarkable how over the last decade, countries with the most dynamic population growth such as Ireland, Canada, the US and Australia have witnessed much higher growth rates than countries with ageing population structures such as Japan, Germany, Italy or France.

Ultimately, two factors appear to be of primordial importance in this discussion: on the one hand, the capacity of a country's own educational system to deliver, year upon year, new cohorts of highly-qualified, natural scientists and engineers, replacing the ageing cohorts of such personnel, and on the other hand, the attractiveness of the profession of researcher and the attractiveness of the surrounding environment – the quality of the local physical environment, facilities available, presence of other research labs, wages and salaries paid, etc.

On both accounts, many of the European countries appear no longer to deliver — the number of domestic students studying science and engineering have dropped significantly because such studies are generally considered too demanding in terms of hours of study; and, the profession of researcher appears increasingly insufficiently rewarding in terms of social reputation, future earnings, or research facilities.

2.2. European Policy Challenges

The policy response to the new challenges reviewed above, associated with the international mobility of highly skilled labour and HRST will either focus on the demand side or the supply side. Given the particular concerns in Europe about the ageing of its population, it is not surprising that the focus in Europe will be foremost on the supply side and possible policy measures to increase supply.

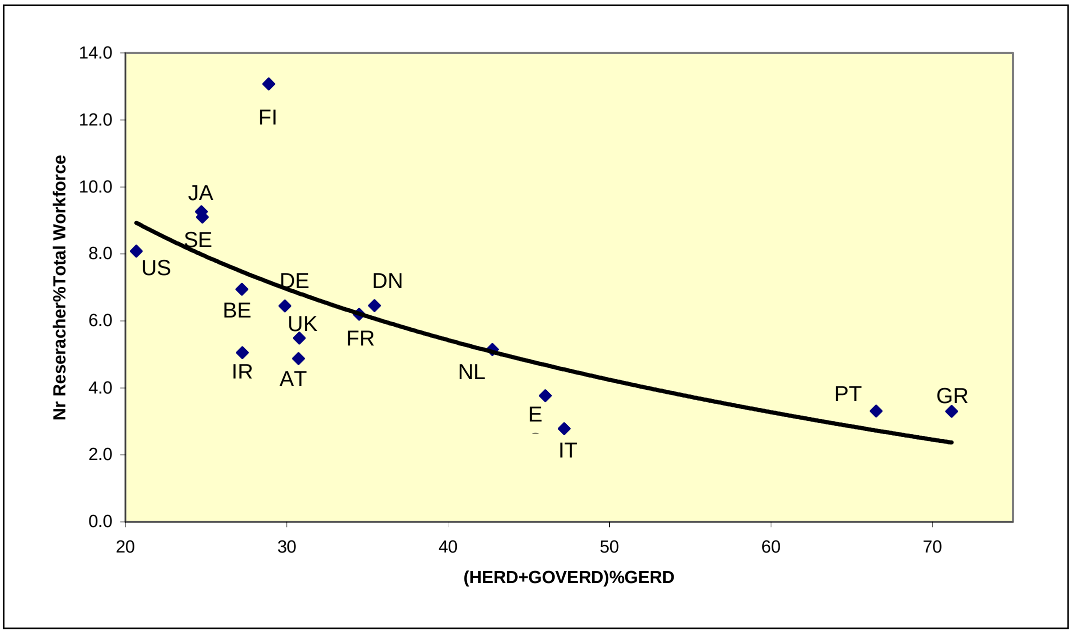
The likely shortage of highly qualified personnel over the next ten to fifteen years represents undoubtedly the biggest threat for Europe's long-term innovative strength and productivity growth. Ultimately, the decreasing domestic supply of scientists and engineers might well be at the very basis of a future decline rather than any rise of research expenditures in Europe. The availability of sufficiently qualified research personnel is indeed central to the European debate on the development of a "sustainable" knowledge economy. Without the availability of additional highly-qualified research personnel, the aim to double private research investment in eight years time (as put forward in the so-called Barcelona declaration), will merely lead to a tighter labour market, and to the "poaching" of personnel from universities and other public research centres or from other European countries. Looking at the current labour costs for R&D personnel, for example, realisation of the Barcelona objective would imply a need for an additional supply of researchers between now and 2010 of between 560,000 and 800,000 full-time equivalents. This should be added to the specific European problem of an ageing population, which also affects the knowledge sector. from the growing shortage of teachers in a large number of European countries to the rapid 'greying' of academic staff in practically all European countries.

When referring to the supply of scientists and engineers within a country, use is sometimes made of the ‘pipeline’ analogy, which illustrates how, from secondary education onwards, the flow of scientifically trained S&E finally seeps through to the various components of the R&D world. A number of factors will be important in the flow of sufficient S&E supply to, for example, the private R&D sector, despite a decreasing inflow following e.g. demographic factors at the beginning of the pipeline. Thus, there are countless obstacles preventing pupils, students, graduates, and PhD students, throughout each of the different education and training stages from continuing a research career trajectory. At first sight, these seem to be equally applicable to the US, the EU or Japan. Yet, here too, essential information is missing, certainly in an internationally comparable form.

In Europe so far, mainly the southern European countries have witnessed a large increase in the numbers of students as part of an internal European catching-up growth process and the relatively high unemployment rate among youngsters, which resulted in, among other things, a considerable expansion of the number of universities and polytechnics. Yet this appears before anything a temporary process, which, incidentally, has not led so far to a proportional increase in the demand from the private sector for highly qualified personnel in these countries. Figure 1 relates the research intensity of the various European countries, measured by the total number of researchers in the labour force, to the percentage of the total research efforts in the public sector, including higher education. Strikingly, the most research-intensive countries such as Finland and Sweden spend the lowest percentages of their total research expenditure on public R&D activities.

Conversely, the least research-intensive countries like Greece, Portugal and Spain spend the highest percentage on public R&D. In other words, the less R&D-intensive countries see, due to a lack of alternatives, their graduates flow off mainly to the public sector, especially the higher education sector, ***and*** to other countries.

Figure 1. Relation between research intensity and public R&D activities.



On the demand side, there is increasing recognition of the importance of the local clustering and local environment for innovation and the development of knowledge, as Michael Porter has emphasised at various occasions. Along with the further internationalisation of production, R&D investments became also, logically, subject to internationalisation. Initially, this was limited to R&D activities strongly linked to the maintenance and adjustment of production processes and product technology to the foreign market conditions. This was, however, further reinforced by the shift that took place in most large firms in the 1980s in the organisation of R&D activities, from autonomous laboratories directly under the responsibility of the Board of Directors to more decentralised R&D activities integrated and part of business units.

In a second phase, firms started to make more effective use of the presence abroad of possibly, relevant knowledge centres. This process of internationalisation in R&D is still going on. Not only production is internationalised, firms increasingly "shop" on the world market for knowledge and chose the best ***locations*** to perform their R&D activities. In doing so, they not only hope to make their own, in-house R&D more efficient, but also look to the efficiency, quality, and dynamics of the external, local knowledge institutions, such as public R&D institutions and universities, hence contributing to the internal knowledge dynamics and growth of the regional growth cluster. More recently, authors like Richard Florida have stressed the crucial importance of local "attraction" factors for the realisation of such local centres of what he called creative activity, which no longer limit themselves to purely technological or scientific factors but include now innovation in all its creative forms and shapes. Hence, the "creative index" developed by Florida (*The rise of the creative class*, 2002) for various American cities comprises not only technological indicators such as research personnel and patents, but also more socially and culturally oriented diversity indicators such as the "gay index". Despite the fact that the local supply of S&E remains undeniably a determinant for the localisation of private research activities as is obvious from the location of private R&D labs near universities and colleges of higher education/polytechnics, the demand for knowledge is also increasingly influenced by physical, social and local, cultural factors that will in fact operate as pools of attraction in exerting a pull on highly educated people, in Florida's words: "the creative class" . In this sense, the tendency to regionally cluster knowledge centres observed both inside the US and Europe is a logical consequence of the agglomeration effects of knowledge and its appeal to researchers and entrepreneurs. The development of a European Research Area will provide room from this perspective for further knowledge clustering with a rise within Europe of labour mobility of highly skilled people. As a side effect though, the European ideals of "social cohesion" are likely to come under increasing pressure[3].

This clustering based on knowledge "attraction poles" has become one of the major factors behind the rapidly growing demand for foreign-born researchers and highly qualified labour. According to the most recent figures of the NSF, around 450,000 researchers employed in American research institutions are of foreign origin, which is about 16% of the total. In American academic institutions, this figure was 80,000, 36% of European origin.

In this view, the concept of a European Research Area (ERA) should ultimately lead to the establishment of more specialised and internationally competitive knowledge attraction poles,

[3] See for example David, P. "ERA visions and Economic realities: A cautionary approach to the restructuring of Europe's research system", EC STRATA Workshop "New challenges and new responses for S&T policies in Europe", Brussels, 22-23 April 2002, mimeo, for a detailed analysis of the possible, undesirable, regional effects of the ERA as a result of mobility effects.

in short to “peaks” in the European knowledge landscape, attracting Europe’s most qualified researchers. At the same time, the question must be raised how a “European” research *area* could possibly be physically delineated. As knowledge is internationalising and international communities are mushrooming, it is Europe’s publicly oriented knowledge in particular which should become more open and developed in interaction with other countries, also outside of Europe. In other words, for the majority of scientists the relevant public research area is the international research area, not necessarily the European. The *cocooning* of knowledge inside a country’s physical borders, national or European, might even lead to undesirable ‘diversion’ effects of knowledge: researchers will prefer to network with European colleagues for the sake of European financial support. While this might have a positive impact on the reinforcement of the European research potential, it may indeed have long-term, negative effects for the maintenance within national borders of top research.

2.3. Recommendations

- The European Research Area must become a research area with peaks and valleys, allowing the demand for excellent research to express itself and compete with the best of the world. **The European Research Area should henceforth be an area without physical borders: it should be open up to the rest of the world**.
- The policy focus in Europe with respect to the international mobility of HRST has so far focused insufficiently on the demand side. The oversupply of S&E in many of the Southern EU countries e.g. has not attracted any private R&D, the result has been employment in the public sector or emigration. **Appropriate HRST policies should focus on improving the conditions for the private sector to employ HRST.**
- Internal migration of HRST within Europe offers many opportunities for a better matching of current oversupply and shortage of HRST. This includes not just Southern Europe but also the CEEC. **Mobility schemes need to be accompanied by more appropriate tax/subsidy regimes to provide on the one hand better private incentives for mobility and on the other hand incentive schemes for emigrating and immigrating countries.**
- The international migration of highly skilled researchers raises some fundamental issues with respect to existing differences amongst national higher education systems in private versus public funding. When privately funded, international migration represent ultimately nothing else but the search (and individual human right) for better employment and career opportunities; when publicly funded, international migration represents effectively a foreign subsidy to the immigrant’s host country. Continuously increased international migration of HRST is hence likely to lead ultimately to a **harmonization of higher education systems in the direction of private funding**.
- On the supply side, **making research as a profession more attractive** is probably the most important factor in increasing the supply of European HRST. Ultimately, increased wages, tax incentives, social security facilities in Europe will have some influence on the increase of the attractiveness of the research profession.
- Differences between countries in Europe with respect to supply and demand shortages and mismatches are rather striking. In fact, if these imbalances at the EU member level persist and do not lead to internal flows to assuage strong demands and supply

shortages and mismatches of supply and demand (e.g. the Scandinavian countries such as Finland with strong demand for highly skilled scientists and engineers in their economies, and also Germany and Benelux for demographic reasons; countries with strong supply and low demand such as Southern countries such as Spain and the CEEC (until recently); negative equilibrium such as Italy with supply shortages and demand shortages); the Netherlands with declining private R&D efforts, etc), the EU may find itself on a downward spiral with all the negative growth and competitiveness implications one may expect, not unlike what happened in Eastern Europe with the collapse of communist regimes. **More research on supply and demand in Europe is needed.** This research could be carried out through a form of a 'stylised' country taxonomies for the EU and expanded to other European countries.

- Information on international flows and the factors which 'push' and 'pull' highly skilled scientists is in short supply. The opportunity offered by the Canadians and the Americans to extend a survey of graduate doctorates to Europe to provide information on the exchange of highly skilled scientists and engineers between these regions is an important and timely development. We recommend **DG Research support the survey development under way with Statistics Canada and the NSF, at the least as facilitator and also consider a more significant role of participant.**
- There is a need for timely information on international mobility on scientists and engineers. The pilot surveys suggest they can be used to collect needed 'micro' data and meet short to medium term information demands. **We recommend the e-survey be considered as a viable instrument to collect this information for short and medium term information needs**.
  - The role of the intermediary is an important one. It allows a survey to reach a targeted audience. It enhances the potential scope, coverage and quality of the results, given the vested interests of the intermediary. **We recommend the e-survey be conducted using an intermediary(s) organisation.**
  - The private sector is an important stakeholder on international mobility of HRST. The availability and mobility of HRST is a priority of policy planning and decision makers of private non-profit and profit organisations (e.g. our pilot intermediary AAAS; exploratory discussions with industry suggest strong support for service-in-kind arrangements). **We recommend an e-survey on international mobility should be carried out with stakeholders in the private sector**.