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Innovative People

MOBILITY OF SKILLED PERSONNEL IN NATIONAL INNOVATION SYSTEMS

OECD

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FOREWORD

Innovation through the creation, diffusion and use of knowledge has become a key driver of economic growth and provides part of the response to many new societal challenges. However, the determinants of innovation performance have changed in a globalising knowledge-based economy, partly as a result of recent developments in information and communication technologies. Innovation results from increasingly complex interactions at the local, national and world levels among individuals, firms and other knowledge institutions. Governments exert a strong influence on the innovation process through the financing and steering of public organisations that are directly involved in knowledge generation and diffusion (universities, public labs), and through the provision of financial and regulatory incentives. They need a sound conceptual framework and an empirical basis to assess whether and how the contribution of public policy to national innovation performance could be improved.

Through a decade of academic research and policy analysis, the national innovation systems (NIS) approach has been developed to provide such a framework and quantitative information. The OECD Committee for Scientific and Technological Policy (CSTP), and its Working Party on Technology and Innovation Policy (TIP), has contributed to this development through its NIS project, conducted in two phases.

The first phase of the NIS project involved country case studies, the development of internationally comparable indicators and thematic analytical work by six focus groups, including one on clusters. Its main results are reported in *Managing National Innovation Systems* (OECD, 1999). This work provided new evidence on the systemic nature of innovation, articulated a new rationale for technology policy and identified broad directions for the improvement of national policies.

The second and last phase of the NIS project was devoted to deepening the analysis on three themes: clusters; innovative firms and networks; and human resource mobility. The work on human resource mobility has been led by Norway. Experts from 13 OECD countries provided inputs and interacted in three workshops. The project has been co-ordinated by Anders Ekeland, of the STEP Group, Norway, in close collaboration with Svend Remoe of the OECD Secretariat.

This publication confirms the importance of human resource mobility, among and between the private and public sectors, as a carrier for the diffusion of tacit knowledge, at both national and global levels. Based on new empirical evidence, it compares the rates and patterns of mobility of high-skilled labour in a sample of OECD countries, and documents the rapid internationalisation of this form of knowledge flows. It provides guidance for the improvement of a still-fragile statistical basis given the need for further comparative analysis and policy assessment of this increasingly important factor of innovation performance. The report is published on the responsibility of the Secretary-General of the OECD.

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Chapter 1

HUMAN RESOURCES, MOBILITY AND THE SYSTEMS APPROACH TO INNOVATION

by

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Introduction

The papers collected in this volume are part of the OECD National Innovation Systems project, which seeks to explore the possibilities for the quantification of systems approaches to innovation. Systems approaches see innovation as a complex collective phenomenon, characterised by interactions between economic agents in the shaping context of infrastructures and institutions. One persistent area of interest in systems approaches has been the institutions and organisations responsible for education at all levels: it has been strongly argued that the interactions between these institutions and industry, in both their educational and knowledge creation functions, have been fundamental in shaping innovation capabilities and economic performance (see David and Foray, 1995, for an influential statement). The chapters in this volume certainly do not treat all of the research and educational issues that are of interest within the systems approach, although they are focused on a key building block for any system-based or economy-wide attempt to analyse education, skills and attainments. This building block is the indicator and analysis issues that arise in seeking to map the structure of human resources, and the mobility of capabilities via labour markets and other forms of personnel exchange.

Education, innovation and development

Why should we focus on education and mobility in the context of innovation and development? About 20 years ago, Richard Easterlin presented perhaps the most systematic argument on the links between basic education and economic growth. In defining and thinking about the nature of economic growth, Easterlin went well beyond the idea that growth is simply an extension or intensification of production, and followed Landes in viewing it in terms of the creation and use of knowledge:

> "The heart of the whole process of industrialisation and economic development is intellectual: it consists in the acquisition and application of a corpus of knowledge concerning technique, that is, ways of doing things." (Landes, 1980, p. 111, cited in Easterlin, 1981, p. 2)

Beyond seeing technology and knowledge as determinants of growth, Easterlin saw knowledge creation as itself requiring explanation, and went on to make a strong causal argument to the effect that education (and particularly mass basic education) was a necessary condition for development.

This emphasis on human capabilities has been followed and developed in modern research on innovation. Basic to all innovation analysis is the idea that innovation and the development of new technologies occur through the activities of skilled personnel: researchers, engineers and managers. Innovation is a social process, involving not only new techniques (such as new items of equipment), but also new forms of knowledge, skills and competences. Competence is embodied in the collective experience and activities of the people who produce and implement a new technology; it relates not only to research results, but also to matters of organisation, problem-solving, marketing, and so on.

However, new technologies do not have their main economic effects solely through the innovation process – that is, through the commercialisation of a new technology – but rather through the diffusion, or spread, of the technology. This aspect of the economics of technology has often been neglected in technology policy, which has concentrated on technology supply rather than technology use. It is nevertheless of extreme importance in translating new technologies into economic outcomes. Just as innovation is a social process, so is diffusion: it relies on channels of communication, through which knowledge, skills and competences can spread. One of the most important of these channels is the physical movement of skilled personnel.

In their very influential study of flows of technological knowledge, Levin *et al.* (1987) examined a range of potential channels of information flow: licences, patent disclosures, reverse engineering, and so on. Movement of personnel – specifically, the hiring of R&D employees away from innovating firms – was a key element, and was closely linked with other forms of information flow involving inter-personal communication (technical meetings, informal conversations, etc.).

Mobility and the spread of industrialisation: historical perspectives

The role of personnel mobility is, in fact, widely emphasised within the historical literature on the spread of industrialisation. In particular, the distinction between tacit and codified knowledge, which has played a central role in modern innovation studies, has long been familiar to historians.

Although there is continuing debate about the precise role of scientific understanding in the Industrial Revolution, there is broad agreement that early industrial technologies depended heavily on human skills, particularly the skills of operators. This was most clearly the case with such technologies as iron-making or early chemicals production, where the timing of production processes was a critical element. It was also the case with mechanical technologies such as cotton spinning, where the construction and operation of machinery was the principal problem. The operative skills required were a persistent obstacle to the acquisition of industrial technology.

A good example of this is the early United States. David Jeremy (1981) has pointed to several cases where America quickly acquired British machinery in the early 1780s (even though the export of such machinery was illegal), but was unable to operate it. In Philadeplphia (at that time the US capital), a complete spinning machine was acquired in 1783, but after four years no-one had been able to erect it, let alone operate it. Three other textile machines were successfully acquired and erected in New England in the late 1780s, but they too could not be operated (Jeremy, 1981, p. 76). This problem of human skills was understood at the highest levels of the new American Government, and the Secretary of the Treasury, Alexander Hamilton, and his assistant, Tench Coxe, organised a range of activities aimed at bringing British workers and engineers to America. Jeremy showed that:

> "At least five recruiters of skilled labour working for American projects were active in England in the late 1780s and early 1790s. Most effective was Thomas Digges ... over a twelve months period in 1791-1792, he claimed to have sent to America eighteen or twenty artisans and machine makers. ... the barriers to Arkwright-technology transfer between Britain and America were largely overcome by the activities of recruitung agents, the readiness of workers to ignore the law in pursuit of better prospects in America, and the fact that the new technologies were embodied in the artisan." (Landes, 1980, p. 111, cited in Easterlin, 1981, pp. 78-82)

Jeremy studied the spread of four major technologies to America, namely cotton spinning, powered cotton weaving, textile printing and woollen technologies. His primary conclusion following these studies was that "most obviously, the artisan emerges as the pre-eminent technology carrier in this period" (Landes, 1980, p. 111, cited in Easterlin, 1981, p. 254), and the primary source of such artisans was Britain.

Similar themes have been widely echoed in studies of European industrialisation. Peter Mathias explored the diffusion of technologies from Britain to continental Europe from the early 18th century, and showed that the movement of workers was central to the diffusion of the techniques of early industrial processes. Bruland (1989) showed that British textile machinery firms organised skilled labour supply for their customers in Western Europe, and that this involved considerable geographical mobility by skilled British workers. More recently, Harris (1998) showed that a considerable amount of technological diffusion in the 19th century occurred as a result of what would now be called industrial espionage, and that personnel mobility was a core component of such diffusion.

There is no reason to think that these processes have diminished in importance. It is widely agreed that a key role of American universities has been to act as gatekeepers for the selection and encouragement of high-skilled immigration, and that such immigration has been central to company creation and the overall dynamics of such regions as Silicon Valley. There is therefore no reason to disagree with William Parker's (1971) remark that "...apart from some striking cases of imitation, the diffusion of technology in the modern world has been largely limited by techniques not unfamiliar to St Paul or Mohammed: the movement of persons and the transmittal of written documents" (Parker, 1971, p. 137).

Some contemporary issues

The long-standing issues concerning education, human resources and mobility are related to fundamental policy problems facing us today. The relevant policy arenas include labour market policy, educational resources and methods of provision, research policy, and policies towards immigration and international mobility. The real issue is that of how we should approach the analysis of problems in these arenas.

A long-standing approach to human resources has been the human capital theory pioneered by Gary Becker. Here, "human capital" refers to the person-embodied knowledge, skills and capabilities of people. The term "capital" is relevant because the theory views the development of such knowledge and skills as an investment process which produces both individual benefits (in the shape of higher incomes) and economic outcomes (in the form of higher productivity). The investment model is followed rather rigorously, and the demand for education is seen in terms of a return-on-investment approach in which the costs of education are related to the marginal benefits in terms of enhanced incomes. This is, of course, an approach reflecting the methodological individualism of neo-classical theory, and it lends itself to various forms of econometric testing of, for example, rates of return to educational investment.

The systems approaches that underlie the studies collected here take an altogether different perspective. They go beyond the level of the individual facing an education decision, into the operation of the system of institutions and organisations that together comprise the knowledge creation and distribution process. Here, the primary issues include the wider significance of education in terms of broader economic and technological trends. For example, Abramovitz and David argue that:

> "Perhaps the single most salient characteristic of recent economic growth has been the secularly rising reliance on codified knowledge as a basis for the organisation and conduct of economic activities, including among the latter the purposive extension of the economically relevant knowledge base. While tacit knowledge continues to play a critical role…codification has been both the motive force and the favoured form taken by the expansion of the knowledge base. Although this particular trend can be traced far into the past, only within our own century has it progressed to the stage of fundamentally altering the form and structure of economic growth." (Abramovitz and David, 1996, p. 35)

These kinds of claims involve ideas that go well beyond the individual level of the human capital literature. As with other ideas within the systems approaches, the arguments of Abramovitz and David involve links between educational attainment, mobility and diffusion, and the nature of technological change. In this, the various forms of systems approaches have probably been guilty of generating more questions than answers (although this should be seen as a sign of intellectual life and vitality). Moving towards a more quantitative and empirical form of exploring these ideas takes us into difficult questions of data and analysis. Approaching this level of analysis is the task that is taken up in the following pages.

A reader's guide to this volume

This proceedings report is the first major collection of papers related to the mobility of human resources. The work of the Focus Group on human mobility began in 1997, in Phase II of the OECD's work on national innovation systems. In the beginning, only the Nordic countries participated in the Focus Group, due to the availability of register data in these countries. In Phase III, it was decided to enlarge the Focus Group, and non-Nordic countries are not in the majority. This expansion underlines the growing interest in human mobility issues.

The proceedings in the current volume are based on a number of workshops and meetings held during 1999-2000. The report is divided into four main sections:

- Theoretical and statistical issues.
- Comparative mobility in the Nordic region.
- High-skilled resources and mobility in Europe.
- International mobility.

Theoretical and statistical issues

The chapters on theoretical and statistical issues discuss the conceptual and measurement problems that are closely connected to the efforts of the Focus Group to use mobility rates as indicators for the distribution and role of human resources in the economy. The "Canberra Manual" is relatively recent, having been first published in 1995, and is currently being revised. These chapters

will contribute to that revision process. In Chapter 2, *Ekeland* presents a discussion of the "Canberra Manual" – the OECD Manual for the Measurement of Human Resources – and the related issues of the International Standard Classification of Education (ISCED) and the International Standard Classification of Occupations (ISCO). This chapter includes a discussion of how well the Canberra definitions serve their purpose when they are implemented using Danish register data.

Tomlinson makes an attempt to explore the relationship between mobility and economic growth in Chapter 3. Although this connection is not easy to analyse empirically, this author makes an interesting and important conclusion that the mobility of high-skilled human resources should be seen in isolation from the mobility of workers with lower skills. In fact, they seem to play different roles relative to up- and downturns in the economy.

In Chapter 4, *Graversen and Friis-Jensen* explore the consequences of using different definitions of the concept of human resources in science and technology (HRST), and point to the measurement problems inherent in this area of study.

The important issue of "firm demography" is discussed by *Svanfeldt and Ullström* in Chapter 5. They clearly illustrate how fundamental this topic is in research on human resource mobility. The issue of firm demography highlights the difficulty of answering the question of what constitutes a firm – defining a "new" firm is not as easy as many of us would like to believe.

Comparative mobility in the Nordic region

The section on comparative mobility in the Nordic region contains material from Phase II of the OECD NIS project, which has not previously been published. Chapter 6 (Nås *et al.*) makes a non-technical summary of the outcome from the previous phase, which was limited to a cross-sectional study in the Nordic countries. This study looks at mobility between two years only, but using rather detailed sectoral breakdowns. The material from Phase III looks at mobility rates over the business cycle, *i.e.* ten years, using various educational, sectoral and age breakdowns (*Graversen et al.* in Chapter 7). *Graversen*, in Chapter 8, examines mobility between the research sector and the rest of the economy in Denmark. This chapter relates to work in progress in a Nordic context; more detailed analysis will soon become available.

High-skilled resources and mobility in Europe

There is, of course, no basic difference between mobility in the Nordic region and mobility in other countries. The rationale for a separate section devoted to the Nordic countries is the availability in the Nordic countries of public registers as a standard component of their national statistical systems.

Most of the studies featured here use data from Labour Force Surveys. Chapter 9, by *Laafia and Stimpson*, uses merged data from the national Labour Force Surveys to calculate mobility rates for the European Union (including associate members and candidate countries). By contrast, the Belgian contribution (*Vandenbrande*, Chapter 10) is based on register data, and is an attempt to make a comparable study to the work in Phase II (see Chapter 6, *Nås et al.*). Chapter 11 by *Martinelli* is based on a large regular survey of French PhDs and shows another side of mobility research: how newly graduated PhDs in different fields of study face different problems and have different developments in income levels, etc. The Hungarian, Czech and UK contributions (Chapter 12, 13, and 14 by *Viszt et al.*, *Gottwald and Šimek*, and *Tomlinson*, respectively) are examples of mobility studies that mainly use the respective national Labour Force Surveys, although they also draw on other data sources.

International mobility

Although basically different facets of the same phenomenon, domestic and international mobility vary in many aspects. Some of the differences are due to data sources, but basically the disparities are due to marked variations between national labour markets and the international market for highly skilled personnel. Since there is a fundamental lack of the data which would be required for an in-depth study of the issue of "brain drain", the chapters in this section are attempts to exploit as much information as possible from the existing, very diverse and fragmentary, data that are available. In Chapter 15, *Mahroum* analyses the behaviour of scientific researchers in selected European countries, using mainly data available for the United Kingdom.

The Italian contribution by *Avveduto* (Chapter 16) is based on a special survey of PhDs that travelled abroad as part of their PhD.

The United States has, of course, a special role in any discussion of international flows of highly skilled personnel. In Chapter 17, *Regets* uses extensive data from the National Science Foundation to analyse this. In his analysis, Regets highlights a number of important issues that are of crucial relevance to policy makers.

In the Nordic countries, register data could potentially provide a very accurate picture of international mobility, although, regrettably, adequate data are for the time-being not being collected on a regular basis. Since the Nordic region has been an integrated labour market for some decades, it is possible to try to analyse inter-Nordic mobility in full detail. Register data do not allow a full-scale analysis, but *Graversen et al.* make a first attempt at such an exercise in Chapter 18.

Finally, there is a contribution from an economy in transition, the Czech Republic. The Czech case described by *Gottwald and Šimek* in Chapter 19 clearly points to the existence of two very different types of labour migration: one from the "East", which mainly concerned low-skilled workers looking for employment or better paid jobs; the second group includes experts from the "West".

In Chapter 20, *Ekeland and Smith* conclude with a brief summary of the main findings of this work, and discuss these in the light of the national innovation systems approach. While the formation and mobility of human capital remain a key component of innovation systems, they make the point that further studies would necessitate much improved data availability, and that countries should make a concerted effort to develop harmonised registry data that can be used for analytical purposes.

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PART I

THEORETICAL AND STATISTICAL ISSUES

Chapter 2

INDICATORS FOR HUMAN RESOURCES AND MOBILITY

by

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Introduction

It is generally agreed that human resources are important for science, technology and innovation policies. However, at the same time, there are very few widely acknowledged indicators for measuring the contribution of human resources to S&T and innovation. This is a consequence of the scarcity of statistical work done in this area, mainly through lack of adequate data.; the rapid spread of digital information technology will hopefully change this situation in the coming years. Meanwhile, the development of large public registers in some countries has made it economically and practically feasible to study human resources in society in radically new ways.

During the late 1980s and 1990s, the need for measurement of HRST was emphasised in a number of reports.[1] Programmes such as the "Human Capital and Mobility" project, organised by the European Commission in 1992, were a clear indication of the increased attention being paid to human resource issues. Consequently, the OECD Secretariat, together with the European Commission and the Group of National Experts on S&T Indicators, initiated work on a statistical framework that resulted in the so-called "Canberra Manual", published by the OECD and Eurostat in 1995. The Introduction to the "Canberra Manual" states that:

> "Highly skilled human resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being. While the number and distribution of scientists and engineers were recognised as important indicators of a nation's S&T effort when the first S&T indicators were being designed in the early 1960s, countries and international organisations usually saw a need for internationally comparable data on human resources only in the context of short-term policy issues, for example, the "brain drain" debate and the "ageing" of the S&T workforce.
>
> In consequence, very few countries established and systematically maintained coherent systems for the monitoring of stocks and flows of scientific, technical and engineering personnel deemed necessary for longer-term analysis or the examination of a wider range of issues. Hence, despite intermittent efforts in the 1980s, the methodology, collection and analysis of quantitative information on human resources

devoted to S&T (HRST) at the OECD was confined to personnel engaged in R&D only."

A precise and operational definition is, of course, central to measuring the *stocks* of HRST and other kinds of human resources. The key to defining HRST is the educational and occupational classification, which will be discussed below. The key to measuring the *flows* of HRST is to be able to establish the link between the employee and the workplace/employer. Many policy questions can be analysed on the basis of stock data and comparative analyses can be conducted on the distribution of HRST stocks and their impact on growth performance, measured by GDP or by a range of other indicators. Data on the flows of HRST open up opportunities for further analysis. The flows determine the changes in the stocks. However, there may be significant mobility of HRST even without any great changes in the stocks – especially at the aggregated level. Furthermore, we can characterise individuals by the firms in which they work, and firms by the characteristics of their employees. This is why data that provide the link between employee and employer are so valuable.

This chapter presents a discussion of statistical indicators for human resources from an innovation perspective. The chapter is structured as follows:

- A brief overview of data sources.
- Standards and methods used to measure human resources in the "Canberra Manual".
- Business demography.
- Possible indicators discussed in the light of the experiences of the OECD Focus Group on human mobility.
- Recommendations for further work on human resource indicators.

Data sources are a central concern of this chapter. Data are of vital importance for measuring HRST with the level of quality necessary for policy development. The discussion in this chapter will centre on Labour Force Surveys – the only common source of mobility data for the OECD countries to date – and the use of public registers.

Existing data sources

In 1993, OECD and Eurostat carried out a joint inventory of international and national sources of information relevant for HRST. This report, with the long title, "Availability of Methodology and Data on Human Resources in Science and Technology in the OCED and the EU Member States" is summarised in Chapter 7 of the "Canberra Manual" (CM). A data source is considered "international" if it contains comparable numbers for a group of states and, as the CM wryly comments: "Very few data sets are in fact collected at the international level". Recently, the OECD initiated an inventory that updates the 1993 survey, adding a preliminary list of special studies (Rosengren, 1998). There has been no radical change in the availability of data in this period. The types of data source are:

- Quarterly and annual labour force statistics.
- Industrial structure statistics: employment, wages, hours of work.
- Population statistics: education and occupation.

- R&D statistics: personnel by sector.

Data collection methods vary, but postal questionnaires are the generally used method.

Labour Force Surveys

Labour Force Surveys provide the most important source of data; this is true even for the Nordic countries where public register data are available. In most countries, labour force data is based on a large sample,[2] which is interviewed in a systematic and professional way over a three-year period. Since 1992 – and particularly since 1996 – Labour Force Surveys have used an agreed terminology and methodology. The samples have been enlarged, and educational variables introduced and made comparable. These developments have made comparative mobility studies feasible for the first time. Several examples of such studies are published in this volume [see, for example, Laafia and Stimpson (Chapter 9), Tomlinson (Chapter 14), Viszt (Chapter 12), and Gottwald and Simek (Chapter 13)].

Of course, using the same definitions across countries gives rise to a certain number of problems, especially in relation to the phrasing of the questions on where individuals are employed today and where was their last job. In most national LFS, the mobility rate between two years can be calculated in one of two ways: one can either use different types of retrospective[3] questions or one can profit from the fact that people are interviewed several times. The difference between establishments and enterprises is common to both approaches. The precise wording of the question – and how the respondents perceive it – can lead to considerably different responses, even among different social/cultural groups in the same country. In the Nordic countries, where the use of register data is widespread, it is possible to check how the answers to the questions in the LFS correspond with the data in the registers. However, no such systematic study has been implemented so far.

Even if one could achieve a sufficient degree of harmonisation in the mobility-related questions in the national LFS, sample size poses a more fundamental problem for using the LFS in mobility studies. Although the LFS has a large sample, the more detailed the breakdown – on education, occupation, industrial sector, sex, age, size of firm, etc. – the less reliable the estimates become, and they soon become useless. In fact, in many countries, NACE codes are only available at the two-digit level, and even so the size of small sectors like research or computer equipment cannot be estimated with sufficient precision. In most cases, it is necessary to divide up the economy into between five and ten rather aggregated sectors, and to be fairly restrictive when analysing sex, age and education variables at the same time.

Since the costs of collecting LFS data are closely related to the size of the sample, it is unrealistic to expect that national statistical offices will significantly increase sample sizes. It is more likely that in the future countries will use register data for much of the information that now comes from the LFS, and that the LFS will be used for more qualitative information that the registers cannot provide. From a human resource perspective, information on the reasons why people change their workplace, if and how they use their education and skills, etc., is only obtainable from a survey.

Both data quality and analysis of the results can be improved with LFS. By paying careful attention to the design of projects, limitations due to sample size can be avoided and useful comparative research can be conducted.

Register data

At this point in time, register data is only readily available in the Nordic countries. The CM states that these countries "have a tradition of centrally co-ordinated registration of characteristics of individuals". However, this is not quite correct; in fact, there has been no centrally co-ordinated registration of individuals' characteristics. However, since the late 1960s, each person in the registers has a unique identification number. Administrative systems in different parts of the public administration make use of this unique identification number. Although the characteristics selected for the register, definitions used, coding rules, etc., were not co-ordinated, the unique number makes it possible to compare/merge/supplement/verify information from various registers even if this was not envisaged at the time the database/register was developed. The public administration, but also banks, insurance companies and several other institutions use this unique ID number.

There are a number of obvious advantages to using an official personal ID – avoiding doubles, facilitating interbank transactions, etc. Those who work with the data contained in these registers are well aware that the various systems contain a certain amount of contradictory information on some individuals: persons are registered as being both employed and seeking employment, or as holding two full-time jobs at the same time, etc. Harmonising the registers with the aim of obtaining agreement on definitions and maintenance rules and how to eliminate existing contradictions is imperative if we are to reap the potential benefits of the unique personal identification number.[4]

Although registration is not centrally co-ordinated, the unique personal ID number enables the use of all kinds of register data. The data set used for mobility and labour market research requires merging information from uncoordinated registers such as the educational register, the census register, and the social security register. In fact, the authorities have what is referred to as "a virtual distributed database": "distributed" because the administration of content and physical handling of the database is carried out in different locations; "virtual" – or, more precisely, "potential" – since the various registers have yet to be interconnected. However, interconnection is technically feasible using existing database and network technology.

As digital information systems broaden and deepen their coverage of social and economic events, register data will replace the traditional survey as a means of collecting information on sales, number of employees, etc. The purpose of the traditional survey will be limited to the collection of data on the motivations underlying observed behaviour and other aspects that the administrative registers do not cover.

Past and present mobility programmes

For centuries, craftsmen, artists and academics have travelled in order to study and learn. Then, as now, the mobile person acquired new knowledge, both formal and tacit. Mobility was – and continues to be – of vital importance for the building of networks. In the universities, substantial resources are allocated to sabbaticals, inviting guest researchers and lecturers, etc. Generally, however, this tradition does not include research and development institutions outside academia (whether research institutes or research labs).

What is new – or, at least, what has been given more emphasis – in research policy formulation over the last 20 or 30 years is the need to encourage interaction between universities, applied research institutes and firms. Achieving this goal has led to the creation of institutions such as science/research parks, the establishment of adjunct posts at universities, and the development of various personnel mobility schemes. Mobility schemes offer incentives for academics and researchers to work in other

institutions and firms – for a shorter or longer period – not excluding the possibility of a job shift. IN addition to national programmes, international programmes have been created. One example of such a programme is the "Training and Mobility of Researchers", which was a component of the both the Fourth and the Fifth Framework Programmes of the European Commission, and which will continue to be part of the Framework Programmes.

The "Canberra Manual"

The starting point for any discussion of the mobility of researchers is, of course, the "Canberra Manual" (OECD and Eurostat, 1995). The "Canberra Manual" is the youngest of the *Frascati* family of innovation-related manuals. The manual is an indicator of the growing attention paid to HRST in policy formulation. In addition to outlining the various policy areas where HRST is important, the main purpose of the "Canberra Manual" is to discuss the definition of HRST and the classifications and standards to be used in order to ensure that the definitions are operational. It also provides a short overview of existing databases; however, it does not explicitly discuss issues related to data collection, reliability and validation. Moreover, as is often the case, the classifications and standards used reflect the data available.

The policy issues

Policy formulation is, after all, what motivates the definition of concepts and the information collected. The "Canberra Manual" describes its own purpose in this way:

> "The combination of science and technology (S&T) and human resources (H&R) is seen as a key ingredient of competitiveness and economic development and also as a means of safeguarding and enhancing our environment over the coming decades. New technologies are being developed and applied, very quickly in many cases. An increasingly skilled and effective workforce will be required if countries are to negotiate the rapid change and new challenges that are emerging in S&T."

The policy issues fall into various categories:

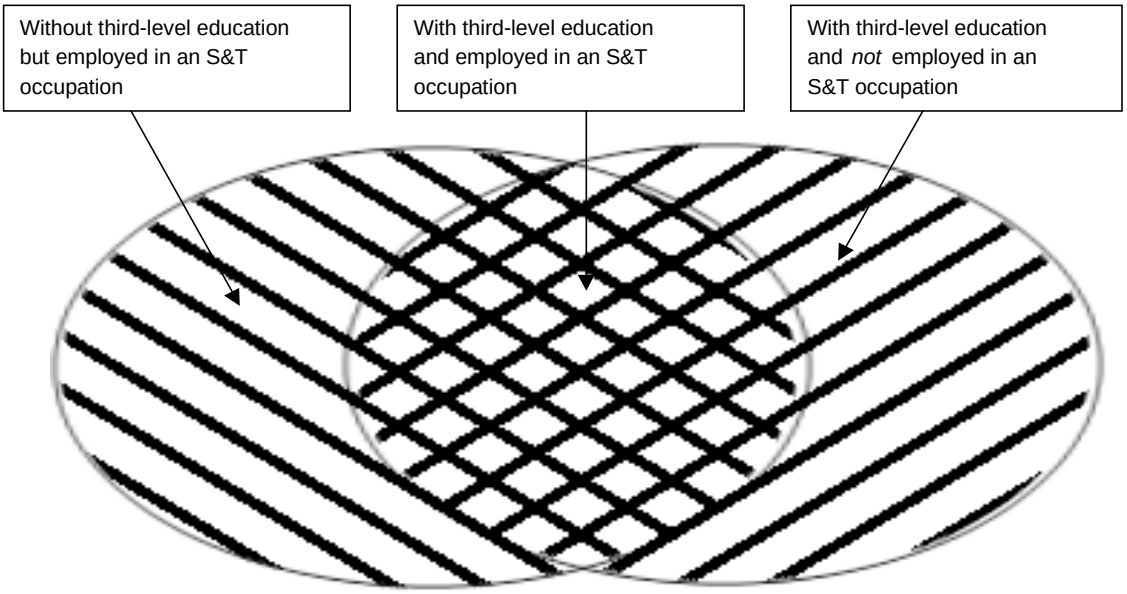
- General demographic issues: ageing, demographic downturn.
- Structural changes and their repercussion on the labour market: *e.g.* the decline of defence industries may lead to a surplus of specialists with what were once scarce S&T skills.
- The internationalisation of the labour market for HRST.
- Brain drain / brain gain in different contexts (international, regional, sectoral).
- Issues relating to education and training, such as planning of supply, use of acquired education and training.

The HRST population

The population of HRST is defined using two established classifications: the International Standard Classification of Education (ISCED) and the International Standard Classification of

Occupations (ISCO). HRST encompasses those who either have a formal education in the field of HRST or have a job where such an education is normally required. The defined territory is meant to delimit the group of persons who are central for the development and diffusion of technology from a national innovation system (NIS) perspective. The aim of the Manual is to show both the potential resources (*i.e.* qualified but not working, or working in occupations where their education is not relevant) and the actual resources (*i.e.* those working and using their education and experience).

Figure 1. **The definition of HRST using occupation and education**



Of course, many HRST personal carry out routine work; while others are more directly involved in innovation and diffusion. The work of the OECD Focus Group on human mobility has raised some questions about how the concepts of the "Canberra Manual" can be applied in real-world situations. This comes as no surprise, and the Manual explicitly states that the definitions proposed to date need to be tested through utilisation in various research and policy contexts.

The classification of education: ISCED – old and new

In classifying education, one of the first questions that arises is how to treat the question of intensity. Ideally, one could define a "normal" annual intensity and then weigh different types of education according to their intensity, based on various sources of data. One could measure the number of hours spent on lectures, studying, etc. However, in addition to the fact that it would be costly to obtain the data needed for constructing such weights, it is an open question whether the results would be really useful. First, because individual effort varies widely – there are hardworking and lazy students in all fields. There are formal and real norms of how much time needs to be spent in an educational programme. Second, educational programmes differ according to subject matter, as is the case with the traditions of educational institutions. All educational classifications are based on the principle that the intensity of education is best measured by an indicator of both its quantity and its quality.

Likewise, one might have chosen to weight the different fields of study according their intensity/quality. Hypothetically, one could choose a base norm, *e.g.* the Humanities, and take one year of theoretical physics as counting for one and a half years of history. However, one could argue against this, by saying that in each field of science, the education provided is as advanced as the average ability of the students. Since students' learning abilities are, on average, equal, there is no selection bias between the various fields of study in terms of talent, IQ or other indicators of the human potential for learning. This implies that the most brilliant social scientist is as capable as the most brilliant mathematician; the potential scientist or mathematician would have chosen his field of study through personal preference and not as a second best due to lack of intellectual capability.

This may seem a philosophical argument, but the practical consequence is that the length, *i.e.* the number of years of education, is used to distinguish the different levels of education. In practice, this means that in many international comparative statistics and research reports, very different types of education, such as two years of theoretical physics at university level and two years of training as a nurse will be treated as equal, since both represent the 13^{th} and 14^{th} year of education. Depending on the problem to be resolved, in order to obtain useful results one might have to combine educational level with field of study.

These remarks held true for the "old" ISCED, *i.e.* the ISCED standard from 1976. However, the "new" ISCED (as of 1997), makes a general distinction between vocational education and more theoretical education. This is not the place to enter into a debate about whether such a division is theoretically well founded and if the division is feasible. There is, however, a real danger that this division into vocational and theoretical training might become a reflection of the "status" rather than the content of the field. Whether or not this new feature will be used by researchers remains to be seen.

A more practical problem is the case of "mixed" courses such as humanities and computing. Although this problem may be marginal, it would be resolved by a more detailed classification of subjects. In many instances, it is possible to provide a rough estimate of the respective amounts of time spent on the various components – linguistics and computing, for example. However, for the time being, ISCED codes tend to be used at such an aggregated level that a more detailed breakdown would not bring about significant improvements.

Two other features of ISCED'97 are worth mentioning: *i)* the possibility to single out PhDs is clearly an advantage; and *ii)* levels 5, 6, and 7 of the old ISCED have been revamped to 5a, short, medium, long and very long, making it possible to differentiate more according to length of studies. It has also become computationally less convenient and might for that reason be less used.

Finally, many countries apply their own classifications, adapted to the specific features of the national educational system. The national classification is then converted to ISCED for international comparisons. When working with very specific groups, one should always ensure that one is really comparing "apples with apples". Engineering education should, for example, be checked since it might be classified differently depending on length and national status.

Although it could certainly be improved upon by adding greater detail, the ISCED classification, built on formal and in most cases national standards, is a fairly reliable indicator of educational level and field of study.

The problem with using formal education as an indicator is, of course, that it does not tell us directly what people do when they work: it is a well-known fact that some people do not have occupations directly related to their educational level. In addition, many people have acquired skills on the job. The "Canberra Manual" uses occupational statistics to delimit such people.

Problems with occupational statistics

Classifying occupations is a far more difficult exercise than classifying education due to the greater dimensionality of occupation, and the varying prestige attached to different occupations in different cultures.[5] At the very least, the dimensions of "occupation" include:

- Structure of decision power in the workplace.
- Type of work – routinised, creative.
- Classification of the field of work according to materials used, techniques, markets served, etc.
- Education/certification requirements.

One compact way of describing such a multi-dimensional area is to use a combined index, *i.e.* a number with one ore more digits expressing the ordinal scale in each dimension. The first digit of ISCED typically describes the level of education, and the second digit the field of study. The following digits are a more detailed, hierarchical description of the field of study. For historical reasons, the ISCO standard has not been organised in the same way. This results in a situation in which different dimensions are mixed at the same digit level, thus leading to operational problems with the ISCO classification. The first digit groups are defined both in terms of hierarchy in the workplace (mangers *vs.* subordinates), ISCED level codes (highly educated, skilled and unskilled) and the institutional context – the armed forces being a one-digit group. For the present purpose, this "multi-dimensionality" is not the major problem with the ISCO standard; two others are more serious. The first concerns managers: as can be seen from the chapters in this volume, the original Canberra definition included managers, but in empirical work this gave strange results. It is not hard to see that "managers" is not a very easily defined category, and that, for example, phenomena like average firm size in a country could have a very large impact on the number of managers recorded.

The second problem is that several important ISCO groups are defined using education as a primary criterion, as discussed above. This has several consequences. One is that as more people receive formal education, the Canberra population defined by education and occupation tends to overlap to a greater extent. Also, given that the educational data are generally of better quality, there will be an increasing tendency to use the highest achieved educational level. This is the other side of the most serious problem – using education to define occupation does not tell us what people actually use their education for. Do lawyers use their law studies or are they just doing administrative or management tasks? The same goes for other professional groups.

Many countries did not use the earlier versions of ISCO from 1953 and 1968, although the latest standard ISCO'88 seems to be more widely employed. Eurostat requirements in relation to the Community Labour Force Survey have contributed to this. Many countries use their own principles for a national standard, which they then transform into an ISCO'88 code for international comparisons. This transformation can often only be done at a rather aggregated, *i.e.* two-digit, level.

Electronic curriculum vitae and other sources of information

The use of CVs might be considered another potential source of information as to what people do at work. CVs contain detailed information on the precise content of a person's work (scientific field, concrete projects worked on, experience acquired, etc.). As such, they could be especially useful in the

study of small groups, for example researchers in research institutes. A number of firms exist that collect CV information via the Internet and the offer that information to other firms seeking to recruit staff with certain combinations of education and experience. It is not unlikely that CV-like information will be a natural part of everyone's homepage in the future. To tap the potential of such sources of information, standardisation is essential; only standardisation allows the automated collection and treatment that makes such information economically feasible. A standard could be very helpful in rendering labour markets more conducive to analysis by increasing the amount of easily obtainable information on job seekers.

Bibliometrics are another example of information that could be useful when studying HRST – and other highly educated persons. Increasingly, reports, documents, working papers, etc., containing the author's name(s), are posted on the homepages of firms and other institutions. Like the CV, such information provide be a valuable supplement to the ISCO code, and may even be a way of validating the ISCO code.

Stocks and flows

The stocks of HRST are an indicator to be used in many analytical contexts. One example is that in many growth models use – as an indicator the educational level – the proportion of the workforce with education at ISCED level 6 and 7. Often, the degree of aggregation is too high because the shares for engineers and natural scientists might be significantly different in Asian Tiger countries and Latin-American countries, even if the share of ISCED level 6 persons is roughly the same.

The development of databases with accurate dates for job shifts also raises the question of how the traditional stock data are compiled, how representative a snapshot of the workforce can really be when the labour market is constantly changing. One example of this is the problem of harmonising Labour Force Surveys with register data. One of the problems is that the very broad definition of employment used in the Labour Force Survey[6] makes it difficult to harmonise Labour Force Surveys with register data due to the fact that very frequent changes disturb the management process. Costs of maintaining the register increase, and the quality of the register drops drastically. That is why the registers (tax, social security, etc.) generally ignore very short, temporary jobs of a couple of hours or days and in practice use a definition closer to the everyday meaning of "having a job". The Norwegian registers "underestimate" the number of persons working by 10% compared to the Labour Force Survey. Or the Labour Force Survey "overestimates" the number of people working. However, this only reflects the fact that the registers were designed with the aim of administering people in stable, full-time occupations, while the Labour Force Survey has been directed towards studying movements in and out of the workforce, in and out of employment.

The major challenge in interpreting stock data - apart from the ISCED and ISCO classification problems - stems from the different sectoral structures in different countries. One classic example is that Norway has below-average levels of R&D due to the fact that the most important sectors in employment terms are not R&D-intensive. In R&D-intensive sectors, Norway achieves an above-average score. In the same manner, the size of the various sectors in a given economy will influence the aggregate numbers of HRST. A large public sector means usually large numbers of highly educated people. However, the size of sub-sectors of the public sector might be very different, as can be seen, for example, by comparing the armed forces to the health system. The same goes for industrial sectors, most of which have about a 5% share of engineers, while in oil extraction engineers make up more than 20%.

Flows

Mobility rates are the main measure of flows. They can be defined in many ways, depending on:

- Whether the population is static or dynamic.
- The time scale used.
- The basic units used.

Static and dynamic populations

With regard to population, a basic choice must be made about whether the model has a given population or whether new individuals will be entering the population during the time period studied. A given population is easier to study since knowing the actual distribution of the population at time *t* among the different states,[7] makes it relatively straightforward to assign the percentages of the population to the different states in subsequent periods. However, when recruitment is introduced, the denominator changes between the time intervals; thus, the resulting distribution is the combined result of the movements of the "original" population and of the persons recruited. If the time scale is just two years, the problem can be solved by studying two models with a given population, the original and the "recruits" (another given population) and analysing the resulting distribution. This method is called – in most cases – inflow and outflow rates. However, if the time scale is as long as a decade, this method becomes inconvenient and other techniques have to be used for analysis and presentation of results. Very often, either the inflow or the outflow rate for pairs of years is used when working with large and rather stable populations. This is a reasonable assumption for most analytical purposes, since the population changes in a slow and predictable manner at an individual level.

Time scale - annual data or event history data?

Although the events to be studied occur at discrete moments and are recorded with high accuracy, *i.e* in days, weeks or months, there is often no other choice but to use annual data. These data might become an obstacle to studying the causal connections between events. We often cannot tell from the data if there was a spell of unemployment between jobs simply because we can only ascertain occupational status at a given moment in time. Neither can we tell if a person was hired to a particular job because he passed a certain exam, or if he took the exam as part of the training in the new job. Another problem relates to the fact that it is difficult to know whether a person moves to take up a job or the other way round. The last example also highlights the problem that "cause" and "effect" are dependent on each other: a person might want both a new job and a new place to live, implying that there is no cause and effect relationship between moving and taking up a new job.

However, apart from such simultaneous cases, knowing the actual dates of events would enable us to study the causal relationships. Again, it should be noted that the use of register data and large databases opens up new possibilities since very often dates of job shifts, exams, etc., are recorded with sufficient precision. The researcher often requests/obtains aggregated annual data. It will be some time before the new possibilities of storing and processing data change this situation, and data that can be used for event history analysis become the rule. The use of event history data means that one can construct a continuous history of a person along all the dimensions - working life, civil status, criminal record, health, etc. Given a detailed recording of various events, the researcher can construct models with more or less complex state-spaces by defining states as combinations of the atomic events recorded in the registers.

Basic units - business demography

The problems associated with defining the basic unit when conducting business surveys are greater then most economists believe. Statistical agencies around the world are increasing their efforts to solve these problems both on a conceptual and an operational level, including the problems of data collection. On the conceptual level, there is no clear answer in many cases to the question: Is this the same firm X or should it be considered as a new firm Y? This is because there is no single characteristic that is generally accepted as the essence of the firm – and firms change their characteristics all the time. A firm might be described by several characteristics:

- Geographical location.
- Ownership (both legal aspect and actual control).
- Employees.
- Internal structure (single/multi product firm, holding company, etc.).
- What it produces and how (industrial classification).

Mainstream economic theory does not offer much help here. Most schools of economic thought generally take the firm as a given, unproblematic entity. This is valid for static models, but not for a dynamic perspective based on time series. The main conclusion is that no detailed and commonly used set of rules exists for defining the birth and death of a firm, a process that includes the rules for issuing new firm identification numbers and deleting old ones. In many countries, there is no central public register of business units.[8] The organisation of the first "Roundtable on Business Surveys" in 1986 is a clear indication of the growing awareness of the importance of high-quality business registers for economic statistics. It also reflects the new possibilities offered by information technology.[9]

Birth and death of the firm

In many cases, the birth of a firm is straightforward. A so-called "greenfield birth" consists of a person who did not previously own a firm establishing one in a specific location and hiring people to produce an easily classified product. Some deaths are also easy to identify: production is stopped, workers laid off, and the capital equipment scrapped. However, the exceptions to this rule are far too numerous and interesting to be ignored: these include spin-offs, mergers, take-overs, break-ups, changes in activity (radically new products, shifting from own production to sales), changes in ownership, change in geographical location. In other words, changes can take place in all dimensions over time and, of course, simultaneous changes can occur in two or more dimensions. The number of different combinations of events can be very high. In addition, many changes are not discrete but rather continuous, events (changes in ownership in a shareholding company, minor changes in geographical location, change in product mix). This poses the question of what characteristic, or combinations of characteristics, constitute the essence of the firm. Let us take the extreme example of an entrepreneur trying to establish firms in different locations to do different things before finally succeeding. Is this a case of one firm (the founding firm) changing location, nature of activity and employees? Or is this a series of births and deaths?

It is interesting to note that "common sense" does not seem to have any such problems with defining a firm. One hears people say things like:

- "They have changed owners but it is basically the same firm".
- "They have changed owners and moved, but is the same firm".
- "They previously produced X, but quit doing that, moved to Y and now only produce Z".

We know from the biographies of individual firms that changes have occurred in very many dimensions (ownership, location, product, employees); indeed, so many changes have occurred that, given the current practices of statistical agencies, many different identification numbers would have been issued and deleted. However, for the economic historian, it is still the same firm.

Most registers define a "kind of activity unit" as the basic unit. This is defined as a "certain type of activity performed at a geographical location". The basic concept is that a firm involves a number of persons organised to produce a more or less homogenous product, and has a "headquarters" that can be geographically located. This is a producing institution, independent of who owns it and, in some cases, of the actual persons who work there. The basic, homogenous dimensions in which most statistical agencies record changes are:

- Change in ownership (both who is the owner and the type of ownership).
- Change in geographical location.
- Change in kind of activity.

The rule of thumb in Norway has been that if simultaneous changes occur in two dimensions, it it assumed that one firm is dying and a new one is born. For most analytical purposes, this is quite reasonable, although, regrettably, there are a number of problematic cases. Take the example of a local grocery store that changes its owner and all of its employees. Since it is located in the same place, and since the nature of its activity is the same, in Norway the firm would not be given a new identification number. It would not be considered as a birth of a new firm. In Norway, two numbers characterise the firm. One – the establishment number – is used to identify the geographically localised production unit, while the other – the enterprise number – identifies the owner of this local production unit. In the case of the local grocery store described above, only the enterprise identification number would change. If the new owner was not one of the big chains, but a classical *gründer*, one might want to treat this as a birth. This could be done by using the change in ownership and employees as the decisive criterion.

Another classic problem is the small, expanding firm, which is simultaneously being bought up by a big firm and moving to new (the big firm's) premises. According to the Norwegian rules, one should have changed both the establishment and the enterprise number. However, in practice, a more nuanced approach is taken. If the change in geographical location is local – defined as staying in the same municipality – only the enterprise number changes. In some cases this is, of course, arbitrary. This example illustrates the general problem of distinguishing between take-overs and mergers, and the different types of take-overs and mergers. Is a firm extinguished in the take-over process? Or does it become a sub-unit? Is this a real merger, *i.e.* the death of two firms and the birth of a new one? Or is it the birth of a new corporation with two sub-units?

Business demography and HRST

From a human resource point of view, changes in ownership and location are generally of less importance. The focus here is on the persons working together, constituting a goods and/or service

producing unit, with each person contributing their different competencies, so that the producing unit is more than just the sum of its elements. When persons move, they take these competencies, experiences and networks from one firm to another. Consequently, the stability of the workforce should be an important criterion of the births and deaths of firms. This criterion has been used in the Nordic countries, although mainly to validate and correct "inappropriate" changes in identification numbers. The main problem is that the statistical agencies and other public authorities have used ownership changes as a decisive criterion for changing identification numbers, thus giving an upward bias to the mobility rates. The answer to this problem is to use the employees to identify the firm. Procedures have been developed in Denmark, Sweden and Finland to verify and correct changes in firms' identification numbers by using the actual persons employed as an indicator. If a large share of firms with identification number X is found by firm Y, then it is considered to be the same firm and, consequently, Y should not have been given a new identification number. In Denmark, a 30% limit was used, in Sweden and Finland, a 50% limit. There are arguments for both cases: a 30% limit means that if a core group of employees are stable, then it is considered to be the same firm. However, the situation might arise where one finds 30% of the "former" employees of firm X in firm Y and 30% in firm Z – how should such a situation be handled? Using 50% avoids that problem, but might – given the substantial "natural" mobility rate of about 20%-30% – prove too restrictive[10]. Such exercises will lower mobility rates by some 2%–3%, depending on the registration practice, the business cycle, etc.

The structure of entities

Small firms are generally located in one place and carry out activities which are easily classified. The problem with small firms is their short life expectancy. Larger firms are more stable in terms of life and death, although they are more dynamic in terms of structure. The ways in which they organise themselves into departments, branches or regional offices can vary considerably, even if we disregard take-overs, outsourcing, splits and mergers. There is also a marked difference between their legal structure and their "production" structure. This creates problems when issuing identification numbers: should legal considerations be fundamental or should a production-oriented point of view indicate the number of entities into which a complex, large firm should be subdivided? National statistical agencies devote substantial resources to so-called "profiling"; that is, undertaking case studies of large firms to classify their internal structure. The choices made here will influence mobility rates, especially when international comparisons are made and, since the issues are by no means limited to large private corporations, will also affect industrial statistics. The public sector is often a hierarchical structure with many levels, but registration practice (at least in Norway) has been very inconsistent and accidental. Since public authorities are major employers, this means that a great deal of important information on mobility has been lost. This situation has led to the construction of an entirely new, and more detailed, classification of the public sector, featuring a four-level hierarchy of organisations which "own" various types of sub-units.

In contrast, in Norway as in many other countries, the classification of enterprises and establishments has a two-level structure. This is not sufficiently detailed to reflect the often complex structures of modern corporations. It is not only a question of identification numbers, but also of industrial classification. Industrial classifications do not incorporate concepts like "headquarters" or "central administration and staff"; therefore, the administrations of large multi-product firms are often given an industrial code even when they were geographically very distant from their production units. The classic example in Norway is the administration of Norse Hydro, located in the centre of Oslo and classified as producing chemical fertilisers, although most of the employees work on things other than chemical production. The actual production facilities in this line of production are located 150 kilometres from the headquarters of Norsk Hydro.

The separation of the reporting unit on financial indicators from the actual production facilities is a major problem in business demography. The production and employment figures are often supplied by the local production facilities (establishments), while accounting data are supplied by the enterprise unit (central administration). This does nothing to facilitate analysis of the links between inputs (R&D, human resources) and financial indicators like sales, revenues, etc. Once again, however, the situation is changing with the diffusion of the new information technologies and the general tendency to consider sub-units as "profit-centres". This makes it possible and feasible to collect more information at the establishment level by exploiting internal accounting systems.

Business demography is of vital importance for the systematic study of HRST flows; however, at the same time, it is a complex issue in terms of both concepts and data collection. It is not the aim of this chapter to systematically discuss these problems, but rather to point to some of the key issues. Generally, the solution adopted is to define a concept such as "producing unit" in which what is fundamental is the employees' subjective feeling of being part of an organisation producing certain things; in fact, this is kinship is even more fundamental than changes in ownership, specific products or processes. How this is operationalised in the routines of statistical agencies is a difficult matter. There are certainly many trade-offs to be made between different legitimate administrative and analytical purposes. It is probably more important that the definitions and registration criteria used are the same, than that they are "correct" from any particular point of view.

Finally, the advent of new information and communication technologies may make it even more difficult to define a firm – but that is beyond the scope of this chapter (Ryten, 1995). Experience has shown that new phenomena such as "the paper-free office" or, in this context, the "virtual firm", are much slower to materialise – if they ever materialise at all – than some people would believe.

Concluding remarks

The further development of indicators of human resources and their mobility can be summed up briefly as follows:

- The data source of the future has to be register data; the LFS sample size is a fundamental constraint on the kinds of analysis that can be conducted with such data. However, this is not simply a problem affecting mobility research: all kinds of mezo- level – not to mention micro-level – labour market research will face this constraint, sooner rather than later.

- Occupational data should not continue to be based partly on education, but should provide information of what people actually do along several dimensions (creative or routine work, technologies and knowledge bases used) as their position in the power structure at the workplace.

- The concepts of job, of change of job, of workplace, establishment, enterprise, etc., need to be harmonised so that common basic entities are used, thus enabling studies of business demography and of group mobility.

The study of HRST mobility is just one aspect of social science which focuses on the role that work plays in people's lives. Improved data and indicators will facilitate a broad range of research and policy making.

NOTES

1. See, *inter alia*, "Background Report Concluding the Technology/Economy Programme (TEP)", especially Chapter 6, "The Supply of Scientist and Engineers: Current Trends and Concerns" and Chapter 7, "Human Resources in the Production System and New Technologies".

2. The Norwegian sample covers 23 000 persons out of a population of some 3.2 million aged between 16 and 70.

3. The retrospective question might be formulated as either "where did you work one year ago?" or "when did you start your present job?".

4. Unique identification numbers present tremendous benefits, especially in the relations between citizens and the authorities. These include pre-filled forms, less overlap in the collection of data, common use of addresses (including e-mail addresses, homepages), etc.

5. Problems associated with data collection as such will not be treated here. The basic difficulties lie in the way data are collected since, very often, the type of occupation is self-declared. This calls for judgement by those responsible for converting the information to ISCO codes. Experience shows that there is no consensus for interpreting this kind of information. A number of re-coding exercises, *i.e.* asking two different groups to convert the same set of job descriptions, have been carried out to check both individual coders and different types of coding. These exercises have shown that differences exist between persons with identical training as well as between trained coders and "experts": there is 80%-90% agreement at the first digit level, dropping to 70%-85% at the second digit level. There is no *a priori* reason to believe that the "experts'" coding is more consistent than that of other groups of coders. Some even claim that there is greater disagreement about coding among "experts" than among trained coders. For an overview of these problems, see Elias (1997).

6. Labour Force Surveys generally define being employed as having worked at least one hour of paid labour in the previous week.

7. By "states", we mean being employed, unemployed, employed in sector X, dead or inactive. What is considered to be a state is, of course, dependent on the problem being studied.

8. A good overview is given in Cox *et al.* (1995).

9. At that time, people were generally very optimistic about data collection using electronic data interchange (EDI), but that process has been much slower than expected. In the meantime, the Internet has appeared as the medium for electronic commerce and consequently for data collection. While both EDI and the Internet have great potential and are more or less suited for business and/or data collection, it should be borne in mind that there are many obstacles which need to be overcome before such technologies take off.

10. One should also bear in mind that both the 30% and the 50% limits should be seen as a rough guide. The implementation of such limits leads to complex algorithms due to the fact that the number of employees is an integer. This is especially important in the case of small firms – and there are always large numbers of small firms.

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Chapter 3

EMPLOYMENT GROWTH, SOCIAL CAPABILITY AND HUMAN MOBILITY

by

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Introduction: the national systems approach and the labour market

One of the strengths of the national innovation systems (NIS) approach has been to integrate institutional factors into the explanation for national differences in innovative performance and competitiveness. However, there have been two different strands of work in the NIS literature (Lorenz and Lundvall, 2000). Authors from the United States have tended to have as their main emphasis the impact of national technology policies on firms' innovative behaviour (Nelson, 1993). In contrast, the other approach to national innovation systems developed by Freeman (1987) and researchers at DRUID in Denmark (Lundvall, 1992) takes as its starting point the fact that important parts of the knowledge base are tacit and emanate from routine-based processes of learning-by-using and learning-by-interacting among firms. Correspondingly, the emphasis here is more on the efficacy of networks of firms and how they undertake innovative activity, than on formal activities related to the R&D system and the science base.

Emphasis is beginning to shift to take on board not only the R&D system and the interactive learning processes between firms and other institutions, but also what might be called "competence-building systems" within the NIS. Because the literature on innovation systems has concentrated more on R&D systems and the relationships between firms, there has been relatively less work done on the variety of institutional set-ups within different countries relating to the development and maintenance of capabilities more generally (such as the education and training system, health systems, and labour market institutions).

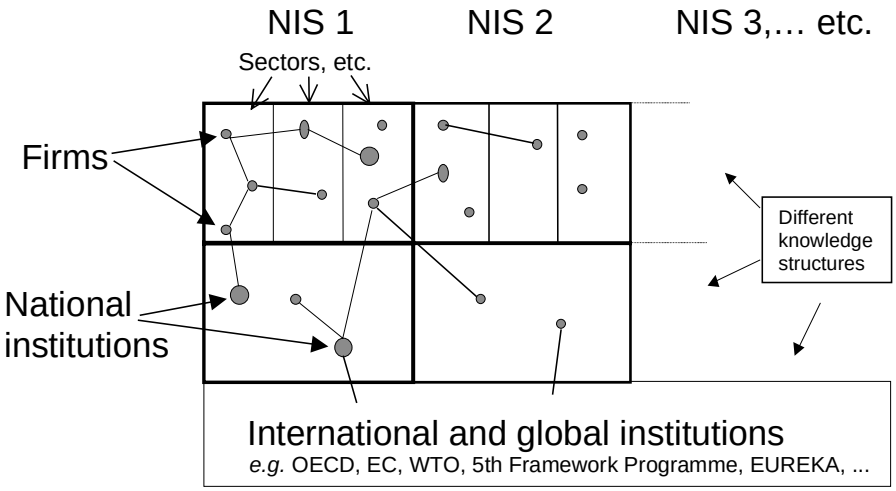
> "One of the major reasons why national systems of innovation differ is connected to people and competence building. How people are trained will determine how they interact in the development of new ideas and nationally specific labour market dynamics will put their stamp on how firms located in a specific nation produce, disseminate and use knowledge. Actually, while it may be argued that the science part of national innovation systems has become increasingly 'globalised', education systems and labour markets remain more closed and nation specific." (Lundvall and Tomlinson, forthcoming)

Firms' interactions with wider institutions of this kind and the role that firms have in shaping such institutions have been somewhat neglected in the NIS literature despite the fact that they play a key role in competence building and innovation – and hence competitiveness. It is the integration of the labour market that is the focus of this chapter.

Some work along these lines has been done outside the mainstream tradition of NIS work, but still within a systems approach [notably the regulation school (Amable *et al.*, 1997) and the work on business systems (Whitley, 1994)]. These approaches explicitly locate the labour market and the diversity of labour institutions as crucial elements in comprehending national differences in economic performance and capability. The increasing globalisation of economic activity also has a bearing on competence building and how knowledge can be transmitted and interpreted among different nation, sub-national and supranational sub-systems within a "globalising system of innovation" (Figure 1).

Figure 1 shows that there are a multitude of linkages between the elements of a global system formed by the (economic) adjacency of several national systems, which are embedded within a global set of institutions and governed by institutional arrangements such as the WTO or the European Commission, etc. The bold rectangles represent national innovation systems (which can be thought of as containing sectoral or regional sub-systems, etc.). The nodes are entities such as firms and national institutions which have various linkages between them (represented by the connecting lines). These linkages can be collaborations such as joint ventures or strategic alliances between firms, government projects that link national institutions with firms, informal networks that foster innovation or whatever. In a globalising world, the number of linkages between the national systems is increasing. More and more cross-border operations between national firms and foreign firms and other institutions are being developed.

Figure 1. **The globalising system of innovation (GSI)**



In the globalising system of innovation (GSI) then there are a multitude of complex relationships among the different entities (firms, institutions, government bodies, etc.) and different "knowledge structures" in place in different locations within and between national systems. By knowledge structure is meant the set of routines and procedures, ethics and work practices adopted by people within specific institutions. For example, an engineer working at a university laboratory will not operate with the same routines, assumptions and knowledge as an engineer working for a private firm. When there is occupational mobility or when workers from different institutions are connected through an innovative network, these knowledge structures can come into conflict with each other and may not enhance innovation. For example, there may be significant tensions between pure research-oriented scientists in universities and the commercial research institutes or firms providing funding. There may be different assumptions and ethics involved between collaborators from different types of institution. Cross-border relations may also be problematic due to cultural and/or national differences

in approach. This all has a bearing on labour processes and the labour market and where the labour market will be operating more or less efficiently.

Within this framework, a number of issues might be raised with respect to labour and labour markets:

- Firm-firm interactions. How is co-operation and interaction facilitated between employees in different firms, consultants, producer services?

- Firm-non firm interactions. How is co-operation and interaction facilitated between employees of different institutions given that they often operate with different knowledge structures?

- Cross border relationships. How do different national/organisational cultures interact?

- How do employees within firms increase learning and generate knowledge?

- How do other interactions generate knowledge?

- Are there increasing knowledge spillovers as networks expand or is the knowledge mainly tacit and hidden?

- How is personal or tacit knowledge diffused? For example, is it beneficial to have occupational, sectoral or geographical mobility? Do flexible labour markets enhance this? What about issues of brain drain or brain gain? How do we square increasing the international mobility of labour with immigration policy, etc.?

The last set of points is at the crux of the matter. If we accept the systemic character of a globalising set of institutions combined with several nationally bound systems, then the interactions and movements of people within this globalising system become essential to an understanding of the system as a whole. How and under what circumstances do people move between the nodes in the GSI model? The state and efficiency of the labour market must be explored. How do people using different knowledge structures interact where there is collaboration? What happens when people move between institutions that are using different knowledge structures? What are the implications where the movements of people or the collaborations increasingly cross national boundaries?

In this chapter, we begin to outline how labour market factors such as employment growth, job mobility and the tracking of the movements of skilled (and less-skilled) people can be incorporated into a NIS approach. As we enter an era supposedly increasingly dominated by tacit knowledge and immaterial production along with increasing globalisation, the people and the movements of the people who possess useful knowledge should increasingly become an object of study. The beginnings of such work have been undertaken already within a NIS approach [see Tomlinson (1999) for an analysis of labour-embodied knowledge flows; Tomlinson and Miles (1999) for examples of how career data can be used to enhance our understanding of learning processes in innovation]. As we enter a more globalised world, international patterns of migration also become more important (for an interesting analysis of this, see Mahroum, 1999; Regets, 1999).

The development of work along these lines has revealed three crucial problems for innovation research. First, it requires a strong multidisciplinary approach. For instance, many of the problems associated with occupational mobility, employee characteristics and skills that are familiar to sociologists are often missing from economic accounts of growth and competitiveness, etc. For

example, it is shown below that there are clear links between economic growth and skills and that a deeper investigation is called for. The reverse is equally true: sociologists tend to have little time for economics. In terms of occupational mobility, sociologists have shown more interest in "origins and destinations" and class mobility patterns which have little apparent economic relevance.

Second, the types of data and methodologies required in the present problematic become more complex. There is relatively little reliable data that can be used to explore issues of occupational mobility from an innovation systems perspective. Data on aspects such as employee career patterns are hard to find and even more difficult to analyse. However, with a little imagination, inroads can be made using existing data sources such as the Community Labour Force Survey and the more detailed national labour force surveys that exist in all European countries. There are also panel studies available that allow careers to be used to analyse competence building, etc. Some preliminary investigations using existing data sources are adumbrated below. These should be thought of as a starting point rather than as definitive studies, but they do raise important questions that require further exploration.

Third, it almost goes without saying that there needs to be strong theoretical work within the innovation studies community to incorporate labour and labour market factors into NIS research.

Linking occupational mobility, innovation and economic growth

One of the interesting issues surrounding economic growth is that employment, productivity and output growth tend to be highly and positively correlated with each other (Verdoorn's law). Hence, it is believed by some that increasing returns and economies of scale must take place. Adam Smith stated at the beginning of *The Wealth of Nations* that the extent of the market could drive the division of labour. This increases specialisation, which in turn drives up productivity and increases productive capacity. Other economists such as Kaldor and Salter were also interested in this phenomenon and argued that endogenous processes of technological change and learning must be taking place spurred by expanding demand. If this is the case, then studying the mobility of people within the economy or within a competence-building system should be a crucial focal point of research. One cannot actually have the employment growth accompanying output growth without some form of labour mobility.

It is also widely held that occupational mobility is a useful way of diffusing knowledge throughout the economy. Given the current trends in research based around the idea of a "knowledge economy", this makes the present work all the more interesting. Moreover, increasing the flexibility of the labour market has become a key feature of many economies and a major concern of policy makers. However, little work has been done to try to better understand the real benefits or pitfalls of flexible labour markets in terms of fostering the diffusion of useful knowledge (see Tomlinson and Miles, 1999). The study of mobility allows some assessment of the efficacy of flexible labour markets, especially when linked up to the NIS framework.

The ideas of flexibility in the labour market and the endogenised learning processes noted by Kaldor and Salter can be linked to the notion of "social capability" [first used by Ohkawa and Rosovsky (1973), and taken up by economists such as Abramovitz (1994)]. If an economy is to function well, it must be endowed with sufficient capabilities. The generation of these capabilities is connected with the improvement of institutions and human resources necessary to allow long-term economic growth. The concept of social capability (SC) can be expanded to include such things as healthcare provision, levels of trust and social capital, functionality of education systems, etc. SC represents a society's ability to organise production in an efficient way that readily allows for

innovation and rapid diffusion of knowledge within the system. It not only includes technological potential, but also human potential.

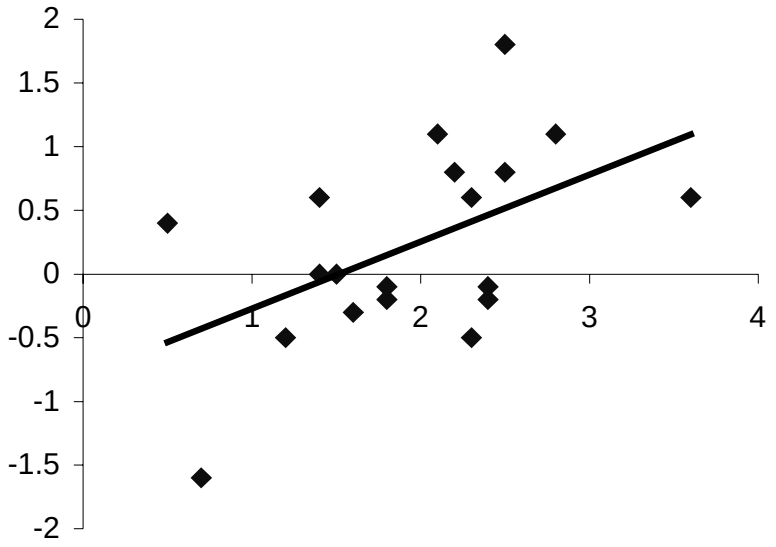
An economic system with superior SC should be able to grow faster than its rivals. The elements of SC readily include the nature of human mobility and labour market functionality. A system without sufficient mobility of people between institutions and firms would surely stagnate and become inward-looking. Similarly, it would be difficult to imagine much innovative behaviour in a society where there are low levels of trust or social capital. Hence, the concept brings in a whole range of issues that are largely ignored by standard economics. There is already a growing body of evidence that trust and social capital are significant determinants of economic growth (Helliwell and Putnam, 1995; Knack and Keefer, 1997).

In the following we explore some current ideas in mobility research and relate them to economic growth. It will be shown that things are not as simple as they seem once the "black box" of employee characteristics is opened up. The current emphasis of study in the OECD focus group has been on the mobility of personnel, concentrating on what might be termed "knowledge workers" (*i.e.* highly skilled and well-trained employees). It will be shown below that there are problems with this narrow concentration: a systemic approach requires that all levels of mobility be taken into consideration, not just that of the highly skilled.

Employment growth and economic growth

At national level, the relationship between employment growth and output growth can be seen in Figure 2 using data from western Europe and Scandinavia. At sectoral level within nations, it is also easy to show a significant positive relationship. In the analysis that follows, the NIESR data set "Britain's productivity performance 1950-1996" is used (O'Mahony, 1999) which includes comparable data from several countries. As we have already stated, employment growth clearly entails some sort of mobility. Therefore, if we find significant determinants of output growth linked to employment growth, this should be linked to a discussion of job mobility and it is proposed that this be incorporated into a NIS framework.

Figure 2. **Employment growth *vs.* GDP growth, 1989-96**



The basic relationships: cross country comparisons

This analysis takes broad manufacturing sectors and analyses the relationship between output growth and employment growth using time series from 1950 to 1995 for the United Kingdom, Germany and France. The model estimated is the following:

$$E = \alpha Q + k$$

Where: E = employment growth;

Q = output growth;

α and k are to be estimated.

Hildreth-Lu regression was used to estimate α and k due to serial correlation.

Table 1. **Results for the United Kingdom, Germany and France**
Manufacturing sectors, Hildreth-Lu estimates

Independent variable Q	Country-dependent variable is E		
	United Kingdom	Germany	France
Output growth	0.401** (0.078)	0.360** (0.057)	0.351** (0.047)
Intercept	-0.021** (0.005)	-0.013** (0.005)	-0.019** (0.003)
Rho	0.397** (0.144)	0.372* (0.140)	0.356* (0.140)
N F	44 26.54**	44 40.31**	44 55.08**
R sqr	.39	.49	.57
Durbin Watson	1.629	1.709	1.792

Note: Standard errors in brackets.* = significant at 5%, ** = significant at 1%.

Table 1 shows that the expected significant relationship between output and employment growth holds for manufacturing in the United Kingdom, France and Germany. We now begin to explore the relationship in more detail using data from the United States.

The relationship between output growth and skilled/unskilled employment growth

For the United States, a reasonable amount of annual data are available for six broad manufacturing groups for the period 1979-93. This data was pooled into a single set of observations in order to obtain 90 observations. This gives us a more reasonable data set for multivariate analysis. The data set has growth levels of employment for three different *skill* categories (low, medium and high – abbreviated as LS, MS, HS), thus allowing an investigation of the relationships between output growth and skilled and unskilled employment growth in the United States. Skills were measured on the basis of educational qualifications (see O'Mahony, 1999).

We obtained the surprising result that output growth is slightly negatively correlated with HS employment growth and positively correlated with *low-skilled* employment growth (Figure 3). Moreover, there is a negative relationship between HS and LS growth (Figure 4) and a positive relation between output growth and *lagged* HS growth. In other words, once the "black box" of employee characteristics is opened, the analysis becomes far less straightforward. In fact, it would appear that we know very little about the relationships between skill levels and competences at individual level, employment and output growth, yet these are essential to an understanding of innovation systems and competence-building systems.

Figure 3. **Output growth *vs.* low-skilled employment growth**
US data

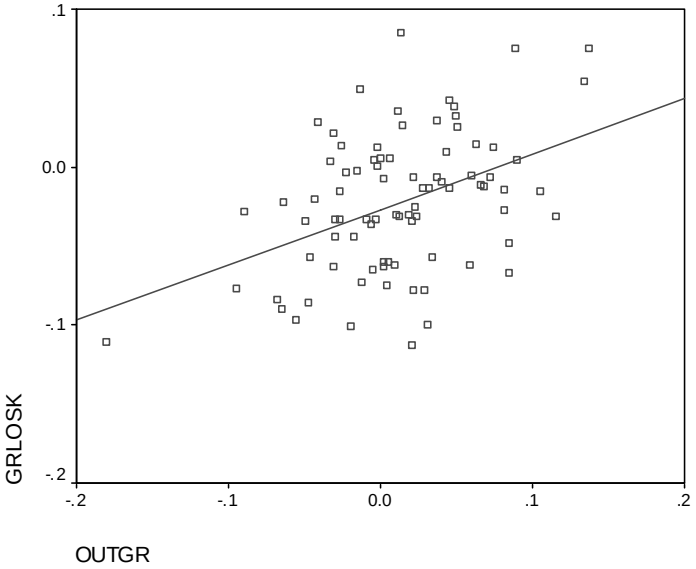
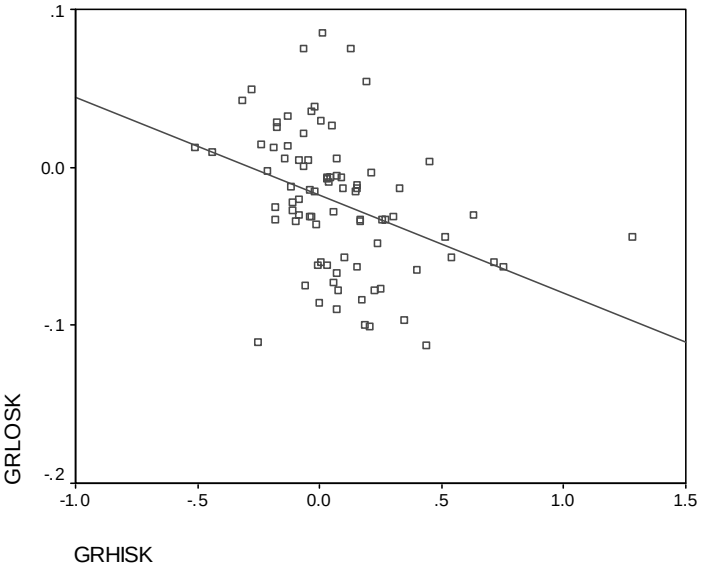


Figure 4. **High-skilled *vs.* low-skilled employment growth**
US data



These results imply that there is a delay before the relative growth of HS workers has an impact on output growth. One possible interpretation is that there is a build-up period in which innovation takes place (requiring growth in HS employment and/or the shedding of LS employment). Once this build up has taken place, there is output growth accompanied by LS employment growth. This would be consistent with a model of product development by HS workers (with little increase in output growth), followed later by increased production using LS workers.

To further investigate this, we constructed models similar to the one above using the US data set (Table 2). As would be expected, a basic model of employment growth as a function of output growth reveals a similar pattern to the results above.

Table 2. **US manufacturing panel data – GLS estimates**

Independent variable	Dependent variables		
	Employment growth	High-skilled employment growth	Low-skilled employment growth
Output growth	0.418**	-0.031	0.346**
	(0.048)		(0.081)
		(0.503)	
Intercept	-0.012**	0.069**	-0.026**
	(0.003)	(0.024)	(0.004)
N	90	84	84
Chi square	74.29**	0.00	18.47**
Log likelihood	250.0	34.2	190.0

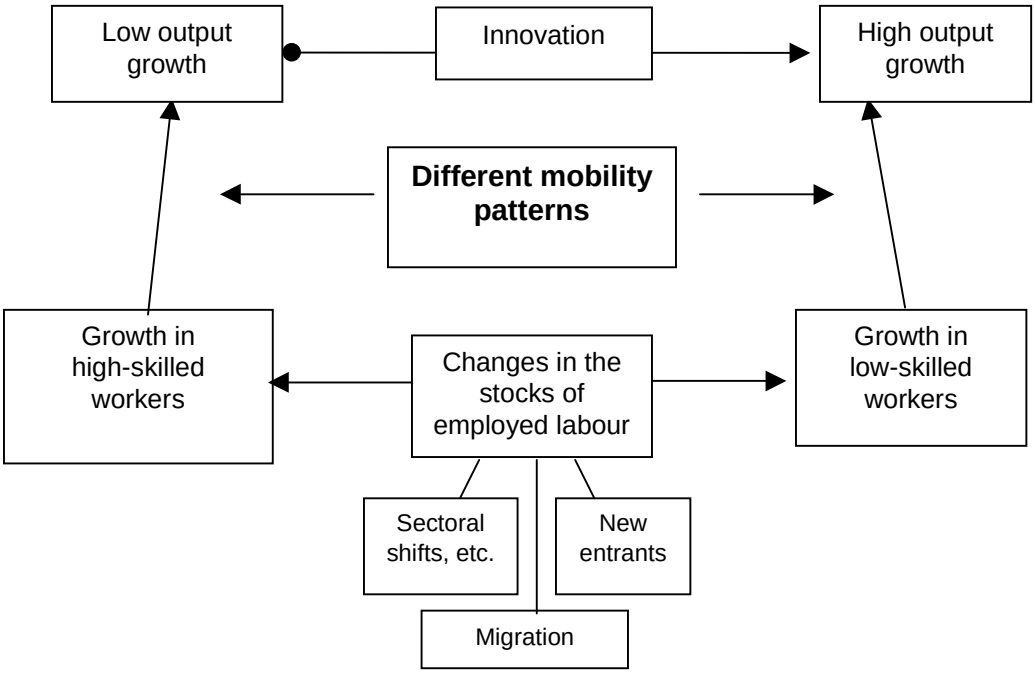
Note: * = significant at 5%; ** = significant at 1%.

However, it is clear from these models that output growth and LS employment growth are significantly related. The HS variable is not significantly related to output growth. The point to reiterate at this stage is that once employment growth of different skill groups is taken into account, the story becomes much more complicated. This observation is hidden when we look at overall employment growth which shows the expected positive coefficient. Predictions of output growth relying on high-skilled employment growth will be inaccurate. It is LS growth that is positively correlated with output growth. Thus, increases in productivity growth associated with high output growth are probably driven by an increasingly specialised division of labour of less-skilled workers (*i.e.* probably performing limited and increasingly narrow tasks). In effect, meeting high output growth requires an influx of labour which does not necessarily have to be highly skilled. This raises important questions as to the flexibility of the labour market and the ease with which less-skilled workers are mobile. It has already been demonstrated elsewhere that there are significant barriers to entry from certain sectors to certain other sectors or occupations (for example, from manufacturing to services) of less-skilled workers (*e.g.* Tomlinson, 1999). Thus, remaining competitive is not simply a question of having a growing market, say, but also requires the existence of a labour market and (re)training system that can cope with shifting demands. If flexibility in the labour market is good for diffusing knowledge workers throughout the economy, it should also take into consideration that flexibility of low-skilled workers might be equally important.

How do we explain the results so far and how can they be integrated into an innovation systems perspective that incorporates mobility? It is to this that we now turn.

A simple model of innovation and growth

Figure 5. **A simple sectoral model of mobility and growth**



This dynamic sectoral model assumes that growth is ultimately driven by innovation. As innovation affects a particular sector, there will be a shift in demand for labour. As output growth increases, there will be a corresponding requirement for low-skilled labour to pour into the sector. At other times, most of the employment growth will be from higher skilled occupations and will probably entail a shedding of low-skilled labour from the sector. Thus, the mobility patterns of the workforce change at different points in time depending on the current economic circumstances and the current levels of innovative capacity in the system. The stocks of labour in the economy must change according to the situation. Studying the stocks and flows of labour in this system will involve looking into issues of labour market flexibility, new entrants to the labour market (*e.g.* is the university system providing enough people with the right skills?), career patterns of different types of employee, migration of employees, etc.

The dynamics of a NIS will depend in part upon how well it can cope with maintaining the necessary competence-building components and dealing with the shifting demands for skilled and unskilled labour. Sectoral shifts in employment will be crucial as different sectors will be at different stages in the model. Mismatches will occur between sectors in terms of supply and demand for labour and it may not be easy to transfer labour from one sector to another. Moreover, workers from different sectors will operate with different knowledge structures and routines and may not easily learn new ways of doing things. The innovation system will have to provide ways of ensuring that disruption is minimised through training programmes and continuous updating of the education system ,etc.

Conclusions: opening the "black box" of labour and mobility in national innovation systems

The basic relationship between output growth and employment growth has been demonstrated for some OECD countries and sectors within countries. It is suggested that this should be linked with the concept of mobility within a globalising NIS framework. This relationship appears to be strongly associated with low-skilled employment growth rather than with high-skilled growth. Thus, once a deeper investigation of basic relationships is undertaken, things become extremely complex.

Taken within a systems approach, this leads to the study of problems such as labour mobility, competence building, careers, skills and training. There are crucial differences between the skill levels and transfers of labour required by innovating and non-innovating parts of the system. The mobility of low-skilled workers is as crucial to output growth as the mobility of high-skilled workers may be to innovation.

Any analysis of economic systems and labour markets that focuses only on high-skilled labour is going to be weak – although it is not a focus of attention in most current research, low-skilled labour mobility may be just as important. A systemic approach requires that all levels of labour mobility be taken into account.

A research programme is necessary to explore these issues further. This will have to be multidisciplinary and will require advanced methodological and theoretical developments as well as the collection of new data and the imaginative use of existing data sources.

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Chapter 4

JOB MOBILITY IMPLICATIONS OF THE HRST DEFINITION: ILLUSTRATED BY EMPIRICAL NUMBERS FROM REGISTER DATA

by

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Introduction

Knowledge accumulation and knowledge diffusion are fundamental explanatory factors in newer economic growth theory (see Romer, 1986, among others). Hence, physical mobility of knowledge workers has an immediate influence on the economy. The higher the knowledge level, the more able the economy to innovate and implement innovations. Similarly, significant mobility of highly educated or innovation-important workers secures the diffusion and circulation of the tacit knowledge that increases overall knowledge and innovation ability through on-the-job knowledge exchange, *i.e.* learning-by-doing (Arrow, 1962).

This chapter examines the mobility of employees and the consequential diffusion and circulation of knowledge for the sub-group of the labour force defined as human resources in science and technology – HRST. The HRST population is defined by the "Canberra Manual" as being either highly educated or employed in jobs with high innovation potential, *i.e.* professionals and technicians (OECD and Eurostat, 1995). The HRST workforce is an important determinant of innovation power in the knowledge economy where both the narrowly defined R&D and the more broadly defined innovation are significant contributors to economic growth (Tsipouri, 2001).[1] The job mobility of the HRST population indicates how well knowledge is circulated, exchanged and accumulated in the economy. Mobility of employees, and especially that of innovative HRST employees, is one of the cornerstones of national innovation systems (OECD, 1997, 1999).

The rationale for analysing HRST mobility is described in more detail below. However, the knowledge embodied in the HRST population is important both for establishments and for the economy as a whole. Continuous circulation of knowledge – among employees, between firms or

* Financial support from the Danish Institute for Studies in Research and Research Policy is gratefully acknowledged. Research assistant Mette Lemming has performed valuable research assistance in the preparation of this chapter. This paper is part of a larger study at The Danish Institute for Studies in Research and Research Policy on knowledge mobility and benchmarks on decomposed human mobility rates. The study also participates in a Nordic research project on competence flows and the OECD Focus Group research project on job mobility and human resources.

research organisations – fulfils two objectives: circulating new knowledge; and increasing the performance and efficiency of the workforce, thereby enabling further economic growth.

This chapter investigates the consequences of adopting various definitions of HRST based on different combinations of educational or occupational information. In general, the educational identifier can be used, since the occupational identifier requires that the worker must be employed before it can be defined. The two identifiers, respectively, give rise to the HRSTE and the HRSTO sub-groups of the HRST population. Their common elements define the core group, HRSTC (Table 1).

Table 1. **Categories of the HRST population**

HRST population		**Education**[*)]		
		3rd level education ISCED '76={5,6,7}	Below 3rd level education ISCED '76 < 5	Total
Occupation	Managers Professionals Technicians	HRST Core	HRST Without 3rd level education	HRSTO
	Other occupations	HRST Non-core		HRSTN
	Unemployed or	HRST Unemployed		HRSTU
	Inactive	HRST Inactive		HRSTI
Total		HRSTE	HRSTW	**HRST**

Note: ISCED '76 is used in this table although ISCED '97 has been implemented from 1998 on. In ISCED '97, third-level education corresponds to the values 5a, 5b and 6.

The following section defines the job mobility rates used in this chapter and presents the implications of using register data, definitions of job mobility and an overview of some stylised facts concerning job mobility rates.

Next, several probability models are presented. The models are estimated both on the mobility probability and on the number of job shifts over a ten-year period. They are estimated for the different HRST populations and the outcomes are compared. A variety of explanatory variables is used in these regressions; for example, the GDP real growth rate, which determines business cycle influence, age group, educational level, and workplace size variables, among others, to determine individual effects as well as technology, sectoral and economic scale effects.

Knowledge and economic growth

The original growth model developed by Solow operates with capital and labour as the only inputs. However, these two factors are only able to explain parts of the empirical figures on growth. The Solow model claims that in the long run growth rates are similar for all countries. This is not empirically evident since countries experience different growth rates, even in the long run. Hence, there is a residual which cannot be explained. This residual, so-called total factor productivity (TFP), is necessary to augment the output of the two inputs to equal the observed growth levels. TFP has been explored in various studies and one explanations for it is that TFP reveals differences in technical progress, in knowledge levels and in innovation abilities. Therefore, knowledge and knowledge

diffusion may create an environment in which higher economic growth is possible with the same input of capital and labour. The latter argument is defended in Mankiw *et al.* (1992) in a study that supports an extended version of Solow's model where physical capital is separated from knowledge capital. However, the empirical evidence in the study seems to be highly dependent on the countries studied. A smaller study of OECD countries in Mankiw *et al.* (1992) does not reveal the same support.

The endogenous growth models developed in the 1980s and 1990s have attempted to decompose and explain the TFP portion of the neo-classical growth model. In general, the empirical outcome is models which, in practice although not theoretically, are augmented versions of the original Solow model. Romer (1986) argues that increasing knowledge imbedded in humans, *i.e.* human capital, increases production efficiency and that the consequential learning increases the knowledge accumulation in the economy. Romer (1990) further develops these arguments in a policy recommendation that the quality of the knowledge stock determines the level of economic growth. In his model, he finds that investment in knowledge is a deliberate decision made by firms (and governments) to improve productivity (and efficiency) in the economy. Lundvall (1992) argues that the channels through which the knowledge is spread are as important as the knowledge creation itself. Hence, networks, institutional structures, new knowledge carriers that diffuse the newest research results, etc., are equally important. It also means that a country or a firm/university can lose growth potential if some research areas are abandoned (Salter and Martin, 1999). Hence, diffusion of knowledge through job mobility to all sectors of the economy is preferable.

The knowledge and innovation created at publicly owned universities and research institutes contribute to the diffusion of highly educated innovative workers throughout the economy. The social value of the candidate production and mobility of researchers is usually far above the corresponding private value (Salter and Martin, 1999). Salter and Martin also find that one of the most important channels for knowledge diffusion is through candidates from universities.

From a socio-economic point of view, the effective circulation of the publicly provided increase in knowledge is important for overall economic growth. Externalities in private investments in new knowledge means that the social returns from investment in knowledge are higher than the private returns to the firms or individuals (Firth and Mellor, 2000). Hence, there are cases where the public sector, *i.e.* public universities and research institutions, invests in profitable knowledge improvements that would not otherwise be performed. At a later stage, efficient knowledge infrastructures in which HRST employees move between jobs are of vital importance in creating the social return that justifies the public investment.

The importance of definitions of HRST

Recognising that human capital is vital for growth in knowledge-based economies (Laafia, 2000; Eurostat, 2001), leads to an interest in measuring highly qualified human resources. The "Canberra Manual" (OECD and Eurostat, 1995) defines a cohort of highly qualified workers; namely, the HRST population. The HRST population of innovative workers is of particular interest since its relative size correlates positively with economic growth, but also because the "Canberra Manual" provides a common definition based on international co-operation, *i.e.* it permits cross-country comparisons. However, the HRST definition does not identify only highly qualified workers, it includes non-innovative workers and excludes workers that are innovative in other job categories (Ekeland, 1998). The advantages and disadvantages of the "Canberra Manual" definition of HRST have been discussed in the literature, for example, in Ekeland (1998) and Laafia and Stimpson (2001), and will not be pursued further in this chapter.

In the original "Canberra Manual" definition, managers without third-level education were included in the HRSTO population. A sensitivity study carried out in 1995 reported that large variations in country definitions of managers distorted the figures considerably (Laafia and Stimpson, 2001). Hence, in later studies Eurostat excludes this category of managers; this is also the approach adopted in this chapter. According to the "Canberra Manual", a HRST person fulfils the following conditions: completed third-level education corresponding to bachelors, candidates, masters, etc,. as measured by ISCED (UNESCO, 1976, 1997) *or* employed in a science and technology occupation that usually requires third-level education as measured by the ISCO classification (ILO, 1988).

Inspired by Laafia (2000), the two requirements defining the HRST population are presented more schematically in Table 1 where the HRSTE population added to the HRSTO population gives the HRST population. As can be seen from Table 1, the HRST population also includes non-working people. Employees fulfilling both criteria make up the core HRST population.

Although the HRST population is defined on the basis of two well-implemented classifications, ISCED and ISCO, the HRST population is influenced by national variations in the implementation of these. For example, the HRSTE part includes unemployed and inactive persons although they do not have a formal job. Hence, they are included in the population stock, but not in the stock of workers. By contrast, the HRSTO part only identifies workers, *i.e.* persons with an occupation. An unemployed person who was previously employed as a technician is counted in the HRST population if, and only if, he has a third-level education. In such cases, increases or decreases in the HRST population can be caused by external factors such as fluctuations in the business cycle. Particularly, in comparisons of the HRST stock over time or across countries, care should be taken to avoid uncritical use of the HRST definition.

In order to set some numbers on the sensitiveness of the definition of the HRST population, actual numbers are given in Table 2. Table 2 follows the same format as Table 1 and indicates the approximate number of people that would be included in the HRST stock depending on whether only workers or the entire population are included, *i.e.* the HRSTO, HRSTE or HRST population. The numbers are averages for 1988-97. As can be seen from Figure 1, the HRST share of the labour force rose moderately over the period. However, since the share of the labour force remained relatively stable over the study period, the average for 1988-97 shown in Table 2 is a representative measure of the HRST stock.

Table 2. **Average HRST population in Denmark in the 1990s**

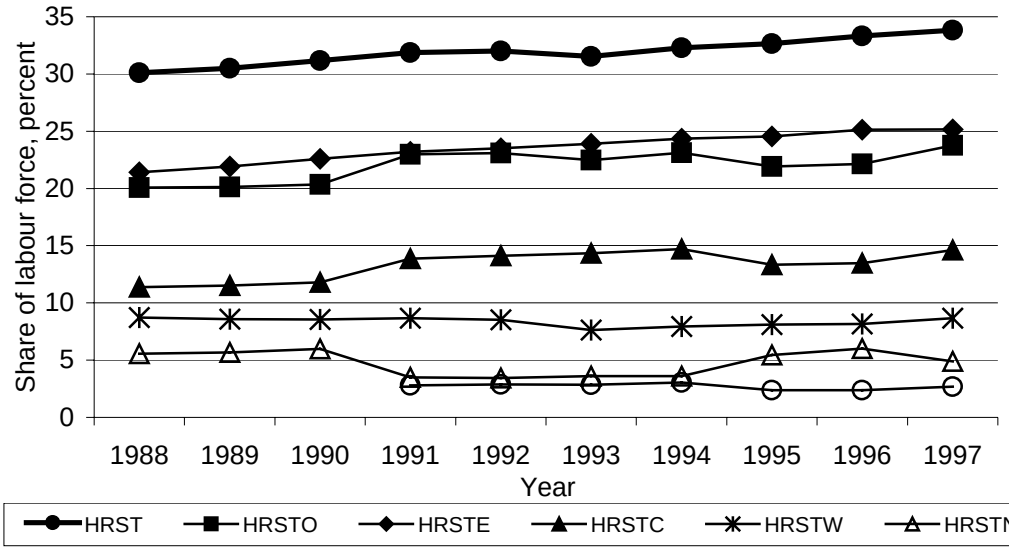
Share of total HRST in brackets; share of men in each sub-group in parentheses

The HRST population		**Education**		
		3rd level education ISCED76={5,6,7}	Below 3rd level education ISCED76 < 5	Total
Occupation	Managers Professionals Technicians	386 260 [42] (46)	242 578 [26] (51)	628 838 [68] (48)
	Other occupations	138 564 [15] (58)		138 564 [15] (58)
	Unemployed or Inactive	159 222 [17] (48)		159 222 [17] (48)
	Total	684 045 [74] (49)	242 578 [26] (51)	**926 623** **[100] (49)**

Note: Average number of persons in 1988-97.

Figure 1. **Stock of HRST and selected sub-populations, 1988-97**

Share of labour force



Note: Due to missing information, highly educated managers are not included in the HRSTO definition for 1988-90. Instead they are included in the HRSTN sub-group. Hence, the HRSTO population increases and the HRSTN population decreases between 1990-91.

According to register data, the HRST stock in Denmark in the 1990s was 1 million persons. Compared to Eurostat (2001) numbers for 1999 based on the Community Labour Force Survey (CLFS), the numbers in Table 2 are around 75-80% of the Eurostat figures, no matter whether the HRST, HRSTE, HRSTO or HRSTC definition is used. Hence, it seems likely that either the registers under-report the actual status of the individuals or that individuals over-report their status in the CLFS. The reality may be somewhere in between. However, the differences pinpoint the caution that should be employed in any comparison of figures based on different data sources. Since the difference between the numbers in Table 2 and the numbers from the CLFS seems to be general, the distribution of people in the different categories in Table 2 is assumed to be sufficiently representative to enable a general analysis. The same holds true regarding the CLFS data.

The core group, HRSTC, accounts for 42% of the total HRST population. The remaining part of the HRSTO population amounts to 26% of the total. The remainder is either employed in a non-S&T occupation (15%), or is not employed at all (17%). The exclusion of the latter group has a considerable impact on the conclusions drawn from HRST studies. Using, for example, solely employees in S&T occupations (HRSTO), or solely the highly educated (HRSTE), leads to an underestimation of the HRST population stock of approximately 25%.

Some 26% of the HRST population has below third-level education. This corresponds to 39% of workers in S&T occupations, *i.e.* HRSTO. Similarly, 56% of the highly educated hold S&T positions, *i.e.* HRSTC, while 68% of the total HRST population does the same, *i.e.* the whole of the HRSTO group. The gender distribution which is more or less equal overall, varies between the sub-groups of the HRST population: from 46% of men in the HRSTC group to 58% of men in the HRSTN group. The gender inequality in the stock is even more pronounced when the scientists and engineers are analysed (Table 3).

Table 3. **Average S&E population in Denmark in the 1990s**

Share of the total S&E in brackets; share of men in each sub-group in parentheses

S&E population	Education		
	3rd level education ISCED76={5,6,7}	Below 3rd level education ISCED76 < 5	Total
Professionals	67 000 [85] (71)	11 639 [15] (79)	78 639 [100] (72)

Note: Average number of persons in 1991-97.

Science and engineering (S&E) is an interesting HRSTO subgroup, consisting of physical, mathematical and engineering professionals and life science and health professionals. The formal classification is ISCO 21 or 22, covering the above-mentioned occupations together with an employment requirement. The S&E group is directly related to the ability to handle and implement technological innovations. For example, S&E workers are on average more innovative than HRST workers (Eurostat, 2001), and the S&E population is of high policy interest in the development of the European Research Area implemented in the forthcoming 6th EU Framework Programme for Research and Technological Development (RTD) (see, for example, Laafia and Stimpson, 2001; and European Commission, 2000). An estimation of the stock of S&E workers over time is given in Figure 1 while the average stock is shown in Table 3. The gender breakdown is, as would be expected, two-thirds men, one-third women.

Table 3. **Average S&E population in Denmark in the 1990s**

Share of the total S&E in brackets; share of men in each sub-group in parentheses

S&E population	Education		
	3rd level education ISCED76={5,6,7}	Below 3rd level education ISCED76 < 5	Total
Professionals	67 000 [85] (71)	11 639 [15] (79)	78 639 [100] (72)

Note: Average number of persons in the period 1991-97.

Again, the figures based on register data are lower than the corresponding figures based on the CLFS given in Eurostat (2001). This time, the difference is large, around one to two in favour of the CLFS. It would seem that register data have difficulty in identifying occupation at the two-digit level. Several employees are classified as ISCO 20, a non-existent category used in the registers to indicate that the person is a professional, ISCO=2x, but that no information is known about the second digit. This solution is unique to Denmark and was chosen by Statistics Denmark. The problem is mentioned in Laafia and Stimpson (2000) in relation to the Danish part of the CLFS. Hence, the figures in Table 3, defined as ISCO 21 and 22, under-represent the actual stock of S&E in Denmark. An approximate figure for the S&E stock in the 1990s is probably around 120 000, above the stock shown in Table 3 and a little below the figure of 143 000 given in Eurostat (2001) for 1999.

Figure 1 shows the Danish HRST stock as a share of the labour force. The total HRST population increases over the study period, as is also found in Eurostat (2001). However, the increase occurs among the highly educated, *i.e.* the HRST and HRSTE shares are developing in parallel. In contrast, the HRSTO and HRSTC population shares increase only slightly, while the share of less-educated S&T employees, HRSTW, remains more or less constant.

Since one aim of the study is to present mobility rates for the HRST population, it is interesting to investigate the rates for the various sub-groups of the population. Table 4 shows job-to-job mobility and overall mobility rates for the three HRST groups, HRST, HRSTO and HRSTE, and for the S&E group (see Box 1 for definitions of mobility rates).

Table 4. **Mobility rates for different HRST sub-populations**

HRST type• • **Mobility type**	HRST	HRSTO	HRSTE	S&E
Job-to-job inflow mobility rates	19.0	18.1	19.5	21.3
Overall inflow mobility rates	25.0	23.0	26.0	26.1

Note: Mobility rates are defined in Box 1. Numbers are averages for 1988-97.

Both job mobility rate measures are biased downwards when only the HRSTO population is used in the calculation, and biased upwards when only the HRSTE population is used. However, the bias is relatively low and least for the HRSTE population compared to the total HRST population. Hence, if information on occupation or education is missing, it is still possible to calculate and use mobility rates that are fairly representative for the HRST population. Finally, the mobility rates for the S&E population are highest, even higher than the HRSTE figures. This means that the S&E population has mobility rates that are 5-10% higher than those for the HRST population in general. In particular, the job-to-job mobility rate is relatively higher for the S&E population. These findings are also confirmed over time (although these results are not shown here).

Box 1. **Definitions of job mobility**

Inflow mobility

Job-to-job mobility is defined as a shift of workplace between the previous year and the current year, *i.e.* shift between two jobs, *i.e.* MOVERS.

Overall job mobility is defined as MOVERS plus NEWS moving into a job from the no-job state, *i.e.* ALL MOVERS = MOVERS + NEWS.

No mobility is defined as the total number of employees employed at the same workplace in both years, *i.e.* STAYERS.

Inflow mobility rate

The *job-to-job inflow mobility rate* is defined as the number of employed movers between two consecutive years divided by the total number of employees this year, *i.e.* MOVERS / (ALL EMPLOYEES).

The *overall inflow mobility rate* is defined as the number of employees not having the same job the previous year divided by the total number of employees this year, *i.e.* ALL MOVERS / (ALL EMPLOYEES).

Register data, mobility rates and stylised facts

Use of register data in analyses of knowledge circulation in the form of physical mobility has both advantages and disadvantages.[2] The registers cover all persons employed at the establishment level, thus there are no sampling errors in the data. Employees can be followed forth and back in time for as long as they have been living in Denmark. Unfortunately, individuals are given occupational codes by their employer, who has no other than legal incentives to correct the codes if they change over time; hence, some of the codes may be outdated. Similarly, more specialised information, such as titles, which may be of importance in classifying occupations, are not immediately available. Such

information can more accurately be collected in surveys (although these often miss the time dimension and contain sampling errors).

Another speciality in registers is the period of coverage, usually one year. Hence, the information on occupation comes from the main job in the year; job mobility as well as job sector is measured once a year, usually in the first week of November. This means that the observed job mobility rates are biased downwards since they only count employees once even though they may move jobs more than once during the year. The registers also lack information on the education levels of foreigners working in Denmark. Hence, the labour force includes these employees, but they are registered without providing any information on their educational achievements. This reduces the HRST population by an unknown factor, which may lie around 5% if foreigners are educated to similar levels as Danes.

Job mobility and the job mobility rate can be defined in various ways. Box 1 provides the definitions used in the present chapter. The distinction between job-to-job mobility and overall mobility is explained, together with the corresponding mobility rates. Only inflow mobility, *e.g.* into job mobility, is used in this chapter.

Studies by Graversen (2000) and Graversen *et al.* (2001) provide some stylised facts on how job mobility rates vary over the business cycle and over some of the background characteristics used as explanatory variables in the model set out below. The findings are based on studies of the Nordic countries using register data. Although the findings are not directly transferable to the HRST population, they can explain some of the observed variations, trends and systematic differences. Generally, workers in all the Nordic countries demonstrate high mobility, with some 25% changing job each year. The rates rise during economic upturns, and are higher for young people, highly educated individuals and workers at small workplaces.

Job mobility rates for the HRST labour force

This section analyses the mobility rate for the HRST population. A model of the probability of job changes is estimated on the entire HRST population and on sub-groups of this, together with a second model of the number of job shifts in a ten-year period in a balanced sample of the HRST and S&E populations. Only job-to-job mobility is used.

Probability models on the propensity to change jobs

First, a probability model is estimated for the propensity for job mobility. A simple logistic model on the probability to move into a job is estimated for the full HRST, for the smaller HRSTE and HRSTO as well as for the S&E population separately. Second, an ordered logistic model on the restricted sub-sample of the HRST and the S&E population fulfilling the HRST (or S&E) definition in all ten years from 1988-97 (or 1991-97) is estimated. Table 5 presents the results for the job-to-job mobility propensities.

A number of background variables are included in the models. The reference person is a 35-44 year old highly educated woman working in the agricultural sector as a physical, mathematical or engineering science professional (ISCO=21) at an establishment with 1-9 employees. Hence, the coefficients in the table are additional effects relating to a change in one of these reference characteristics, all else being equal. The estimation results in Table 5 show relative stable coefficients across the samples. Hence, the mobility patterns seem to be relatively identical for all groups, fitting well with the stylised facts in the general Nordic study (Graversen *et al.*, 2001). However, as discussed below, there are some differences in the parameter estimates across the samples.

Table 5. **Job-to-job mobility propensities for the HRST population in Denmark, 1991-97**

Logistic models on pooled data sets

Population Explanatory variables	HRST	HRSTO	HRSTE	S&E	HRST	S&E
Business cycle indicator	Binary logit model				Ordered logit model	
GDP real growth rate	0.026*	0.030*	0.024*	0.022*	0.071*	0.029*
Gender						
Male	0.117*	0.164*	0.058*	0.300*	0.306*	0.642*
Age groupings						
20-24	1.274*	1.334*	1.283*	1.700*	2.090*	1.762*
25-29	0.844*	0.836*	0.949*	0.658*	1.349*	-0.081*
30-34	0.446*	0.478*	0.481*	0.428*	0.743*	0.166*
45-54	-0.379*	-0.384*	-0.384*	-0.497*	-0.659*	-0.992*
55-64	-0.706*	-0.742*	-0.685*	-0.912*	-1.133*	-2.004*
Above 64	-0.225*	-0.187*	-0.220*	-0.495*	-0.564*	-1.046*
Educational level						
1st level	0.268*	0.248*	-	-0.305*	0.309*	-2.742*
2nd level	0.034*	0.010*	-	-0.030	-0.080*	-2.170*
PhD	0.165*	0.148*	0.190*	-0.286*	0.456*	-2.521*
Working sector						
HEI sector	0.062*	-0.046*	0.059*	0.318*	-0.519*	0.444*
ICT sector	0.225*	0.238*	0.164*	0.080*	0.154*	0.002
Trade	0.083*	0.101*	0.050*	-0.028*	0.162*	-0.065*
Community service	0.113*	0.104*	0.145*	0.223*	-0.001	0.179*
Unknown	2.805*	2.932*	2.747*	2.097*	2.426*	0.854
Establishment size						
10-49 employees	-0.198*	-0.266*	-0.194*	-0.111*	-0.145*	0.626*
50-99 employees	-0.261*	-0.317*	-0.272*	0.041*	-0.233*	1.319*
100-249 employees	-0.145*	-0.167*	-0.120*	-0.052*	0.055*	0.706*
More than 249 employees	-0.222*	-0.279*	-0.239*	-0.159*	0.095*	1.175*
Occupational code						
Professionals						
No inf. on discipline	-0.135*	-0.071*	0.192*	-	0.155*	-
Life science and health	0.440*	0.490*	0.391*	0.470*	0.851*	0.820*
Teaching	-0.250*	-0.116*	-0.340*	-	-0.169*	-
Other professionals	-0.009	0.039*	-0.006	-	0.147*	-
Technicians						
No inf. on discipline	-0.175*	-0.160*	-0.715*	-	0.863*	-
Physical, mathematical or engineering science	-0.125*	-0.108*	0.073*	-	0.133*	-
Life science and health	-0.053*	0.007	-0.149*	-	-0.163*	-
Teaching	0.196*	0.257*	0.104*	-	0.621*	-
Other technicians	-0.010*	0.015*	0.114*	-	0.471*	-
HRST Managers	0.203*	0.242*	0.220*	-	0.266*	-
HRST Non-core	0.108*	-	0.089*	-	0.352*	-
Pseudo-R^2	0.256	0.248	0.211	0.088	0.615	0.303
Number of observations	5 077 254	4 297 413	3 486 651	523 954	3 105 710	149 982
Sample	Unbalanced				Balanced	

Note: The constant terms are omitted from the above table, but can be obtained from the authors.

*: Significance at the 5% level. The reference person is a 35-44 years old woman with a Master's degree employed in the agricultural, etc., sector as a physical, mathematical or engineering science professional (ISCO=21) at an establishment with 1-9 employees.

The GDP real growth rate is used as an approximation of the business cycle. An increase indicates improving economic conditions. The positive coefficient to the explanatory variable indicates that the into-job mobility rate is pro-cyclical. A 1% increase in the GDP real growth rate increases the job-to-job mobility rate by 2-3%. The coefficients for the balanced samples are generally slightly higher than those for the unbalanced samples, indicating that job mobility reactions to variations in the business cycle are smaller for the latter group. In particular, the balanced sample of HRST workers shows a stronger reaction to business-cycle changes.

The gender coefficient reveals that male HRST change jobs more frequently than do female HRST. This is less pronounced when the overall mobility rate is used (not shown in here). Hence, men have a higher mobility rate; however, more women than men experience a period of unemployment between jobs.

The age dependence is very stable, decreasing with age except for the oldest workers.[3] This is in line with both search theory and match theory. It takes a number of trials before one finds the perfect job or the perfect job match. The age variable is highly correlated with corresponding variables measuring job experience and job tenure. Since these factors are more difficult to measure in, for example, surveys, the age variable is chosen in the present analysis.

Compared to academics, all other HRST workers show higher job mobility rates, except for S&E, where the opposite holds. Hence, the most stable portion of the HRST population, *i.e.* academics, changes jobs less often.

Comparing sector-specific job mobility rates, employees in the ICT and community service sectors have the highest rates of mobility. Again, S&E is slightly different, demonstrating the highest job mobility rates in the HEI and community service sectors. Employees in the "unknown" sector are few and are usually present in only a few periods, *i.e.* the firm may lack information on the sector to which the worker belongs.

Job mobility rates decomposed by establishment size, *i.e.* number of employees, fit only the stylised facts for the unbalanced sample. The rates decrease in line with establishment size, indicating that larger establishments may have larger internal job circulation, that small establishments may need faster knowledge recruitment due to expansions, or that smaller establishments often emerge (and disappear), hiring rapidly and firing equally rapidly. However, looking at the balanced sample, higher job inflow rates occur for S&E, especially when they are employed at larger establishments. Larger establishments may be more innovative and employ more researchers, thus confirming the present findings if the balanced sample indicates a higher rate of researchers among the HRST and S&E populations than the unbalanced sample.

Decomposing the mobility rates by occupation and work discipline reveals a mixed pattern. Life science and health professionals generally demonstrate higher job mobility rates than do physical, mathematical or engineering science professionals. Teaching professionals have lower mobility rates. On the other hand, technicians appear to have lower mobility rates (except teaching technicians). Again, the balanced sample results are somewhat different. Managers generally show high job mobility rates, as do non-core HRST employees.

In general, the coefficients in the estimated models show the same patterns and tell the same story. Hence, an estimated model based on the smaller HRSTE population may be as good as a model based on the HRSTO population or even the S&E population. However, there are significant differences in the estimated coefficients when a balanced sample is used instead of an unbalanced sample.

A comparison of the estimation results in Table 5 with the corresponding coefficients in an estimation of the overall mobility rate shows similar robustness in the findings. Expanding the samples with into-job mobility from outside employment does not significantly change the conclusion from Table 5. Although gender differences decrease, all other coefficients in Table 5 approximately equal the corresponding coefficients in probability models on the overall mobility rate.

Conclusion

This chapter examines how knowledge diffusion and circulation caused by job mobility of employees are influenced by the choice of the sub-group of the labour force to be analysed. The population studied here is the group defined as human resources in science and technology – HRST. The HRST population comprises persons that are either highly educated *or* are employed in jobs with high potential for innovation, as defined in the "Canberra Manual". The HRST workforce is an important determinant of innovation power in the knowledge-based economy, where both the narrowly defined R&D and the more broadly defined innovation make a key contribution to economic growth. The job mobility of the HRST population indicates the extent to which knowledge is circulated, exchanged and accumulated in the economy. Mobility of employees, especially innovative HRST employees, is a significant component of a country's national innovation system.

The chapter analyses the consequences of various definitions of HRST based on combinations of educational or occupational information. The educational identifier can be used generally while the occupational identifier requires employment before it is defined. The two identifiers define the HRSTE and the HRSTO subgroups of the HRST population. In common they define the core group, HRSTC. The core group covers 42% of the HRST population, with a small female majority. The HRSTO group represents 68% and the HRSTE group 74% of the HSRT population. There is a male majority among the non-core highly educated employees. The sub-group of S&E is highly male-dominated (72%). Although the register-based figures underestimate the corresponding CLFS figures (see Eurostat, 2001), the distributions are believed to be representative. The job mobility rates for the various HRST sub-groups reveal such a high degree of similarity that general comparisons can be made across the sub-groups. Hence, for example, mobility rates based on the HRSTE population solely can be approximated to cover the entire HRST population.

Next, the chapter presents estimation results on job shifts for the four HRST samples. An ordered model is also estimated in a balanced sample on the number of individual job shifts over a ten-year period. A variety of explanatory variables is used in these regressions; for example, the GDP real growth rate, which determines business cycle influence, age groups, educational levels, and workplace sizes, among others, to determine individual specific effects as well as other demand effects. The results are remarkably stable across the four HRST samples, although they differ somewhat for the S&E sample. In general, the estimations from the four unbalanced HRST samples confirm the stylised facts presented in Table 5. The balanced sample estimation results differ with respect to establishment size and occupation codes. However, this is to be expected since the balanced sample fulfils the HRST definition in all ten years. It is generally true that register data reveal higher mobility rates than do LFS data (Laafia and Stimpson, 2000; Nås *et al.*, 1998).

The decomposition of the HRST population shows a core group of 40%, 85% of HRST is employed and the HRST population makes up nearly 35% of the labour force. Into-job mobility is high, at around 20%-25% depending on the population studied. Hence, knowledge diffusion among the HRST population in Denmark is significant, giving support to the notion of an innovation-friendly environment with regard to knowledge resources, *i.e.* a national innovation system capable of handling inventions throughout the economy and continuously increasing the economic growth rate.

NOTES

1. Innovation power is defined as the economy's ability to innovate, *i.e.* to develop and implement new inventions.

2. The IDA register database is used in the present study. IDA is the Danish abbreviation for the "Integrated Database for Labour Market Research". IDA was created by merging of existing national registers; in principal, it covers the last 25 years. The database is longitudinal in its construction and has unique links between employees and employers/establishments over time through a November registration each year. We use data for the period 1988-97.

3. Possibilities for early retirement, part-time jobs and pensions, etc., increase the mobility rate among the remaining part of the oldest workers.

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Chapter 5

FIRM DEMOGRAPHY: MAPPING FIRM DYNAMICS USING HUMAN RESOURCE DATA

by

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Introduction

Economic growth is the main policy goal of national governments, regional bodies such as the European Union, and international organisations such as the OECD. The provision of a welfare system and full employment are considered of prime necessity. In a knowledge-driven economy, innovative SMEs and new firms play an key role in generating new jobs and economic growth. There is evidence to show that jobs are moving out of the traditional manufacturing sector to the service sector, and that net employment increases have come from SMEs rather than from large firms. However, the problems associated with monitoring growth at both the micro- and macroeconomic levels are considerable. Job destruction in some firms and sectors can result in job creation in others (*e.g.* through outsourcing or spin-offs). The creation and destruction of firms can have very different causes and very different effects: compare a spin-off or a merger with the creation of a completely new firm or the closure of an existing firm. Are new and small firms generators of growth? Or are the human resources and knowledge base contained in large firms the real engines of growth?

The firm demography project carried out at the Swedish Agency for Innovation Systems (VINNOVA)[1] aims to develop a method for studying firm dynamics by defining firms[2] as sets of employees rather than as legal entities. The basis of the exercise are yearly employment and organisation registers, in which organisations and individuals can be linked. Basically, if a sufficiently large proportion of the employees of a firm can be found in the same organisation the following year, the firm is considered to be a survivor, regardless of any changes in name, ownership, etc. In the same way, we have defined different types of spin-offs, mergers, acquisitions, etc. We believe that the firm demography project will provide a truer picture of firm creation, its roots and its effects on employment. It will also provide answers to questions concerning firm destruction (*e.g.* what happens to the employees of firms which disappear? Are they scattered or are they absorbed as groups into other organisations?).

Background

There are many types of firms, varying in terms of size, industrial sector, maturity, innovativeness, survival rate, and so forth. Our understanding of the firm dynamics (creation of firms, growth, destruction, etc.) is based primarily on macroeconomic data and limited panel or survey data. Panel and survey data provide a clearer picture than do macro data, but are limited by the size of the population. From the available statistics, we can conclude that firms are born, jobs created, firms close and jobs disappear, but we cannot identify either the roots of new firms or the factors that generate long-term growth or employment. New firms can be created more or less in isolation from other activities or they can result from spin-offs, mergers or existing activities. If we consider firms as "milieus for competence" – competence embedded in the organisation by combinations of employee skills and organisation-specific knowledge – the fact that, for instance, a firm disappears is not as important as knowing *how* the firm disappears: Is it simply shut down and the employees scattered? Or is it bought up by or merged with another firm? Do the employees leave in groups to go to other firms or do they start up new firms, again in groups? In other words, when firms disappear, what happens to the competence and skills embedded in the organisation? A closed firm with its employees scattered is an example of negative job destruction, *i.e.* the competence embedded in the organisation is lost. On the other hand, if the employees are absorbed in groups into other firms, there is a much higher likelihood that organisation-specific knowledge is carried on to the absorbing organisation. The effects on long-term growth are quite different.

Another problem with existing statistics on firm creation and destruction is that they do not always mirror real events. In most statistical systems, firms are identified by name or by some sort of identification number. This has been the case in Sweden, where firms are attributed an organisational identification number. The system works fairly well but problems arise when firms change their legal status, name, etc. When its legal situation changes, the firm's identifier is changed and it is registered as a new firm, even though no major changes have taken place in its activities.

The above discussion illustrates the need for a more elaborate way of studying firm dynamics. Ultimately, it would be useful to have longitudinal micro data covering the whole economy. The firm demography project represents a considerable step forward towards gaining a better understanding of firm dynamics and job creation/destruction.

The firm demography project at VINNOVA

Together with Statistics Sweden, VINNOVA is developing a new methodology to study the dynamics of firm creation and destruction – "firm demography". The result is a new longitudinal database covering all organisations from 1985 on (presently 1997). Not only does the database enable a validation of existing statistics on new-firm creation, it also provides unique possibilities to study survival rates, spin-offs, mergers, deaths, etc.

The basis for the database are the annual registers of regional labour markets, education and firms. The first two registers contain the entire Swedish population aged 16 and over, while the last one comprises a complete register of all organisations in Sweden. By linking the registers, employees can be linked to work establishments and firms. We can also determine the educational levels and fields of the employees, as well as the industrial sectors of organisations, work establishments and employees. By linking consecutive years, we can create longitudinal data on the dynamics of all organisations in Sweden.

The basic assumption for the firm demography database is that firms are fundamentally better defined by their employees than by an administrative name/number. Previous work undertaken in Denmark with the IDA database, and by Statistics Sweden on work establishment demography, has helped to lay the foundation for the firm demography database. In the past, analysis has concentrated on separating individually induced labour mobility from organisationally induced mobility. It has attempted to identify "real" new firms from those erroneously classified as new. The uniqueness of the firm demography database is that we have brought the logic one step further and set up operational criteria for a whole set of possible events relating to firm dynamics. Not only are we able to separate natural mobility from induced mobility, "real" new firms from false, we can also determine how new firms came into being and how existing firms disappeared.

The firm demography database

By studying flows of employees in, out and between organisations, we can determine whether firms should be classified as "survivors" or as some type of new firm (completely new firm, spin-off, merger, etc.). For instance, if a sufficiently large proportion of employees remains in a firm between time T and time T+1, the firm can be considered to be the same, regardless of any changes in administrative identification. In the same way, spin-offs are defined by both a minimum number and share of employees from the mother organisation. We used a specific set of criteria for firms with less than seven employees (taking into account work establishment location, sector, remaining employees, etc.), as well as allowing firms to grow or shrink organically without being classified as new (Tables 1 and 2). All organisations are given a firm demography ID which remains constant as long as the organisation is considered a survivor. The first figures of the ID show the year of creation, the last indicate how the firm was created. Linked to the firm demography ID of any given year is that year's organisational ID, permitting us to link the database with all other databases where the organisational ID is used.

Table 1. **Typology of (new) firms**

Spin-offs with sisters	One of at least two spin-offs originating from the same mother organisation in the same year, with the mother organisation surviving.
Spin-offs without sisters	Spin-off with surviving mother but without sister.
Splits with no surviving mother	Firms split up with no parts qualifying as spin-offs or cleavages.
Cleavages	Firms divided into two or three parts that would all qualify individually as survivors.
Mergers of whole firms	Firms merged that would all qualify individually as survivors, and where the merging parties are in the same order of size.
Mergers of spin-offs	Parties merged that would all qualify individually as spin-offs, and where the merging parties are in the same order of size.
Mergers of spin-offs with whole firms	Parties merged that would either qualify individually as spin-offs or survivors, where the merging parties are in the same order of size.
Survivors	Qualify as survivor but not as cleavages, or are fast grower or fast shrinkers.[1]
Fast growers (survivor)	Do not qualify as survivors because of too fast organic growth.[1]
Fast shrinkers (survivor)	Do neither qualify as survivors (because of too fast shrinkage), nor as part of cleavages or split-ups.[1]
Completely new	New firms that do not qualify in any other category, *i.e.* without roots in pre-existing firms.
Unknown	Unknown or survivors created pre-start year of the database.

1. Survivors retain their firm demography ID – in itself an indication of survival. This means that the origin and year of creation is preserved in the ID.

Table 2. **Typology of firms that have disappeared**

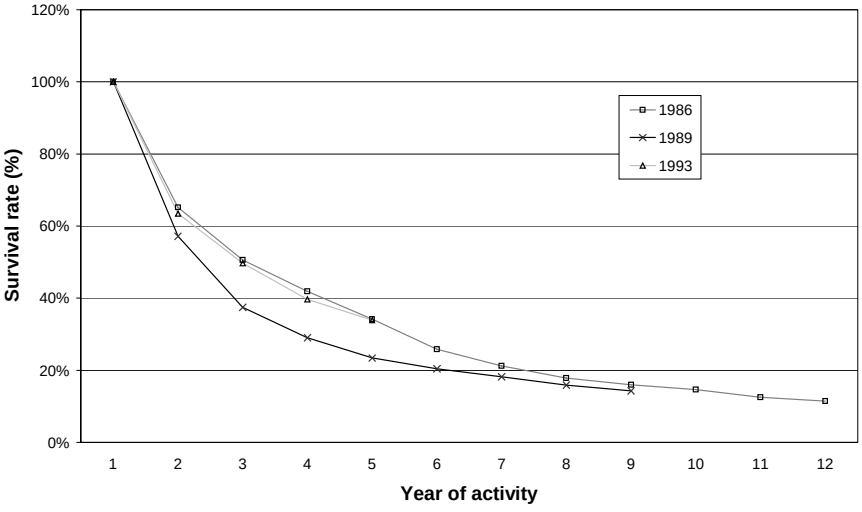
Whole firms	
Absorbed firms	Firms absorbed by significantly larger firms (the smaller firm would be in the magnitude of a spin-off compared to the larger firm).
Disappeared	Firms that disappear with out any trace.
Intermediary constellations	
Absorbed spin-offs with sisters	The same size criteria as absorbed and as spin-offs in Table 1.
Absorbed spin-offs without sisters	The same size criteria as absorbed and as spin-offs in Table 1.
Absorbed split-ups with no surviving mother	The same size criteria as absorbed and as spin-offs in Table 1.
Absorbed cleavages	The same size criteria as absorbed and as cleavages in Table 1.

An illustration of the possibilities of the firm demography database

As mentioned above, the firm demography database provides a range of possibilities for analysing job as well as firm creation and destruction. Coupled with other databases on employment, education, innovation and economic performance, the problem is one of a shortage of analysing capacity rather than scarcity of data. In this section, we illustrate the types of information that can be retrieved from the firm demography database. Given time constraints, work has focused on the firm demography database itself, rather than on attempting to link the data with other databases. The data are presented as they come, with no attempt to explain the findings. However, our intention is to present more detailed studies in the near future, incorporating data on education and age of employees.

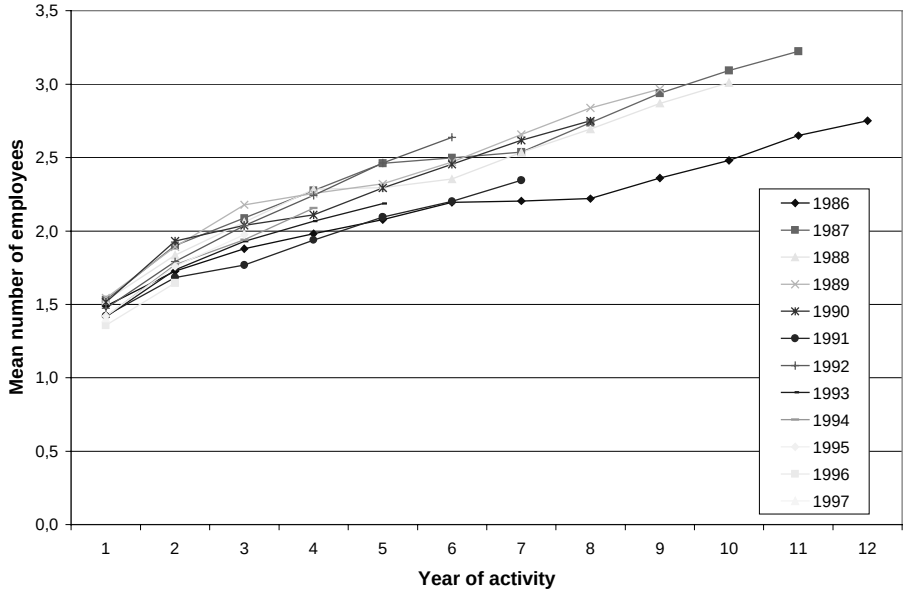
Figure 1 presents the survival rates of completely new firms (*i.e.* firms which do not have their origin in other organisations). The survival rate is very similar whatever the year of creation (although the effects of the deep recession in Sweden in the early 1990s are clearly visible on firms set up in 1989). Figure 2 shows how the average number of employees evolves for completely new firms by year of activity. Here, too, we find very similar patterns across different birth years, except for the first year of the study, 1986, which shows a weaker evolution than the following years.

Figure 1. **Survival rates of completely new firms created in 1986, 1989 and 1993**



Source: VINNOVA and Statistics Sweden.

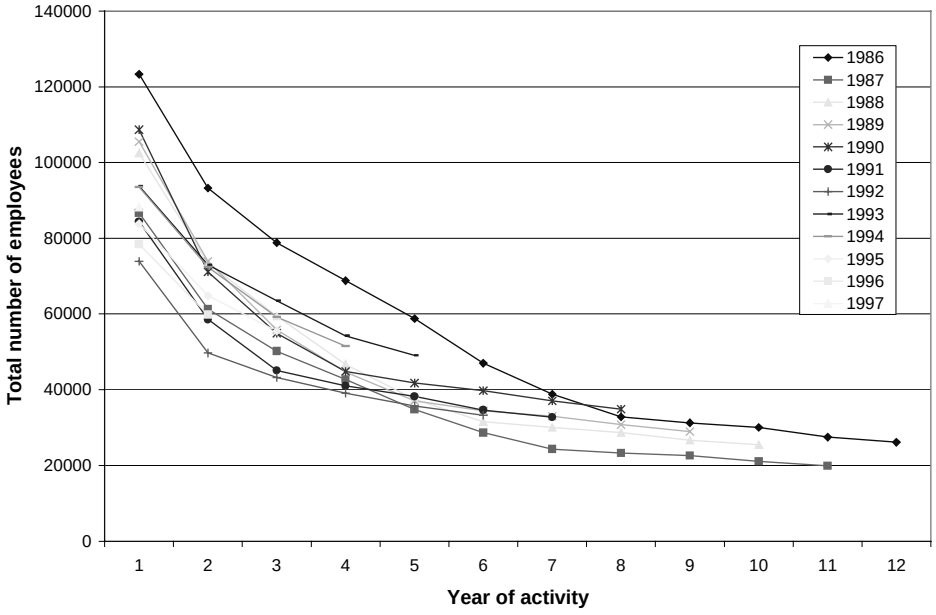
Figure 2. **Mean number of employees for completely new firms created between 1986 and 1997, by year of activity**



Source: VINNOVA and Statistics Sweden.

Given the relatively weak evolution of the mean number of employees compared to the death rate for completely new firms, it is not surprising that the net contribution to employment for each cohort of completely new firms decreases by year of activity (Figure 3).

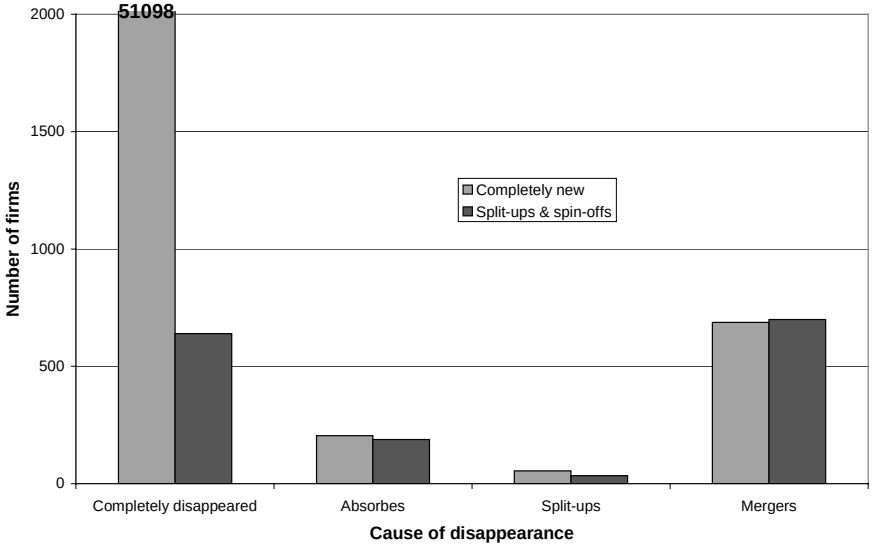
Figure 3. **Employment in completely new firms created between 1986 and 1997, by year of activity**



Source: VINNOVA and Statistics Sweden.

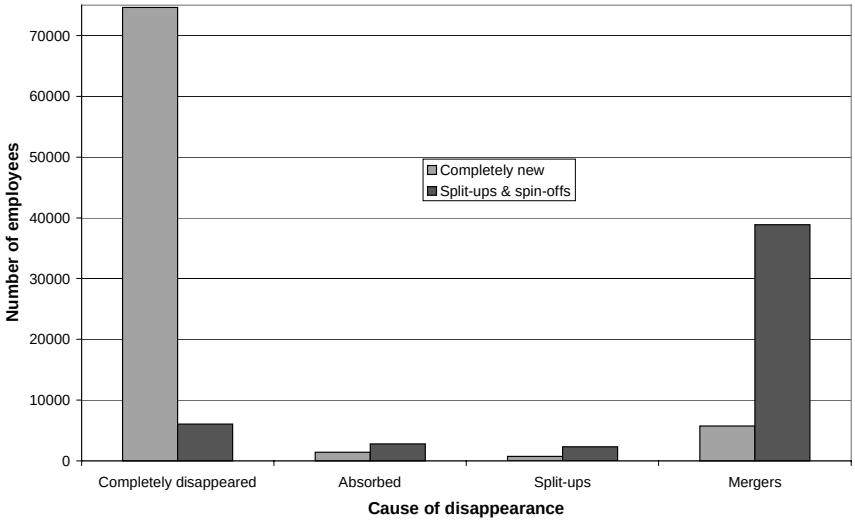
When the survival rates of completely new firms are compared with those of various kinds of spin-offs, we find, as would be expected, a much higher survival rate for the latter. Indeed, not only do spin-offs survive better; when they do disappear, they are integrated into other organisations to a much greater extent. Figures 4 and 5 show that firms disappear in much the same way they are born, *e.g.* a firm started from scratch is far more likely to disappear without a trace than is a spin-off or a merger.

Figure 4. **Cause of disappearance: spin-offs and completely new firms**
Number of firms



Source: VINNOVA and Statistics Sweden.

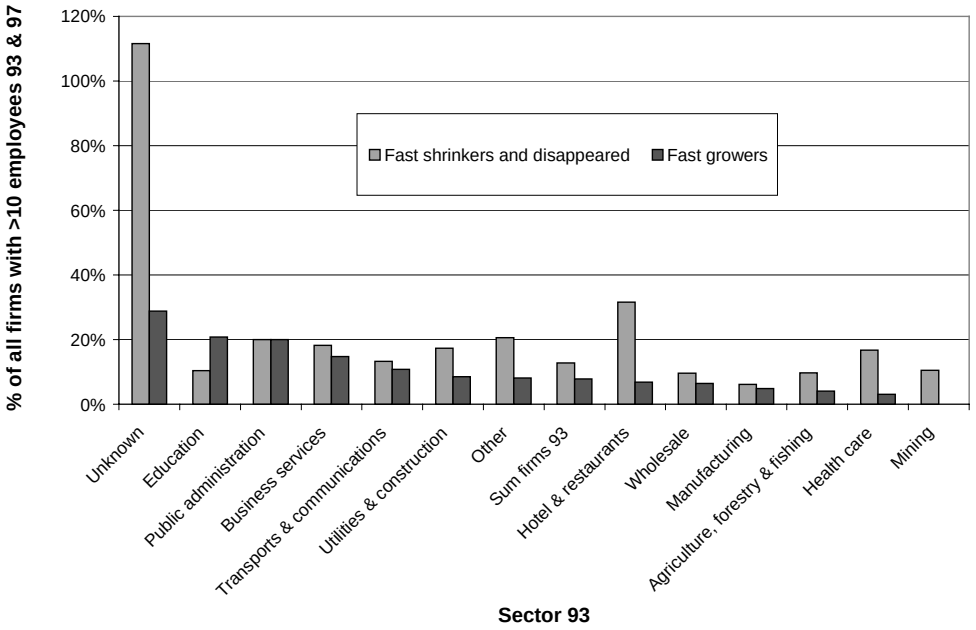
Figure 5. **Cause of disappearance: spin-offs and completely new firms**
Number of employees concerned



Source: VINNOVA and Statistics Sweden.

As a final example of the potential of the firm demography database, we have singled out fast growers and fast shrinkers (including firms that have disappeared) in terms of number of employees (Figure 6). The figure shows that high growth and rapid decline are unevenly distributed among sectors, providing some hints about future developments in the various sectors.

Figure 6. **Number of fast growers and fast shrinkers/disappearing firms, 1993-97**
In relation to the whole population of firms with >10 employees in both 1993 and 1997



Note: Fast growers are defined by >30 % average growth rate in 1993-97 *and* at least 10 employees in 1997. Fast shrinkers are defined as firms decreasing by the same rate in 1993-97 and having >10 employees in 1993. Disappeared had >10 employees in 1993 and disappeared without a trace between 1994 and 1997.
Source: VINNOVA and Statistics Sweden.

Suggestions for future research

The firm demography database can be linked to all data for which organisational IDs are available, including economic performance, educational level and profile of the workforce, regional distribution of the workforce, work establishments and whole firms, data on economic group, etc. The database can also be linked to panel and survey data for which organisational IDs are available, such as innovation surveys. Since the firm demography database is scheduled to be updated yearly, follow-up work will be possible in areas of special interest. Issues for which further analysis would be highly useful include:

- Effects of job destruction.
- Correlation between innovativeness, employee education, sector, size, age, etc., of organisations and their contribution to growth.
- Evolution of industrial sectors.
- Effects of downsizing and outsourcing.
- Any common denominators of fast organic growers.

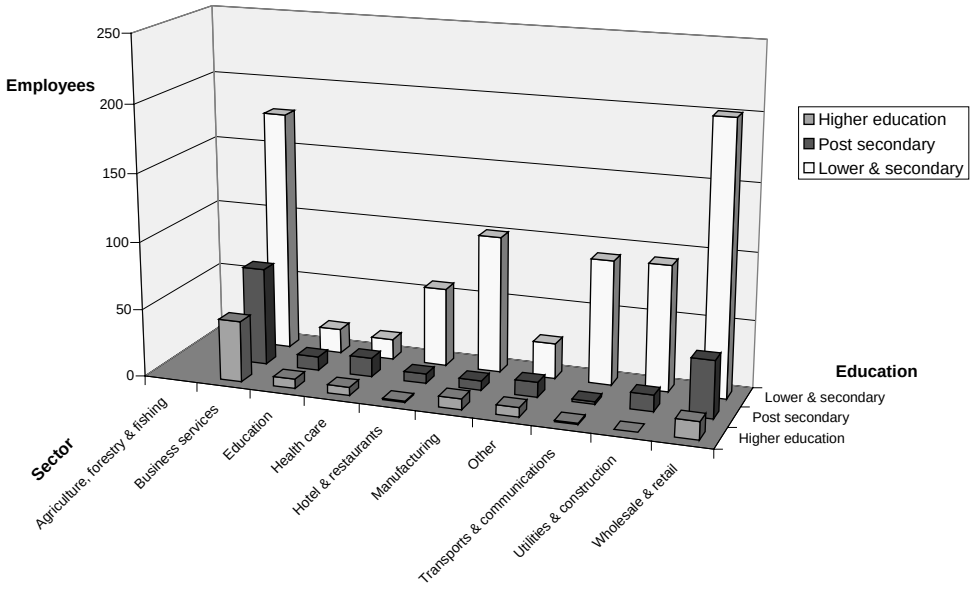
Mobility of human resources (*e.g.* highly educated S&T personnel) can serve as an indicator of knowledge flows. Studies of knowledge flows using human resource data are currently being carried out as a joint project in the Nordic countries, as well as in the OECD (as part of the work on national innovation systems – NIS). These flows can be intra- or extra-sectoral, as well as between different types of NIS institutions. Employment registers for consecutive years are used in the Nordic countries to map the flows. In this context, the firm demography project will enable flows induced by organisational changes to be distinguished from those initiated by individuals changing jobs.

We have now begun to study the impact of employee education on firm survival and growth. As expected, preliminary research on completely new firms points to a positive effect of education – in terms of growth, although not in terms of survival. The higher the educational level of the employees, the greater the likelihood of higher growth, followed by a merger or a split of the firm. This indicates that such firms are seen as milieus of competence that can be traded (Figure 7).

In addition to the exploratory studies mentioned above, a slightly modified version of the methodology will be run on establishments with the aim of setting up a firm establishment demography database. Such a database could prove particularly appropriate for considering establishments from the "milieu of competence" perspective as a set of employees with interdependent skills.

Figure 7. **Employee educational level and sector of firms, 1994**

Firms that were completely new in 1991, were still in existence in 1994, but were merged or split between 1995 and1997



Source: NUTEK and Statistics Sweden.

The policy implications of the project are very broad-sweeping, depending on which data are linked to the database. The project will certainly enable a better understanding of the movement of jobs away from the manufacturing sector to the service sector, and will allow the effects of down-sizing and outsourcing to be monitored. In a wider context, we will be able to provide better input and policy advice on innovation, education and labour market policy.

NOTES

1. VINNOVA (www.vinnova.se) was created on 1 January 2001, with the reorganisation of the Swedish system for public funding of research. The project was initiated by the Innovation Policy Studies Unit at the Swedish National Board for Industrial and Technical Development (NUTEK), which now forms the Division of Innovation Systems at VINNOVA.

2. Enterprises and *not* enterprise establishments.

PART II

COMPARATIVE MOBILITY IN THE NORDIC REGION

Chapter 6

KNOWLEDGE TRANSFER THROUGH LABOUR MOBILITY IN THE NORDIC COUNTRIES: STRUCTURE AND DYNAMICS

by

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Introduction

The innovation systems approach to economic behaviour stresses the fact that firms exist within complex institutional and organisational frameworks, and that innovation outcomes depend very much on linkages between firms and universities, regulatory agencies, suppliers, and so on. So, interactions and linkages are a core theme of the innovation systems literature.[1] The reason for the emphasis on interactions is that, although innovation performance at the firm level depends primarily on the extent and coherence of the knowledge base of a firm, firms are necessarily limited in terms of their ability to create and sustain distinctive knowledge bases. This means that flows of knowledge between elements of the innovation system are essential if firm-level knowledge bases are to be constructed, maintained, and above all renewed. This point has been strongly emphasised by David and Foray, who argue that the "distribution power" of a knowledge system (*i.e.* how the structure of firms, universities, research institutions, etc., shapes the flow of knowledge within the system) is a key determinant of overall economic performance (David and Foray, 1995).

This chapter explores an empirical approach to understanding how such flows of knowledge work in an innovation system, focusing on one aspect of the knowledge-flow, namely the mobility of highly qualified labour. In a knowledge-based economy, the level and flow of human resources are likely to be central elements of performance. How can we quantify this? And how can we map the pattern and dynamics of flows in a system?

The chapter builds upon research carried out in the first phase of the OECD national innovation systems (NIS) project, which represented an initial effort to explore mobility data for the Nordic area. A summary version of that research was included in the synthesis report from the NIS project (OECD, 1999). This chapter uses the same data, but aims at presenting the issue of mobility and knowledge flows in a less technical manner, and to include the analysis in a more explicit discussion of innovation systems. Hence, it provides a link between the theoretical and statistical discussion in the preceding section, and the next chapter of this volume, which explores time-series data for the Nordic region.

The approach presented here rests on the fact that the Nordic economies possess a data resource that, although it exists elsewhere, is probably unique in terms of accessibility to researchers. This data set consists of registers that describe, on the one hand, the educational backgrounds of all employees

in the economy and, on the other hand, tracks their movements between jobs over time. So, the data has both a cross sectional and a dynamic aspect. The data are available in a highly disaggregated form, covering many millions of employees over many years, and offer exceptional insights into the nature of labour market dynamics. The approach taken here is simply to look at what such data can tell us about mobility and knowledge flows within the Nordic economies. We draw in part on our previous research.[2]

Mobility of highly educated labour is perhaps the most obvious mechanism of knowledge transfer. It should be noted, however, that just as there can be mobility without any significant knowledge transfer, so can knowledge flows and transfers can take place without any prolonged physical mobility of individuals as the channel for the knowledge flow. The rapid development of information and communication technologies has enabled forms of knowledge transfer in which no permanent, or even transitory, human mobility is involved. Knowledge transfer mechanisms other than permanent labour mobility include inter-firm co-operation, temporary exchanges and placements of staff, various types of networks, interactive learning via buyer-supplier relationships, R&D collaborations and strategic partnering. Other applicable indicators might include co-authorships, co-citations, co-patenting, number of external contacts and co-operations, joint ventures, industry-specific common activities, etc. One should be aware therefore that our approach to mapping nodes and links in national innovation systems covers only one among many different phenomena that together constitute the system. The patterns emerging from the study of human resources must be seen in conjunction with the other approaches presented in the OECD NIS project. In particular, we will argue for the need to combine labour mobility data with other sources of information regarding knowledge creation and use, such as R&D statistics, innovation surveys and indicators for more embodied knowledge flows such as investments in machinery and equipment. Nevertheless, this type of labour market data can be very important, for it opens up a detailed micro-level perspective on where mobility occurs and between which sectors or institutions.

Mobility indicators

The stock and flow indicators of human resources that result from the Nordic labour force registers serve as an important complement to traditional R&D statistics on R&D expenditure, personnel and performance. It is important to remember that R&D expenditure is effective only insofar as it is translated into the activity of researchers, and that these workers are mobile. The mobility of highly qualified personnel is therefore an important vehicle for knowledge flows, and indicators of this movement can help us map important linkages in innovation systems. Mobility indicators can further be used to evaluate the effects of different policy measures in areas such as education, research, labour markets, regional development, etc. The focus of the analysis here is to investigate to what extent register data on employees can be utilised to study stocks and flows of personnel in a national innovation systems perspective.

The registers contain information on every employee in the three study countries (Sweden, Norway and Finland), including information on age, education and employment at any particular time. This information can used partly to compare stocks of employees with different types of education across industrial sectors, and partly to describe flows of personnel between sectors. In the sectoral breakdown, particular attention is paid to higher education institutions and research institutes. From a systems perspective, the analyses of stocks can be said to describe the nodes in the innovation systems, while the flow analysis establishes and describes the links in the systems. If information on knowledge creation, such as information on innovative activity or R&D expenditures, is added, the methodology would allow for detailed tracking of knowledge flows in innovation systems. However, this is for the future; so far, such additional information has not been utilised.

Although our experience shows that register-based analysis of labour market dynamics is a feasible and productive way to expand our knowledge about innovation systems, a number of methodological problems remain – even when comparing countries, such as those in the Nordic region, which exhibit many similarities. The problems mainly relate to differences in industrial structures and education systems, with the resulting incompatibilities in coding and updating of registers. Despite these problems, we are confident that we have presented a reasonable comparative picture of the Nordic countries. At an overall level, we find the same main structures in all three countries, although, naturally, there are also clear differences on a more detailed level. The chapter is organised as follows: first, the methodological problems and choices involved are described, including experiences from previous work; second, the main results from the analyses are presented; third, the policy issues raised by the work are highlighted.

Previous work and methodological issues

The approach taken here is new; even though the importance of humans as vehicles for transferring knowledge has long been recognised, suitable data – *i.e.* register data – have not been available until recently.[3] A number social mobility and labour market studies exist. However, they are usually based on specialised surveys, and consequently there is little previous research upon which to draw.

Mobility of personnel to and from the research institute sector has been studied in Norway.[4] The mobility rates found were in the range of 6–8%, *i.e.* considerably lower than the rates found in the presents study using register data (there are various plausible reasons for this discrepancy – different collection methods, etc. – which will not be investigated in this chapter).

Recent work using the same register data in Norway shows that the *business service sector* acts as a sort of second knowledge-infrastructure in that it both recruits and supplies skilled manpower from a far wider range of sectors/branches than any other sector/branch (Nås *et al.*, 1998). Stock data also shows that the educational level in business services is on par with that of the public sector. A study of the employment of natural scientists and engineers in industry in Sweden showed that human resource mapping may provide a more accurate picture of a country's technological strength than R&D spending statistics, especially for non-manufacturing sectors (Stenberg *et al.*, 1996). The same study concluded that PhD mobility appeared to be a weak mechanism of knowledge transfer, at least in the 1990-93 period. Another Swedish study on the internationalisation of qualified scientists and engineers showed that firm strategies regarding the recruitment and internationalisation of human resources differ significantly across European countries, and that cultural factors play a significant role.[5]

Studies of job creation and destruction using register data have been carried out in Denmark, addressing problems related to "business demography". Similar techniques are now explored in other countries.[6] Business demography is one of the main methodological challenges for mobility and knowledge transfer studies.

Approach and assumptions

A basic assumption underlying our work is that mobility of personnel between organisations or institutions indicates that knowledge transfer is taking place. However, the extent to which this is valid presumably varies, depending on context and circumstances. It depends – among other things – upon each person's ability and opportunity to learn from the organisation in which he or she is employed prior to the move. In turn, this is likely to depend on the duration of employment and the education of

the person – variables that are available for the analysis. In addition, the position or occupation held in the organisation will influence any learning that is taking place. However, this information is not available at present.

At a practical level, choices were necessary in terms of level of detail, population to be studied, and timeframe. A more conceptual issue is the definition of what constitutes employment and labour mobility. In the remainder of this section, we review some of the choices made and the rationale for the decisions:

- First, by *employed*, we mean an individual who is employed in at least one of the years covered by the study.

- Second, we define *mobility* as a change of workplace (establishment). We could have chosen other bases for mobility, such as change of organisation, geographical change, etc., but we decided that a change of work establishment is the most robust mobility indicator available. An added criterion could be used, such as change of sector, but we take the view that the choice of level of detail in the sector classification would overly influence mobility rates.

- Third, we have striven to arrive at a sectoral breakdown that reflects the characteristics of each country's national innovation system (NIS). For practical reasons, we chose to include what are arguably the most important NIS institutions: *the higher education sector* and *the R&D sector* (including the industrial research institutes). These two sectors show significant differences between the three countries. Apart from these sectors, we separate the data into nine industrial or public sectors.[7]

- A fourth choice involves the years for the stock and mobility data. For practical reasons, we used the latest available years for each country. The choice of years has little effect on stocks, but mobility patterns show great variation even over shorter periods of time, and are heavily dependent on the pervading economic climate. Mobility rates are strongly affected by business cycle conditions, a topic which is analysed in detail in the following chapter.

How can we represent knowledge? One of the principal interests of mobility data is that human resources are assumed to represent knowledge bases and flows of knowledge within economies or innovation systems. However, there exist many forms of knowledge – formal knowledge, skills, competencies, codifiable knowledge, tacit knowledge, etc. In the present study, the indicator "level and field of formal education" is used to denote type of knowledge. The use of formal education as a knowledge indicator on a large scale presents a number of advantages, since indicators of other forms of knowledge would require data collection/collation exercises. An alternative might be occupational classification, although not all OECD countries collect such data, and the classification differs (Elias, 1996). We readily acknowledge that highest achieved formal education has clear limitations as a knowledge indicator, but it is probably the best we have. In the case of indicators involving the highly educated (including those with research credentials), the degree of specialisation is so high that formal qualifications are probably an acceptable indicator of knowledge.

It is more difficult to assess the impact and extent of knowledge transfer associated with experienced personnel. In principle, we could use a combined indicator of education and characteristics of a person's occupational career. However, strict compatibility of data from different countries is very difficult to achieve. When indicators of flows are studied, they must be related to stocks of the same or broader categories, as well as to population size. There is also a clear need for a thorough understanding of the institutional conditions of the individual countries. Variations in institutional and educational systems necessarily reduce the value of direct comparisons, since theories are only possible on a very basic level. Our analysis shows that even when three countries that are

very similar in many respects are compared, work is needed to render the comparisons analytically meaningful. One of the limitations of our approach is that we have not yet been able to take international mobility into account, even between the Nordic countries.[8] This includes both permanent mobility between countries and temporary exchange of personnel.

Mobility rates

Mobility of employees is by no means a marginal phenomenon: between one-quarter and one-fifth of employees are recorded as having left their employer between one year and the next (Table 1). This share is roughly the same for the higher educated group as for all employees, independent of education level, although there is somewhat higher mobility in Finland and Sweden than in Norway. The majority of people who change their employment situations move between jobs.

Table 1. **Mobility rates**

Total employment and employees with higher education,
broken down by technical, medical and social sciences and other for Sweden, Norway and Finland

Type of employees	Type of mobility rate	Sweden[1]	Norway	Finland
All employees	Wide	24.0	20.1	23.3
All employees	Narrow	16.2	12.4	11.5
All higher educated employees	Wide	23.4	18.6	23.9
All higher educated employees	Narrow	19.5	12.8	17.9
Natural sciences and engineering	Wide	22.4	19.9	23.3
Natural sciences and engineering	Narrow	19.0	14.6	17.8
Medical fields of science	Wide	25.1	21.4	26.7
Medical fields of science	Narrow	21.9	14.7	21.2
Social sciences, humanities and other fields of science	Wide	23.3	17.4	23.6
Social sciences, humanities and other fields of science	Narrow	19.2	11.7	17.4

1. For Sweden, only persons working in establishments with valid NACE codes both years are included.
Data: Percentage of total employment first year. Wide definition of mobility: Includes persons leaving the active workforce. Narrow definition of mobility: excludes those leaving active workforce.

If mobility or turnover in employment were to continue at the levels recorded here for every enterprise for each year, the total staff body would change every four to five years (if everybody had the same propensity to change jobs). However, there are large differences both between individuals and between groups. In a given firm, there are “stayers” and “movers”. Furthermore, an important cause of mobility is entry and exit of enterprises: a significant share of mobility is the result of enterprises going out of business or being restructured in such a way that they change their identity number in the registers upon which our definition of mobility is based. To what extent this mobility is “real” mobility depends on the definition of firm “birth” and “death”; that is, on business demography.

It could be argued that changing jobs should be the core focus of any study of knowledge transfers, since this covers persons bringing their knowledge from one workplace to another. On the other hand, the turnover in companies resulting from retirement and other reasons for leaving, facilitates the employment of new staff members, whether they come from another company, from unemployment or are newly graduated candidates. All of these groups bring new knowledge into the organisation and thus contribute to the flow and renewal of knowledge.

To obtain insights into the degree of stability of employment over a longer time span, we explored how many employees in Norway in 1986 are still with the same establishment in 1994, eight

years later. The results show that almost a third of employees remain with the same establishment after eight years (31.5% in 1986 and 30.7% in 1994). A similar Swedish exercise revealed that over the seven-year period 1986-93, only 20% of the original employees are found within the same establishment. Even if this points to some degree of stability, it implies that between 70% and 80% of employees stay with their employers for less than 7-8 years. Breaking down mobility rates by type of higher education reveals much the same patterns between the countries, with generally higher mobility rates in Sweden and Finland than in Norway (see also Table 1).[9] There are broad similarities on this aggregated level, but also many differences which have yet to be explained, such as the variations between "narrow'' and "wide" mobility depending on field of study and country. Consequently, we can conclude that much new knowledge is brought into organisations by the movement of personnel – and much knowledge is necessarily lost. In such a fluid, dynamic situation, a major challenge in human resource management in the firm is to find the correct balance between these two tendencies.

A closer picture can be obtained as follows. Bringing in data for one extra year allow us to decompose mobility in the middle year according to inflows and outflows. Combining inflows with outflows and with stable employees results in a total of nine categories. The possible states include employees who remained with the same employer during all three years, employees who changed employer in the previous year or in the subsequent year, and persons that are neither active in the workforce in the previous year nor in the following year. The total for each year is set at 100%.

The results show a high degree of turnover (Figure 1). Some 60% of employees remain with the same employer (*i.e.* they have the same employer two years in a row). National differences in this share are marginal or non-existent: 62% for Norway and 62% for Finland. In other words, the mobility rate when both inflows and outflows are taken into account is around 40% over a two-year period. Inflows are marginally greater than outflows, indicating a small increase in employment.

As the figures illustrate, mobility takes many forms. The majority of mobility involves those who change states from one year to the next, and then become stable (within our short time horizon of one extra year). Among these are employees who continue to work for the same employer in the following year. This group will encompass those who have accumulated experience working for one employer, who may therefore be viewed as the most valuable type of recruit for the subsequent employer. The group of employees that have accumulated work experience with one employer before starting work with a new employer accounts for around 7-8% of employment (Norway and Finland). In addition, there is a small group of "experienced workers" who are employed for each of the three years, but who change employer each year. These may be called "experienced nomads", and they make up around 3% of employment (Norway and Finland). Another group of "nomads" involves those who were not employed in the first year, work for an employer the next year, but who change employer again the subsequent year. Such "inexperienced nomads" involve, probably to a large degree, newly educated employees seeking a suitable job by experimentation. This group is even smaller, around 2%.

It is possible to separate out two distinct groups from the mobility patterns above: those who were not employed by the same employer in the previous year ("new employees"), and those who were employed by the same employer in the previous year ("stable workers"). Checking their employment status the following year allows us to compute mobility rates for each of these groups. As is shown in Figure 2, the patterns clearly differ. From the group of stable workers, about 17-18% (Norway and Finland) have left by the following year, while as many as 37%-45% (Norway and Finland) of new employees have left by the following year. From the employer's perspective, the loss of experienced workers is arguably more serious than the loss of new recruits. The high mobility rate among the new employees should probably be interpreted as representing a kind of trial and error process, as both employer and employee "shop around".

Figure 1. **Permanent and mobile employees broken down by type of mobility: Norway 1992-94**

Percentages

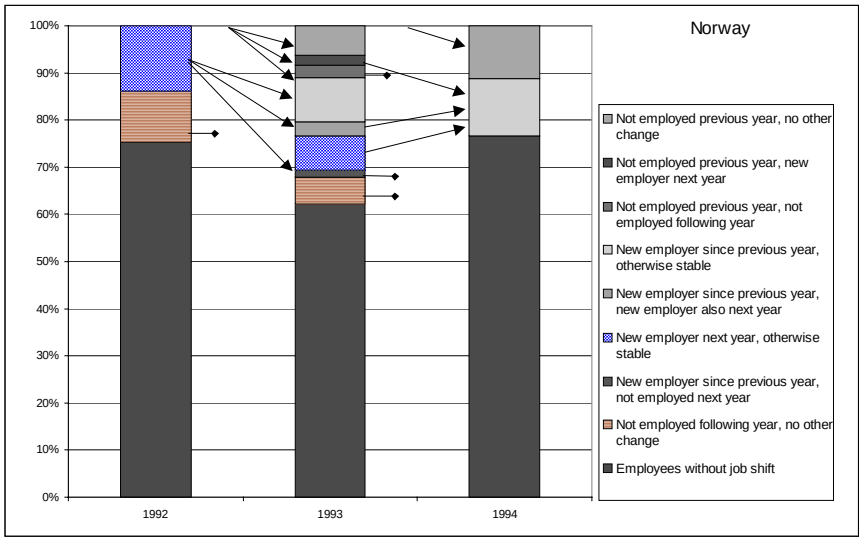
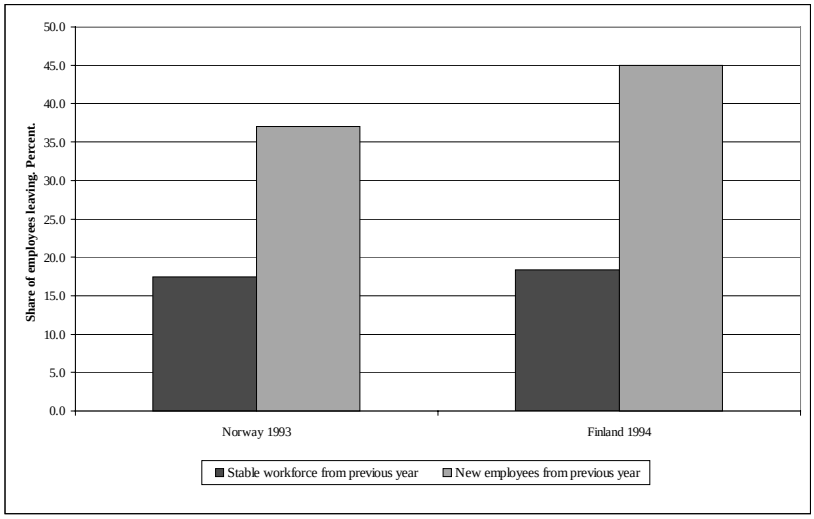


Figure 2. **Mobility rates for "stable employees"(same employer in previous year) and "new employees" (different employer in previous year), by country**

Percentages



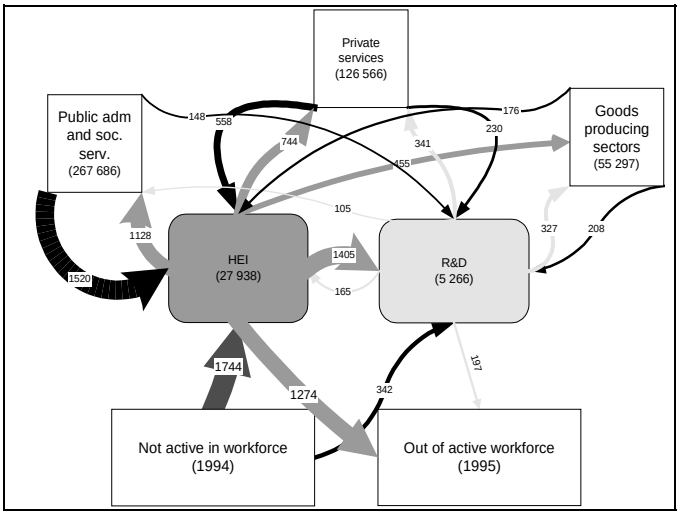
Sectoral flows

By bringing both the industrial and public sectors into the analysis, it is possible to map knowledge flows in terms of labour mobility between sectors. This is shown in Figure 3 for higher educated personnel, where the presentation is focused around inflows and outflows from two distinct types of NIS institutions: universities and other higher education; and research institutes. The patterns point to both similarities and differences between countries. A detailed breakdown for the three countries is presented in Annex.

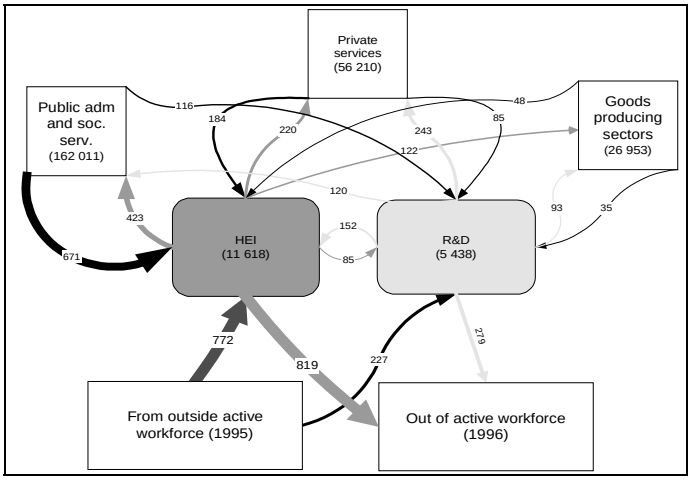
Figure 3. **Mobility of employees with higher education by delivering and receiving sectors**

Absolute numbers

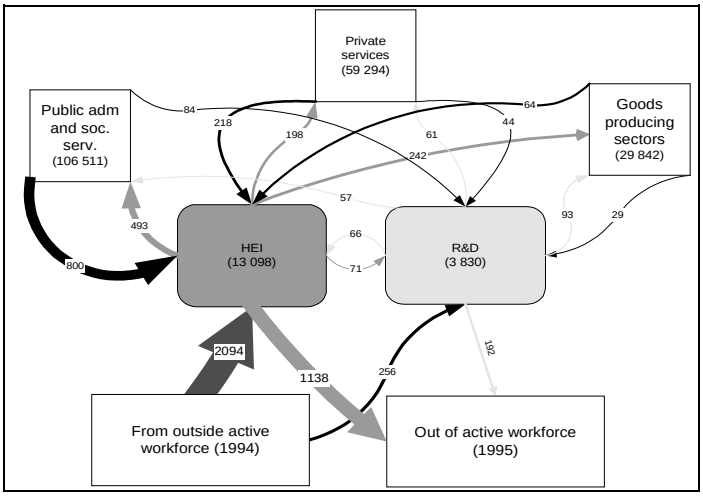
Sweden, 1994-95



Norway, 1995-96



Finland, 1994-95



In the Swedish case, the basic pattern of mobility for personnel with higher education is very much the same as for the flow of all employees. Internal flows are important for all sectors. Flows concentrate around the higher education sector, due to its larger size compared to R&D institutes. The dominant links for institutes of higher education are with the public sector, which accounts for 18% of those leaving higher education institutions (HEIs). R&D institutes also receive a large number of employees from HEI (23%); however, this is in a strongly asymmetric relationship, with the flow in the opposite direction being very limited.

The links to manufacturing sectors (goods) do not involve a large contribution from any of the two NIS institutions, although in relative terms these links are far more important for the R&D institutes than for higher education institutions. Almost one-quarter of those leaving R&D institutes move to manufacturing industries, whereas only 7% of those leaving higher education institutions find work there.

As was the case with all employees, the net flow of persons with higher education is out of NIS institutions to goods-producing sectors and private services. Again, we find that the net flow is in the opposite direction for the public sector.

Within the aggregate group of private services, the subgroup "business services" plays an important role as recipient of personnel from R&D institutes. This link is stronger from R&D institutes than from institutions of higher education. It accounts, however, for only about half the share of persons moving out of R&D institutes compared to the link with manufacturing.

To characterise the "degree of openness" towards sectors outside the NIS institutions themselves, we can simply calculate the difference between total mobility and the share of persons changing jobs within the NIS institutions. Doing this reveals that R&D institutes are substantially more interactive with other sectors of the economy than are institutes of higher education. In the latter case, around 50% of those leaving a position in a higher education institution change to another job in the same sector or to one in an R&D institute. For those leaving a job in an R&D institute, the same share is only about 25%, meaning that these employees carry their expertise to a larger part of the economy. In addition, there is a somewhat higher mobility rate out of R&D institutes than from higher education institutions. In absolute terms, however, the education institutions are more important because they are larger and consequently disseminate and receive greater numbers of highly educated workers. This is particularly so in the Swedish case, where higher education institutes are about five times larger than R&D institutes in terms of personnel with higher education.

In the Norwegian case, the same basic conclusion holds as for Sweden. As above, the mobility pattern for personnel with higher education is very similar to that found for total employment independent of education although, again, the numbers are much smaller than those for the working population as a whole. Higher education institutions dominate the picture in line with their larger size. Their links with the public sector are greater than their external links with other sectors, and are stronger than the links from R&D institutes to the public sector. Only 4% of those leaving higher education institutions go to R&D institutes, while 14% of those leaving R&D institutes move to higher education institutions. This situation is different from the Swedish case both in terms of number and share of people, and the net direction of flows.

As was the case with all employees and the Swedish case above, the net flow of persons with higher education move out of NIS institutions to goods-producing sectors and private services. Once again, we find that the net flow is in the opposite direction for the public sector. As we found for all employees, internal mobility – between different employers within the same sector – is high for most sectors. The importance of internal mobility, however, is different for higher education institutions and

R&D institutes: it is more important in the higher education sector than in R&D institutes. This should be considered in relation to the greater degree of mobility from R&D institutes to higher education than in the other direction, a difference that more or less balances this picture. Therefore, it would appear that mobility patterns to a certain degree reflect a typical career pattern, moving from R&D institutes to higher education, and subsequently changing positions within the higher education sector.[10]

As above, "the degree of openness" of NIS institutions (*i.e.* their interaction with sectors other than themselves) is calculated as the difference between total mobility and the share of persons changing jobs within the NIS institutions. This reveals a somewhat higher degree of interaction involving R&D institutes than higher education institutions – a difference in the order of 15 percentage points. This is similar to the findings for Sweden, except that the difference in the Swedish case is somewhat larger. However, in terms of the number of highly educated employees who change their work situation, the importance of institutes of higher education is greater, due in part to their larger size.

The shares of those moving from both types of NIS institutions to manufacturing industries are limited to 4%-5%, or about the same level as for the working population as a whole, independent of education. Again, this result differs from that witnessed in the Swedish case, where the links from R&D institutes to manufacturing were far stronger than from higher education institutions. The dominating links from R&D institutes are with business services: 17% of higher educated employees leaving R&D institutes move to this sector – a clearly higher share than for higher education institutions. The same structure was found for Sweden.

Looking at exit from the active workforce, a large share of persons who change job situations move out of the active workforce. As would be expected, this share is lower for the more highly educated than for the workforce at large. Focusing on the NIS institutions, a somewhat greater share leave the active workforce from higher education institutions than do from R&D institutes, 38% *vs.* 27%. Why this is so is not clear. Our hypothesis is that it is because there are more temporary employees at the higher education institutions in terms of visiting scholars, assistants leaving to study abroad, to perform military service, etc.

As for Sweden and Norway, the basic structure of mobility of higher educated personnel in Finland is very similar to that for employment as a whole, independent of education. Flows are dominated by the larger higher education sector, and these flows are particularly strong to and from the public sector – as in Norway and Sweden. A relatively small number of persons move between the NIS institutions (although calculated as shares of total flows from each of them, the flow from R&D institutes to higher education institutions is the larger). What seems to be a rather robust pattern across countries and types of education is confirmed here: net flows go out of the NIS institutions to goods-producing sectors and private services, but in the opposite direction to the public sector.

For R&D institutes, a somewhat greater share of those who change their work situation go to manufacturing than was the case for all employees independent of education (10%). This is somewhat higher than in the Norwegian case (5%), but considerably lower than the 23% found in Sweden. The same kind of difference is not found for higher education institutions. On the other hand, links to business services, which were found to be rather important for Sweden and Norway, seem to be somewhat weaker in Finland.

Finland differs from the two other countries in terms of the share of personnel changing employer from one R&D institution to another. In Finland, the share is high at 39%, with the comparable numbers for Norway and Sweden as low as 14%. In addition, there is a much higher mobility rate of

persons leaving institutes of higher education than from R&D institutes. As a result, the degree of openness to other sectors seems to be smaller in the Finnish case than in the other Nordic countries. In fact, there is more movement from higher education institutions in Finland to other sectors than there is from R&D institutes, both in relative terms and in absolute numbers.

Another aspect of the Finnish case that differs from the Norwegian and Swedish cases is the greater difference in the ratio of the highly educated leaving active workforce than for all employees. This share is particularly high for *all employees*, with 41% and 47% of those changing jobs in higher education institutions and R&D institutes, respectively. The comparable shares for the highly educated are low at 26% and 27%.

Future work on mobility

Many questions arise from this exercise and there are many possible avenues for future work. For example, even though a large number of persons shift jobs or move in/out of the active workforce, not all establishments are equally affected by these changes. Much work remains to be done with respect to how many, and which, firms or establishments deliver and receive mobile employees. From the perspective of national innovation systems, we have investigated such involvement by the firm units in a very strict and narrow sense, looking at the share of firms having received personnel from HEI or R&D institutes since the previous year. The results show that well below 1% of the units were involved, but with some sectoral variation. The patterns, however, were very similar for the two countries included in this comparison, Finland and Norway.

Going through the mobility rates and the number of effective delivering and receiving sectors by our 42-sector classification, a greater disparity becomes evident between the three countries. It is clear that, although the three countries are basically very similar, there are differences between the functioning of the labour markets, the industry recruitment patterns and the interaction between industry and the R&D infrastructure. Overall, it is likely that national circumstances play a decisive role in mobility at such a disaggregated level, but this is a hypothesis that requires further investigation.

In this work, the focus has been on flows in the labour market, *i.e.* flows of the employed population. Only one type of mobility has been studied. We have looked solely at stocks and flows of individuals, ignoring the stocks of firms or organisations, and in most cases the number of organisations affected by mobility. Further work would include more detailed studies and categorisation of the population outside the labour market (new graduates, the unemployed, immigrants, emigrants, etc.). It would also cover more NIS categories and include studies of the impact of mobility of organisations. Yet another aspect would be to analyse mobility of persons between countries, in particular of a temporary kind, as for instance within large multinational firms. Such work would be a natural continuation and development of the work presented in this chapter.

Policy issues

A standard conclusion from both conventional analyses of economic growth and the more heterodox national innovation systems approach, is that education and human resources are central to economic performance. However, this conclusion is rather general and provides no real guide to policy formation, other than that education is a good thing. At the very least, an analysis of the use and mobility of labour in a national systems context points towards the potential beneficial effects of

integrating policies with respect to education, the labour market and innovation, and thereby developing a coherent and consistent approach to innovation policy.

The data and analysis presented here cannot take us very far in developing policy conclusions, although some limited but firm conclusions can be drawn. Perhaps the most important of these is that the labour forces studied here are – in contrast to much of the conventional wisdom about the Nordic economies – highly dynamic. Mobility rates are high, and this must cast serious doubt on the necessity of policies aimed at improving the flexibility of labour markets. At the same time, there are definite flow patterns within the system. Most NIS models argue that knowledge infrastructural institutions, such as universities and research institutes, operate to support the knowledge creation and distribution process in the production sector, and the mobility data we have studied supports this finding. Policy makers might draw the conclusion that something in these systems is going right.

More serious issues for the future concern the coherence of the innovation system in terms of the link between the production of educational qualifications, and their use and distribution within the system. This calls for more detailed analysis than has been possible here and would require an analysis that links the changing knowledge bases of economic activities to flow patterns within the innovation system, and to the longer-term planning and resource allocation processes of the education system. From a policy point of view, such an exercise could provide real insights into the vexed question of bottlenecks and mismatches in the education system, in relation to the needs of the innovation system. Such an analysis is desirable but probably far away. However, at least we have some indications that a detailed view of the links between education, industrial and innovative specialisation, and the labour market is, in principle, possible.

Conclusions

We believe the results of this study to be reasonably comparable between the countries. There are – as in all cross-country comparisons – many possible pitfalls. Therefore, the results should be interpreted with caution. There are, however, some rather clear findings that we think are sufficiently robust to withstand future adjustments and corrections.

When studying mobility flows between the higher education institutions (HEI), the R&D sector, the public sector, private services and the goods-producing sectors, differences in research infrastructures and the roles of the HEI and R&D sectors become evident. The HEI and R&D sectors of Norway and Finland are roughly comparable in size, while the Swedish R&D sector is slightly smaller in absolute numbers. This is compensated for by a larger HEI sector compared to the other countries. There are greater flows out of the active workforce from the Finnish HEI and R&D sectors and the interactions between the R&D sector and the service sector seem weaker compared to Norway and Sweden. Norway's R&D sector seems better geared for the service sectors, partly due to its relatively larger size compared with the other countries. Flows from HEI to R&D are much stronger in Sweden than in the other countries, while the reverse flows are very weak. The flows from R&D to HEI in Norway are bigger in relative terms than in the other two countries.

The turnover of employees is generally high. In two consecutive years, between one-quarter and one-fifth of the staff is lost. Of these, the majority change jobs, while the rest leave the active workforce (permanently or for a period). The rate is more or less the same for the higher educated as for all employees, with some national variation. However, the causes for such job shifts might be different. The higher educated might be seeking better pay and/or new challenges, whereas the influence of the business cycle (job creation and destruction) may be more important for other educational groups.

The inclusion of an extra year allows us to integrate new employees entering firms into our calculations of mobility rates. This exercise reveals even higher mobility rates: 38% of employees in both Norway and Finland entered the workplace since the previous year or left by the following year. Newcomers are more mobile than "old" workers. The probability that a new entrant changes position in the next year is more than twice that of old workers leaving a position the subsequent year. Taking age into consideration, the share of stable workers increases with age and the share of mobile workers decreases almost linearly with increasing age.

The analysis of flows between different sectors is dominated by the larger size of the higher education institutions compared to R&D institutes. Even if there are clear national differences, some common features emerge: there is a strong link between the public sector and the higher education institutions, and the net direction of flows tends to move from the public sector to institutes of higher education. This is even true for the comprehensive group of the higher educated, with the exception of natural scientists and engineers. The general direction of net flows for the other sectors – *i.e.* goods-producing sectors and private services – is from the NIS institutions to the goods producers and private services. The links between R&D institutes and the institutes of higher education is in general relatively weak, with the exception of Sweden where fairly high numbers of people move from HEIs to R&D institutes. For Norway and Finland, the net direction of flows between the two are in the opposite direction.

Significant differences exist between countries. For instance, there is somewhat more interaction between manufacturing and the NIS institutions in Sweden and Finland than in Norway. In the Norwegian case, there are stronger links in terms of personnel transfers to private services – in particular business services. Comparing the "degree of openness" – the share of mobility out of the NIS sectors – of the two NIS institutions reveals that R&D institutes interact with other sectors to a higher degree than do higher education institutions in Sweden and Norway. In Finland, institutes of higher education are more "open", in particular because of a high level of mobility between different R&D institutes. Lastly, the influx of those that were not active in the workforce the year before, and out of the active workforce the following year, seem to be particularly high in Finland.

On the whole, Finland, Norway and Sweden are similar in terms of stocks and flows of human resources. Norway has not experienced the economic difficulties suffered by the Swedish, and particularly the Finnish, economies. Mobility rates in the latter two countries are naturally affected, especially in terms of flows into and out of the active workforce. Another major difference involves different institutional orientations. In Sweden, a great deal of industrial research takes place in universities. By contrast, in Norway and Finland, the industrial research infrastructure is concentrated around large industrial research institutes (SINTEF and VTT, respectively). Such differences impinge on the flows between the R&D sector, institutes of higher education and industry in the three countries. Meanwhile, historical differences mark the national systems of higher education, in terms of academic orientation and duration of degree; this has affected the relative share of, for example, the PhD system in the three countries. However, these differences appear to be lessening over time as the countries adapt their education regimes in line with international standards.

In terms of educational level and specialisation in different sectors, the three countries show very similar patterns at the eleven-sector level. The major difference is that there is a higher share of the highly educated in the primary sectors in Norway, mainly due to the presence of the Norwegian petroleum industry. Looking at how natural scientists and engineers are absorbed by "user sectors", Sweden shows a wider distribution of sectors which recruit such employees, which in turn reflects Sweden's relatively larger manufacturing sector.

The human resource data used for this study appear to provide a solid description of key aspects of the innovation systems of the three study countries. The differences found have not been overly surprising, and the data can be said to have confirmed some but not all of our presuppositions. Nevertheless, the study has shed new light on the relationships between the three countries and, perhaps most importantly, has given rise to new and more focused questions on how best to utilise this data source in future analyses of innovation systems and related topics.

NOTES

1. This has been emphasised by many of the most influential writers on the issue of national innovation systems and related topics. See, for instance, Edquist (1997), Freeman (1995), Lundvall (1992), Nelson (1993), Nelson and Winter (1982), OECD (1992).

2. For full details of the work and results, see Nås *et al*. (1998).

3. For an overview of data and related studies see Rosengren (1998).

4. Some earlier results are documented in a series of STEP reports: Wiig and Riiser (1992), Wiig and Ekeland (1994a). The latter contains comparisons with similar studies in other countries. There have also been studies of mobility of university personnel (Wiig and Ekeland, 1994b).

5. Euro QSE.

6. For an overview, see Hansen (1993).

7. The breakdown of sectors is important for mobility patterns and rates. In the main report, 42 sectors are used at the most disaggregated level.

8. Although the Nordic countries have tried to create an inter-Nordic labour market, there are various formal and practical obstacles that need to be overcome. For an overview, see Roos (1994).

9. Finland has to a certain degree corrected for "false" mobility. If a majority of the employees in an establishment in year T changed employer collectively in year T+1, the change of employer identification number is considered to be an statistical artefact. Overall, this lowers the calculated Finnish mobility rate by 2-3 percentage points. However, since we do not have a "benchmark practice" on how "births" and "deaths" of firms are handled in the business registers of the Nordic countries, it is hard to tell which rates are the most comparable.

10. However, mobility in the HEI sector is dependent on the classification of that sector. It is not clear which organisational level corresponds to "establishment" in this sector, and statistical practice varies across countries.

Annex

Mobility of employees with higher education by delivering and receiving sectors

Sweden

Delivering sectors (1994) → **Sweden** ↓ Receiving sectors (1995)	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence, health and social work	Other non-public services	Out of active workforce	No. of persons moving	No. of persons employed	Mobility rate in
Primary sectors, mining, oil	8.9	0.4	0.4	0.3	0.1	0.3	0.4	0.1	0.1	0.3	0.6	0.6	444	2 252	19.7
Manufacturing	9.1	38.8	9.3	11.9	7.2	4.1	11.9	23.5	6.8	2.1	3.6	10.7	8 989	46 126	19.5
Utilities and construction	1.4	1.2	11.3	0.8	1.3	0.5	2.4	0.8	0.4	0.6	0.4	1.4	847	5 560	15.2
Trade, hotels, restaurants	2.6	6.9	8.1	21.2	4.2	3.9	6.5	4.0	1.3	1.7	2.7	6.7	4 969	21 536	23.1
Transport, storage, communication	1.8	2.0	1.8	2.8	19.9	3.0	3.3	7.1	0.6	0.7	1.4	3.1	2 132	12 534	17.0
Financial services, real estate	0.4	0.9	0.9	1.8	1.7	28.8	3.9	0.7	0.5	0.5	0.5	1.9	1 775	12 397	14.3
Business services	12.1	16.3	21.7	17.0	15.9	22.1	25.5	12.4	6.6	5.7	6.8	13.6	11 289	51 511	21.9
R&D institutes	0.0	2.2	1.0	0.7	0.8	0.6	1.1	13.8	22.8	0.4	0.6	1.2	2 027	4 861	41.7
Higher education institutions	3.0	1.7	0.8	1.3	1.1	1.5	2.0	12.4	16.8	4.2	3.9	6.2	4 637	26 547	17.5
Public adm. health, social	17.4	5.4	16.6	12.5	11.6	10.5	12.4	7.9	18.3	36.4	23.2	42.7	41 376	284 093	14.6
Other non-public services	10.7	1.9	2.0	2.4	3.2	2.2	4.1	1.3	3.1	3.7	19.7	5.9	2 002	6 374	31.4
Out of active workforce	26.9	21.1	22.6	25.2	30.5	20.8	23.6	14.7	20.7	30.4	31.3	0.0	3 492	14 325	24.4
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	475	7 605	929	5 143	2 001	1 907	9 604	845	6 118	42 900	1 623	3 734			
N persons employed	2 283	44 742	5 642	21 710	12 403	12 529	49 826	3 679	28 028	285 617	5 995	14 567			
Mobility rate out	20.8	17.0	16.5	23.7	16.1	15.2	19.3	23.0	21.8	15.0	27.1	25.6			

1. Total includes a residual category consisting of members of the workforce that were active in unclassified NACE groupings in 1994. The value for this residual varies between 0.0 and 13.3 (Public administration), with an average of around 4 for each category represented in the table.

Mobility of employees with higher education by delivering and receiving sectors

Norway

Delivering sectors (1995) → **Norway** ↓Receiving sectors (1996)	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence, health and social work	Other non-public services	Out of active workforce	No. of persons moving	No. of persons employed	Mobility rate out
Primary sectors, mining, oil	27.4	1.5	1.1	1.2	0.7	0.7	1.7	3.2	1.0	0.4	0.7	0.3	963	5 977	16.1
Manufacturing	3.7	38.4	9.2	6.9	4.4	3.3	6.6	4.8	4.2	1.2	3.2	1.4	3 551	15 911	22.3
Utilities and construction	0.5	1.9	28.5	1.6	1.7	1.5	2.1	0.9	0.5	0.6	1.2	0.4	1 050	5 181	20.3
Trade, hotels, restaurants	19.8	7.3	4.5	28.8	5.7	3.6	6.9	3.1	1.5	1.9	3.0	1.5	3 655	13 127	27.8
Transport. storage. communication	3.0	3.8	2.0	2.8	30.6	1.9	4.1	0.6	0.4	0.6	1.0	0.7	1 580	6 280	25.2
Financial services, real estate	0.6	0.7	1.3	1.7	1.4	31.7	2.2	1.3	1.0	0.3	0.7	0.3	930	6 050	15.4
Business services	6.0	12.1	11.8	14.9	10.9	14.6	36.5	17.2	4.5	2.6	6.6	2.8	6 355	23 669	26.8
R&D institutes	1.0	0.6	0.3	0.5	0.5	0.4	0.7	14.0	3.8	0.4	1.1	0.3	710	5 110	13.9
Higher education institutions	0.6	1.1	0.6	1.1	1.2	1.5	1.1	14.6	22.4	2.5	3.4	1.2	2 318	11 781	19.7
Public adm. health, social	6.9	4.2	11.8	12.5	12.5	5.3	8.6	11.6	19.6	55.5	22.5	11.8	25 165	160 168	15.7
Other non-public services	0.5	1.3	1.3	1.6	1.7	1.0	1.7	1.2	2.8	1.6	22.0	1.0	1 804	8 663	20.8
Out of active workforce	29.6	26.5	27.0	26.0	27.7	33.0	26.7	26.9	38.0	32.0	34.2	78.1	65 949	65 949	200,0
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	1 296	3 232	958	3 412	1 381	972	5 232	1 038	2 155	27 008	1 748	14 308			
N persons employed	6 516	15 592	5 089	12 884	6 081	6 092	22 546	5 438	11 618	162 011	8 607	14 308			
Mobility rate out	19.9	20.7	18.8	26.5	22.7	16.0	23.2	19.1	18.5	16.7	20.3	100.0			

1. Total includes a very small residual category consisting of members of the workforce that were active in unclassified NACE groupings in 1995. The value for this residual varies between 0.3 and 1.3 for each category represented in the table.

Mobility of employees with higher education by delivering and receiving sectors

Finland

Delivering sectors (1994) → **Finland** ↓ Receiving sectors (1995)	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence, health and social work	Other non-public services	From outside active workforce	No. of persons moving	No. of persons employed	Mobility rate in
Primary sectors, mining, oil	17.0	0.3	0.4	0.5	0.2	0.1	0.5	1.5	0.1	0.1	0.6	1.0	377	2 211	17.1
Manufacturing	5.8	56.8	11.4	11.7	5.4	2.3	10.7	9.9	5.3	1.2	5.4	14.7	8 061	23 576	34.2
Utilities and construction	0.3	1.5	34.5	0.7	1.5	0.2	1.9	0.5	0.1	0.1	0.3	2.0	888	2 924	30.4
Trade, hotels, restaurants	3.5	5.9	2.8	37.6	3.7	1.6	4.1	1.4	0.9	0.5	2.6	7.0	3 357	11 992	28.0
Transport, storage, communication	1.0	1.4	1.0	2.2	47.7	0.7	1.9	0.4	0.2	0.2	0.7	2.3	1 244	4 588	27.1
Financial services, real estate	0.0	0.5	0.4	0.7	0.2	65.2	2.2	0.3	0.2	0.3	0.7	1.2	2 087	6 599	31.6
Business services	4.5	5.9	10.1	7.2	5.7	7.6	38.3	4.8	3.3	1.5	4.5	12.2	5 777	20 812	27.8
R&D institutes	0.6	0.4	0.1	0.2	0.1	0.2	0.5	39.2	1.6	0.3	0.3	1.3	794	3 625	21.9
Higher education institutions	1.3	0.9	1.0	1.5	0.3	0.5	1.3	8.5	34.5	2.9	4.1	10.8	4 787	11 508	41.6
Public adm., health, social	6.7	5.1	5.5	6.5	4.1	2.9	7.5	7.3	11.4	67.2	14.9	38.0	28 582	100 638	28.4
Other non-public services	2.9	1.1	0.6	1.2	1.6	1.0	1.7	1.0	0.0	0.0	0.0	4.9	1 184	11 687	10.1
Out of active workforce	56.1	19.8	30.7	28.7	28.1	17.5	28.3	24.7	26.3	17.2	55.4	0.0	12 229	19 300	63.4
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	312	5 944	690	2 813	955	2 416	4 643	778	4 327	27 251	2 447	19 300			
N persons employed	2 374	24 395	3 073	12 838	4 556	7 012	21 931	3 830	13 098	106 511	12 957	19 300			
Mobility rate out	13.1	24.4	22.5	21.9	21.0	34.5	21.2	20.3	33.0	25.6	18.9	100.0			

1. Total includes a residual category consisting of members of the workforce that were active in unclassified NACE groupings in 1995. The value for this residual varies between 0.3 and 8.7 (Other non-public services) for each category represented in the table.

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Chapter 7

JOB-TO-JOB MOBILITY RATES IN THE NORDIC COUNTRIES, 1988-98

by

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Introduction[1]

A significant element of the national innovation system (NIS), is knowledge circulation and exchange between workplaces. The introduction to the "Canberra Manual" (OECD and Eurostat, 1995) states: "Highly skilled resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being". The rationale for the "Canberra Manual" was, among other reasons, the need for systematic and comparable measures of knowledge (Ekeland, 1998). The OECD has had an ongoing project on the NIS for several years now. The aim of the NIS project is to improve the use of innovation policy instruments in the economy. The construction of better indicators of economic knowledge and an improved understanding of the role of knowledge as a driving factor for innovation, accomplish this. This chapter contributes to that work through the provision of a set of benchmarking knowledge flow indicators, where unique, comparable register data sources are used for the Nordic countries.

Mobility of educated or skilled labour is one of the most obvious mechanisms of knowledge transfer. A typical knowledge carrier is a worker who changes jobs.[2] Hence, a common and easily interpretable and identifiable indicator of the knowledge transfers and the well-being of an economy is the share of workers moving between workplaces.[3] This can be measured and summarised by mobility rates, *i.e.* job shift rates, for all employed workers, the labour force, and various sub-groups of the labour force, among others. A detailed mapping of the types and amounts of mobility determines the significance of mobility rates in measuring the transfer of knowledge and innovation abilities. As reported in Stern *et al.* (2000), the human stock of innovators – or the innovative manpower – determines the national innovative capacity. Similarly, the mobility of workers determines how efficiently the innovation capacity is being used, a factor which again influences economic growth.

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Several studies of employee mobility between workplaces have been conducted in recent years.[4] These studies typically use matched employer-employee data to show worker mobility. Worker job mobility rates can be generated for all countries since these rates only require a representative sample of workers, such as that collected in, for example, the Labour Force Surveys (LFS). Mobility of job positions is much more difficult to identify, since a worker in a new job may replace another. If so, the job position is not new for the firm and will not count as a job position move. The identification of job position mobility contrary to worker job mobility requires more data from employers, data that are not usually available.[5] Hence, only worker job mobility will be analysed in this chapter.

The main purpose of this chapter is to identify fluctuations in worker mobility rates over time and between various sub-groups. Determining this fluctuation gives the average level of mobility, *i.e.* the benchmark. Hence, our goal is to present a collection of stable and valid benchmarks of mobility rates characterising the Nordic labour markets.

Economic conditions, *i.e.* the business cycle, in the Nordic countries are used to illustrate that some of the variations in mobility rates over time can be explained and that the business cycle has to be taken into account when mobility rates are compared. Mobility rates are decomposed according to various characteristics such as workers' age and educational level or the workplace size, to illustrate that any comparison of mobility rates is highly dependent on these characteristics among the populations being compared. The chapter shows that micro-based figures can be aggregated to obtain macro figures and can be related to the country's business cycle. This results in a list of stylised facts on worker flows that can be used as a benchmark for labour markets in other countries.

The present study determines and compares worker mobility rates based on matched employer-employee data for 1988-98 for the four Nordic countries, Denmark, Finland, Norway and Sweden.[6] The decade was characterised by a somewhat parallel business cycle, which began negatively and ended positively (Figures 1 and 2). The full business cycle allows a comparison with the mobility rates of employees on the labour market. According to earlier Danish and Norwegian findings, a pro-cyclical pattern is to be expected in worker inflows, *cf.* Bingley *et al.* (1999), Albæk and Sørensen (1998), Dale-Olsen and Rønningen (2000) and Ekeland (2000).

The present analysis gives a comprehensive picture of mobility flows on the Nordic labour markets over a decade. The first section sets out the theoretical arguments for an analysis of worker mobility and of cyclicality in mobility rates. It then goes on to describe the empirical data and the mobility definitions more carefully. The second section compares business cycles in the Nordic countries over the analysis period, and presents aggregated job-to-job inflow mobility rates. Although the levels differ, the business cycles in the Nordic countries show remarkable similarities. In the same way, the movements in mobility rates over time follow a common trend, in line with the business cycle. Hence, a first indication of pro-cyclicality in mobility rates is established.

The third section comments on the decomposed mobility rates for various subgroups and relates them to expectations and explanations.[7] The distribution of mobility rates according to sector, age, educational level, size of workplace and other variables, provides a snapshot of the national cases. Common stylised facts for the Nordic countries include: mobility rates decrease with age, increase with educational level and decrease with establishment size. Sectoral variations are more mixed and appear to be somewhat demand-driven (Table 2).

The trends in the data are more formally compared with the business cycle in the next section, where correlation coefficients between the mobility rate and the business cycle are calculated for each country. The general tendency is again towards pro-cyclicality of the mobility rates (Table 3). In this section, a full probabilistic (logistic) model on mobility is estimated. The model quantifies the

business cycle effect as well as mobility rate differences between the different sub-groups (Table 4). The empirical model generally confirms the results presented in the earlier sections.

The final section concludes and highlights potential areas of research for the future. The conclusions of the mobility study are summarised in Tables 2, 3 and 4.

Worker mobility and cyclicality

Mobility rates of employees are closely linked to knowledge exchange and circulation in the economy. The mobility of individuals is a well-defined and comparable measure, although it only measures one dimension of knowledge exchange between firms. Firms can change or increase their knowledge stock through, for example, internal or external upgrading of the existing workforce. Such knowledge upgrades can afterwards be spread throughout the firm. Other knowledge links which firms may use in their knowledge upgrading include external experts and consultants, co-operation with other firms, and own R&D departments. However, information on such kinds of knowledge exchange and tacit knowledge is difficult to collect in a comparable way. The same holds true for the tacit knowledge obtained through internal knowledge exchange. Hence, mobility of individuals is uniquely measurable and comparable and provides the best indicator for overall knowledge exchange.

Theoretically, firms adjust their workforce in response to the shocks they face. This may be the economic state or level represented by the business cycle or worker-related conditions such as the composition of the workforce at the establishment level. In a neo-classical world, a representative firm optimises its profits through representative workers and common wage rates. This is obviously not the case in the real world, in which firms react simultaneously on several fronts: financially, through personnel management or through changes in levels of input/output. This may result in a simultaneous hiring and firing process at the firm level. The average of these hiring and firing activities aggregates to the macro-level change in the total number of employees. It is important to bear in mind that the micro-level figures may point to job creation and job destruction occurring at the same time in the same firm (Hamermesh *et al.*, 1996). The observable behaviour can partly be explained by sectoral differences, worker characteristics, firm size, etc. However, this heterogeneity at the firm level is in stark contrast to the representative firm theory, where only one thing occurs, namely the average effect. This chapter looks at selected supply and demand factors that can explain parts of this heterogeneity through measures of worker flow magnitudes and worker flow cyclicality.

The business cycle is the most frequently used indicator for the overall well-being of the economy. Shifts in the prevailing economic conditions in a country influence both demand behaviour in firms but also supply behaviour among employees. In economic upswings, firms may hire more and fire less, while workers are more likely to seek, and find, more attractive jobs; the opposite effect occurs during downturns. Hence, the magnitude, persistence and distribution of the mobility rate are expected to correlate positively with the business cycle, *i.e.* they are pro-cyclical. This chapter uses empirical analyses to investigate whether this is the case in the Nordic countries.

A common stylised fact is that job destruction is counter-cyclical, that job creation is pro-cyclical (Boeri, 1996), and that the sum of the two is counter-cyclical. The explanation is that jobs are easy to destroy and hard to create, so the destruction rate is more volatile than the creation rate, giving a counter-cyclical job reallocation, *i.e.* mobility rate. However, this may not be the case in the Nordic countries where a large public sector seems to stabilise the employment situation (Bingley *et al.*, 1999). Similarly, a large number of the studies which underlie these stylised facts has been performed on sub-sets of the manufacturing sector, and some have concerned job mobility with a focus on the net or macro effect. Gross mobility rates are of greater interest to the present study, which focuses on

knowledge circulation and exchange. Hence, the stylised facts in previous studies may not describe the actual situation from the knowledge point of view. This chapter documents the substantial knowledge transfers (flow of workers) between establishments in the Nordic countries and the size of the cyclical variations in these knowledge transfers.

The *ex ante* expectations about the cyclicality of the mobility rates are mixed, but the argument goes like this: firms fire less and hire more in favourable periods, resulting in an increase in employment in economic upswings, *i.e.* counter-cyclicality dominates pro-cyclicality. Employees search more and receive more job offers in good times, *i.e.* separation and hiring increase pro-cyclically. However, the firm's decision and the employee's decision are not distinguishable, *i.e.* firings and separations cannot be separated out. This set up is illustrated in Table 1. Table 3 below summarises the empirical evidence for the cyclicality of the inflow and outflow mobility rates in the Nordic countries.[8]

Table 1. **Expectations of cyclicality in inflow and outflow mobility rates**

	Type of business cycle		Type of cyclicality
	Boom	Downturn	
Firm (demand side)			
Fires	Decrease	Increase	Counter-cyclical
Hires	Increase	Decrease	Pro-cyclical
Total employment	Increase	Decrease	Pro-cyclical
Employee (supply side)			
Separations	Increase	Decrease	Pro-cyclical
Job offers	Increase	Decrease	Pro-cyclical
Total employment	Increase	Decrease	Pro-cyclical

Data descriptions and mobility definitions

Longitudinal register databases with unique links between workers and employers over time have been constructed from national register in the Nordic countries. The data used in the present analysis are already collected for other purposes, so there is no extra reporting or survey burden on the employers or employees. The only exception is Iceland, where LFS data are used. LFS data can reveal the same information, but the sample is small and some interesting decompositions are not possible due to small sub-sample sizes. Register data can be decomposed in many ways and the only limit in practice is that the decomposition variable be included in some of the registers which underlie the longitudinal register database. For example, background characteristics, such as age, education, gender, family type, income, tenure, experience, workplace size, etc., are typically available in the registers.

Mobility rates are estimated from national register databases (except for Iceland where LFS data is used). The national register databases are longitudinal and include matched employee and employer data in the first week of November each year. Hence, mobility of an employee is measured as a move between two establishments from November to November in two consecutive years (Box 1). Since only movements between two consecutive November weeks are used to calculate mobility rates, the rates should be considered as lower bounds for actual labour mobility between workplaces. An unknown number of employees switch jobs more than once in a one-year period. In the LFS, it would be possible to ask for this information. Studies using LFS usually report lower mobility rates than similar studies using register data (Åkerblom, 1999, and Laafia and Stimpson, 2000). This is probably

caused by the selection and understanding mechanism in the LFS; namely that the respondents may neglect small establishments, highly volatile workers, young people, etc,. and that the employment and mobility question may be understood differently, hence giving a downward biased rate.

Box 1. **Definitions of job mobility terms used in this chapter**

Inflow mobility

Job-to-job mobility is defined as a shift of workplace between the previous year and the present, *i.e.* a shift between two jobs, MOVERS.

No mobility is defined as the total number of employees who are employed both years, STAYERS.

Inflow mobility rate

The job-to-job inflow mobility rate is defined as the number of employed movers between two consecutive years divided by the total number of employees employed both years, MOVERS / (MOVERS+STAYERS).

Inflow and outflow mobility rate

The job-to-job inflow mobility rate in year t equals the outflow mobility rate in year t-1, since the number of MOVERS into year t and out of year t-1 are equal and since the stock of STAYERS in year t and year t-1 are equal.

In the main part of the present study, only job-to-job inflow mobility rates are used. This means that only employees who had a job one year earlier are included in the analysis.[9]

In the present analysis, mobility rates for employees are decomposed according to a number of supply and demand characteristics. For presentational reasons, only a few examples are given here. The amount of knowledge embodied in an employee is specific to that individual, but it can be approximated by formal education, job tenure, job experience, and working sector, among other characteristics. In this chapter, knowledge is approximated by education (measured according to the ISCED code), by age (highly correlated with tenure and experience), and by working sector (measured by the NACE code). Furthermore, a common demand- and supply-side variable is included, namely establishment size measured by the number of employees. Åkerblom (2000) suggests the groupings of the employees.

The rationale behind the groupings is the need to identify significant knowledge carriers from an innovation point of view. In national innovation systems, the main emphasis is on highly qualified employees, since these are the people who contribute the highest innovation potential. This means that an extreme country mobility rate caused by employees with low education levels is biasing the actual knowledge flow inherited in those employees who move. Hence, employees need to be decomposed by low and high formal education levels. The mobility rate is expected to increase with the educational level since it is easier for the well-educated to find (better) jobs.[1] Both the human capital theory and the search theory explain that mobility increases with educational level. The human capital theory predicts higher mobility among employees with relatively low firm-specific capital, *i.e.* the highly educated, and low mobility among employees with high firm-specific capital, *i.e.* the less well-educated. The search theory predicts more job offers or higher expected returns to job search for higher educated employees, *i.e.* a higher mobility among highly educated personnel.

Since formal education does not measure tacit knowledge, another decomposition variable is used in this chapter. As a proxy for job tenure and experience, the age of the employee is used to indicate

whether he/she is experienced on the labour market. Hence, the older the employee, the more knowledge is transferred through a job shift. Labour market theory tells us that mobility rates are expected to decrease with age since employees tend to stop searching for better jobs once they have found one which satisfies their ambitions. Similarly, the job search decreases when family relations become binding, *i.e.* when mobility costs increase due to real-estate ownership, children, constraints due to spouse's or husband's job, etc. Hence, high mobility rates among younger employees do not necessarily point to a high knowledge transfer in the economy.

Another interesting aspect of the knowledge transfer debate is knowledge transfer in highly innovative parts of the economy. In the new knowledge economies, these are, for example, the information and communication technology (ICT) sector, the higher education institutions and the R&D institutes. For presentational reasons, only five sectors are referred to in this paper. The three other groups are: the industrial production sectors, the production-related service sector and the humanity-related service sector. Åkerblom (2000) also suggests decomposition into 20 sectors, following the five major groups defined above. However, the interesting split between types of knowledge transfer in knowledge-intensive or -extensive sectors can be fully illustrated using the five sectors.

Finally, the implications of sampling employees in establishments of certain sizes are illustrated by a decomposition of mobility rates for different size groups. Since large establishments have better possibilities for internal recruitment than small establishments, and since small establishments are often younger and have a higher employment growth than large establishments, the inflow worker job mobility is expected to decrease by establishment size. The theories of selection predict that new establishments will employ more updated technologies and a more efficient workforce. Thus, they will expand at a faster pace and have a higher inflow mobility rate. Similarly, the vintage theory predicts that older establishments no longer update their technologies and workforce, hence they cease to grow. It is likely that they may even shrink, resulting in a lower inflow mobility rate for old firms. This effect is termed "creative destruction" in the new growth theory. If – *and only if* – new firms are smaller and old firms are larger, the two theories explain decreasing mobility rates with establishment size.

This means that the exclusion of small establishments considerably decreases the mobility rates. From a knowledge transfer point of view, this is important if small establishments are less innovative or have less tacit knowledge attached to their employees. Hence, mobility rates among larger establishments may be most important if the employees that leave carry more knowledge than corresponding employees in small establishments. The relationship between age/education and establishment size is postponed for future work. However, the size effect is included in the present chapter in order to illustrate its importance.

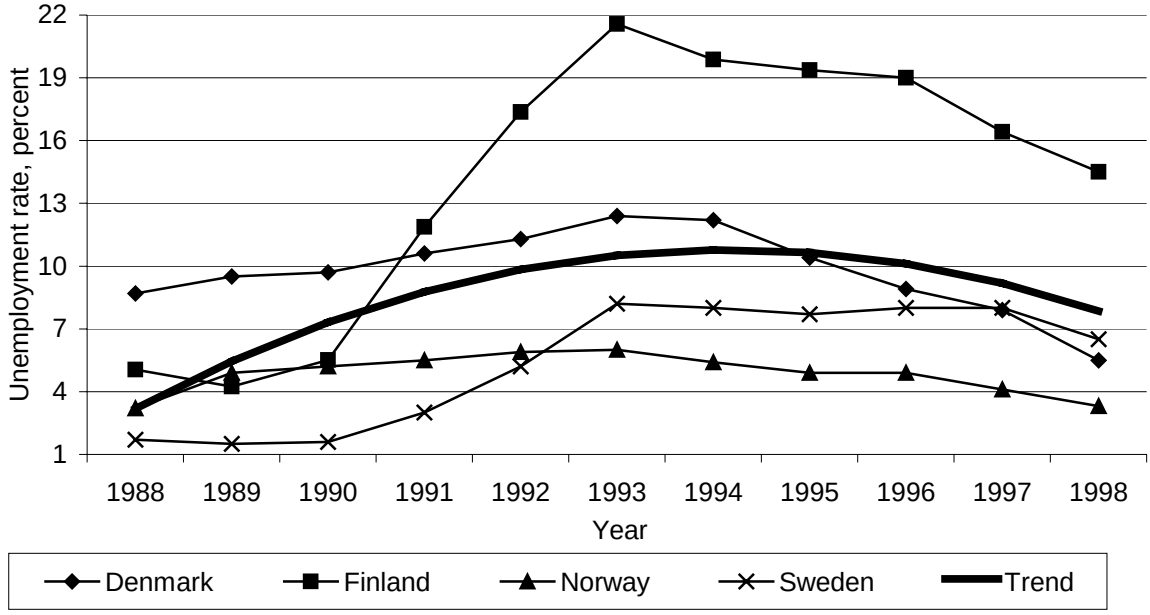
Job-to-job mobility rates and the business cycle, 1988-98

Two indicators – the unemployment rate and the real growth rate in GDP – are used to measure the business cycle in the period.[10] Other measures may be used, as long as the correlation between the indicator and the business cycle is strong and stable over time. The unemployment rate may show some time lag since separation, firing and hiring usually happen some time after changes in the economic environment. This is due to the fact that firms usually increase productivity or make use of natural or voluntary job shifts, etc., in their adjustment process before actively initiating job changes. Hence, the GDP indicator may show a more up-to-date business cycle compared to the unemployment indicator, *i.e.* the GDP indicator reveals economic demand-side conditions rather than immediate labour market conditions. However, the real GDP growth rate may also change due to external factors

such as booming oil resources in Norway (and more moderately in Denmark). In this case, the GDP contribution from the oil sector may be significant without having any influence on the job mobility rate. Similarly, job mobility may show a time lag compared to changes in the business cycle, so that the unemployment rate may provide a better approximation of the change in mobility rates than the real GDP growth rate. If this is the case, there will be a time lag between changes in the business cycle and changes in mobility rates. Figures 1 and 2 show the two measures for the business cycle in the Nordic countries.

Figure 1. **Unemployment rates by country, 1988-98**

Percentages



Note: The trend is fitted by a second-order polynomial trend based on a non-weighted average of national unemployment rates.
Source: Statistics Denmark, Statistics Finland and ILO, *Yearbook of Labour Statistics*.

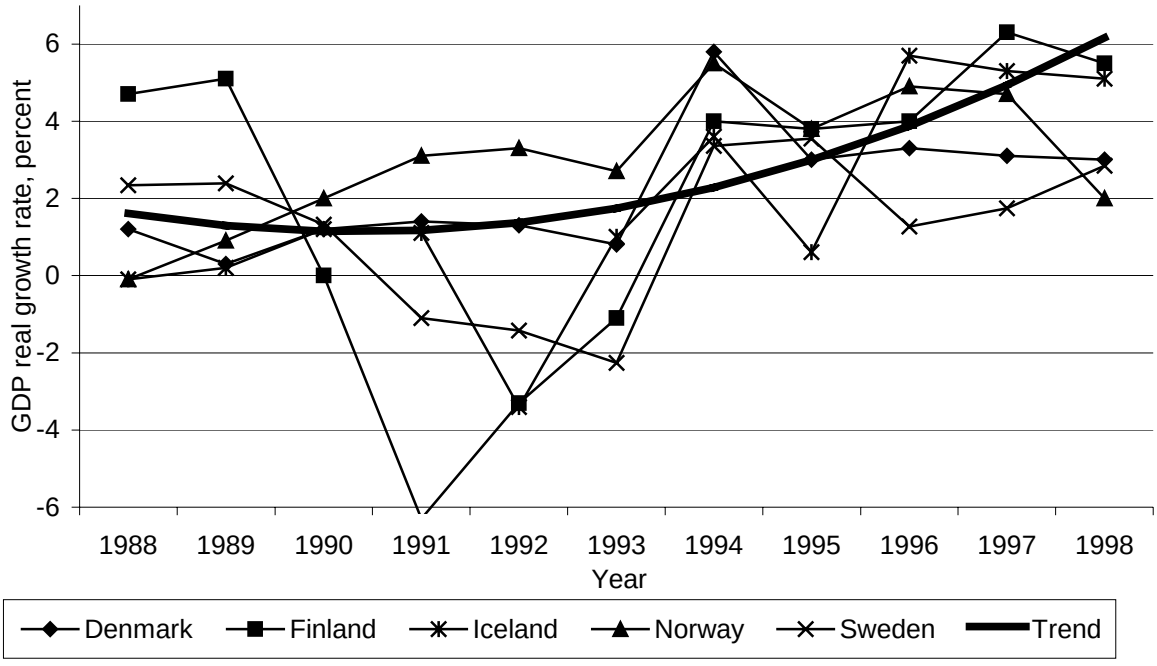
The unemployment rate and the real GDP growth rate follow a common trend. Although the country-specific levels are different, the changes are in the same direction, with a common shift around 1992-93. The unemployment rate is bell-shaped, showing an inverse relationship with the business cycle. Conversely, the real GDP growth rate clearly demonstrates the economic climate, *i.e.* the business cycle. All in all, Figures 1 and 2 show a u-shaped business cycle in the Nordic countries in the 1990s, with the bottom of the downturn lying around 1992-93.

A country-specific comparison was made of the unemployment rate, the growth in real GDP, together with the inflow job-to-job mobility rates for the Nordic countries. The mobility rates for all four countries are shown in Figures 3 (as levels) and 4 (as indices), together with a common second-order polynomial trend.

Register information for 1988-97 is available for Denmark. Both the unemployment rate and the growth rate in real GDP indicate that a shift in the business cycle took place in 1993: before 1993, the business cycle is negative; after 1993, it becomes positive. A level shift in the inflow rate between

1993 and 1994 indicates a cyclical mobility rate where the worker mobility rate changes with the business cycle. There is a weak tendency for the hiring and separation process to be pro-cyclical.

Figure 2. **GDP real growth rates by country, 1988-98**
Percentages



Note: The trend rate is fitted by a second-order polynomial trend based on a non-weighted average of national GDP real growth rates.
Source: Statistics Denmark, Statistics Finland and OECD, *National Accounts* and Nordic Statistical Yearbook.

The Finnish data covers the period 1988-98. This period was characterised by a massive increase in the unemployment rate from 1990 to 1993, and a small decrease thereafter. This is illustrated by the negative growth rates in real GDP. According to the figures, mobility rates declined correspondingly, from a high level before 1990 to a low level after 1992. At the end of the period, the mobility rates increase slightly. Thus, in Finland there seems to be a particularly clear inverse relationship between the unemployment rate and the mobility rates, which demonstrates the business cycle influence on the mobility rates very well.

The Norwegian case is less volatile. In Norway, there seems to be a business cycle with a lower bound around 1993, where the unemployment rate peaks. Unfortunately, the same business cycle is difficult to recognise in the GDP real growth rate. In the first part of the period, there is a correlation between the unemployment rate and the mobility rate. This is, however, less clear in the latter part of the period. The Norwegian data on mobility are characterised by a shift in 1995, caused by the implementation by Statistics Norway of a new method for identifying job mobility. A change in workplace definition seems to be the explanation for this very significant shift.

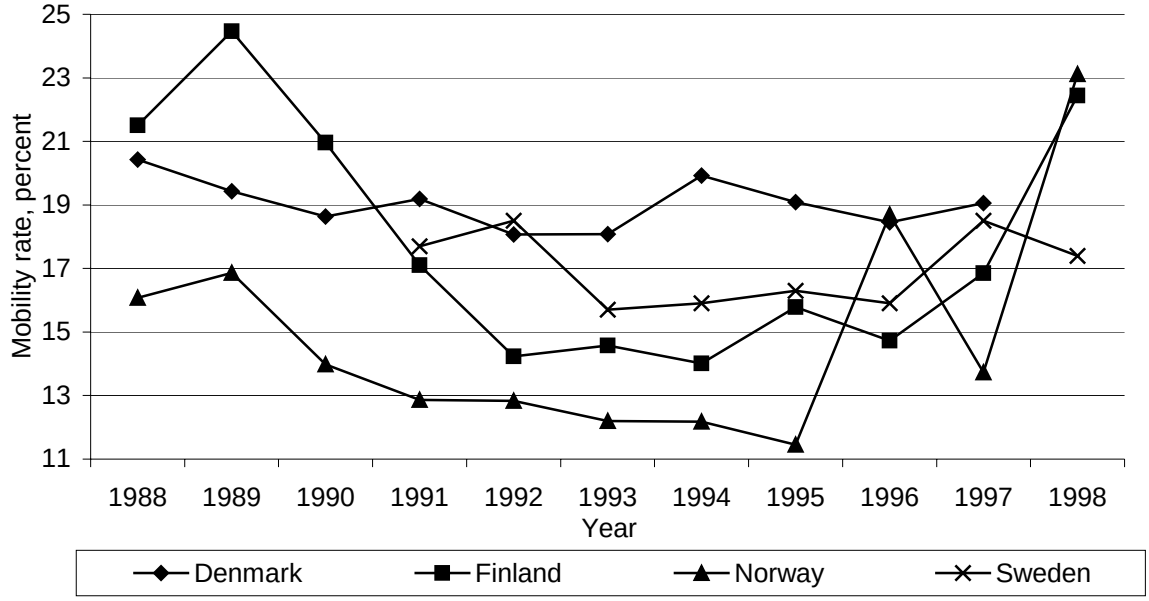
In the Swedish case, there is a common trend development between the business cycle indicators and the mobility rate. Unfortunately, the Swedish mobility rates are only available from 1991 onwards. However, the shorter time period does not change the impression of pro-cyclicality in the mobility rate.

In general, the business cycles in the Nordic countries seem to demonstrate the same pattern, with a downturn until 1993 and a recovery thereafter. However, the size of the business cycle varies, with the deepest recession in Finland, followed by Denmark and Norway. Finland also shows the most perfect eye-view correlation between the business cycle indicators and the mobility rates.

Although the level of the inflow mobility rates varies between the Nordic countries, as shown in Figure 3, they show a remarkable common development. The levels are different but the development follows the same u-shaped pattern.[11] Only the Finnish and the Danish data have been corrected for artificial changes in establishments; such a correction usually decreases the mobility rates by a couple of percentage points.

Figure 3. **Job-to-job inflow mobility rates by country, 1988-98**

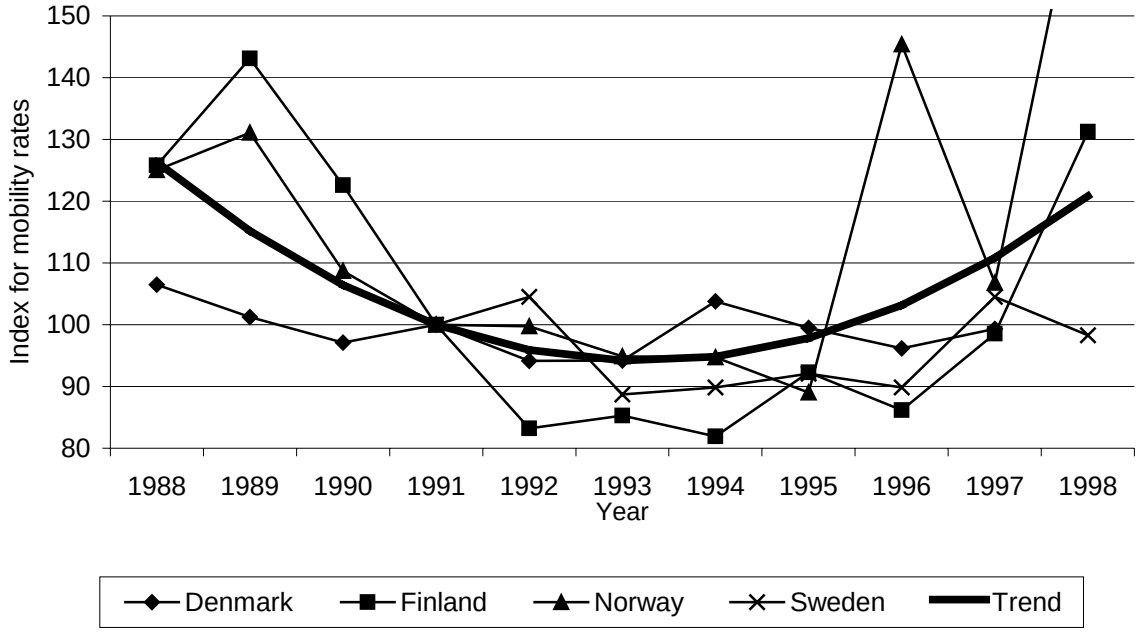
Percentages



Note: Swedish data is only available for 1991 and onwards. The volatility in the Norwegian data after 1994 is caused by a change of establishment definition, which influence the mobility rates.
Source: Own data.

In order to drag the trend a bit in front, Figure 4 shows the indexed mobility rates for all the countries, together with a fitted polynomial trend based on the average of the country mobility rates. The trend shows the lowest mobility rate in 1992/93, which fits in well with the observation of the deepest recession occurring around 1993.

Figure 4. **Indexed job-to-job inflow mobility rates by country, 1988-98**
1991=100



Note: The trend rate is fitted by a second-order polynomial trend based on a non-weighted average of national mobility rates. Swedish data is only available for 1991 onwards. The volatility in the Norwegian data after 1994 is caused by a change of establishment definition, which influences the mobility rate.
Source: Own data.

Decomposed job-to-job inflow mobility rates, 1988-98

Job mobility rates for various sub-groups can be drawn similar to Figure 3. This section comments on inflow mobility rates for the Nordic countries broken down by various characteristics of the job, the employee or the employer, such as sector, age, educational level, and workplace size. The presentation of the mobility rates is grouped by the decomposition variable.

Mobility rates decomposed by sector and age

The first decomposition is that of the inflow mobility rate by five aggregated industrial sectors for younger and older employees. The decomposition into younger and older employees is based on earlier analyses (see, for instance, Graversen, 2000), where an obvious difference in the mobility rate occurs around the age of 35.[12] As the coefficients to the age dummy variables in Table 4 show, the mobility rates decrease with age, with smaller and smaller steps (a decreasing rate, *i.e.* the first half of a u-shaped pattern). Hence, the youngest workers show the highest mobility rates, while the oldest employees have mobility rates close to or in common with middle-aged employees (see Figures 5-8). The age effect is highly correlated with the corresponding job tenure or job experience measures, *i.e.* younger employees have lower tenure and experience, and vice versa. Hence, decomposition by groups based on job tenure or job experience will demonstrate the same mobility pattern as decomposition by age.

The five industrial classifications are suggested in Åkerblom (2000) and reflect an increasing interest in the innovation and R&D potential of the research sector and the information and communication technology sector.[13] Both sectors play a vital role in the new and expanding knowledge economy. The three other sectors represent the industrial production economy, and the tertiary service sectors, decomposed by the product service sectors and the human service sectors, respectively. The number of employees in the five sectors varies considerably. In general, the ICT sector is the smallest employer, while the community service sector is the largest employer.

Job-to-job mobility rates for young employees aged 20-34 and for older employees aged 35-64 have been calculated for all four countries.[14]

In the Danish case, a clear difference is found between mobility rates for the younger and the older employees, regardless of the sector in which they work. Another clear pattern is the highest (lowest) mobility rates for the young (old) employees in the HEI sector. The ICT sector has the lowest mobility rates in the downturn period for the youngest employees, increasing to the highest rates in the upturn period. The mobility rate for the oldest workers in the ICT sector is among the highest for the entire period. Since experience is important in this growing industry, the result is partly to be expected as inexperienced workers are less useful. In between lie the mobility rates for the other sectors. In general, only the youngest workers seem to be influenced by the business cycle since there is a level shift in 1993. This is not the case for the oldest employees. The ordering of the mobility rates by sector is not obvious for the youngest workers; it is, however, much clearer for the older workers. The below-average mobility rate for the manufacturing sector seems to be general. Hence, this sector usually hires less than the rest of the economy. This may be due to longer tenure, fewer open positions or shrinking industries. The product services sector presents above-average mobility rates for the oldest, but not for the youngest workers. A striking trend seems to be that the mobility rates for the other community services sector are close to the average of the job-to-job mobility rate but above the average of the overall mobility rate for the youngest workers. This indicates that this sector has a higher-than-average recruitment share of workers who had not previously been employed.

In the Finnish case, too, there is a clear difference between younger workers and older workers, together with a higher volatility for the young. The inflow mobility rates for the older workers are more stable over time for all groups compared to those for the young. The inflow mobility rate for the ICT and HEI sectors are in the top range for both age groups. The lowest mobility rates are found in the manufacturing, etc., sector which seems to have been hit very badly by the Finnish recession.

In Norway, the age level effect on the mobility rate is also very clear. The sectoral groups seem to have more equal and similar mobility rates compared to Denmark and Finland, where a larger difference is apparent. The ICT sector has very low mobility rate, especially before 1995; thereafter, it increases rapidly. The opposite occurs the other countries. The HEI sector has lowest rates, which is also the case in the other countries.

Although the Swedish figures only cover a short period, they demonstrate a similar ordering to that shown in the other Nordic countries. The mobility rates are highest among young workers. The inflow is especially high among young employees in the HEI sector but is relatively high among older workers in the ICT sector. The inflow to the production sector is, in general, low throughout the period.

Mobility rates decomposed by educational level and age

Both search theory and human capital theory predict the ranking and causes of mobility according to different age and education groups. Mobility rates are expected to decrease with age, since both employers and employees are searching for the perfect match. Over time and/or age, this match becomes more and more likely to happen. However, at the same time, inflow mobility rates may be higher for experienced workers in negative periods of the business cycle. The more highly educated have greater opportunities to search and find the perfect job offer, therefore it would also be expected that mobility rates increase with education. This may not be the case if the job market is closed, as is the case in the HEI sector, where only a selected group of highly educated individuals are allowed to work. Similarly, if a sector is shrinking, then the inflow mobility rates for the highly educated may be low, since it is easier for the well-educated to seek and find jobs in other sectors. Finally, since the focus here is on job-to-job mobility, the flow from unemployment to a job is not included in the mobility rates. If less well-educated workers are more often unemployed between jobs, the direct job-to-job mobility rate will be lower for less-educated than for highly educated workers. Evidence from Graversen (2000) indicates that this may be the case, at least for Denmark.

Job-to-job mobility rates for high- and medium-low educated young people aged 20-34 and for high- and medium-low educated older people aged 35-64, have been calculated for the Nordic countries.[15] In general, the expected patterns are found in all four countries (Figures 5-8).

In Denmark, higher educated employees have higher job-to-job mobility rates than low educated employees. The difference in mobility rates caused by education is higher for young workers than for older workers. The differences seem to have decreased during the economic upturn of the late 1990s.

The Finnish case shows that higher educated youngsters have the highest job-to-job mobility rates and low educated olds the lowest rates. The difference in mobility rates due to education seems to widen over time. Hence, it would appear that less educated employees are hit harder by a recession and recover more slowly.

The Norwegian case also illustrates that higher-educated employees have the highest mobility rates. This is the case both for younger and older workers. The educational difference is very persistent over time, and was most significant at the lowest point of the business cycle, around 1993-94.

Inflow mobility rates for Sweden are highest among higher-educated employees. Although there is a clear educational effect, the age effect seems to dominate in Sweden. Hence, well-educated employees have easier access to new jobs, *i.e.* the net benefit of a job switch is more often positive, but, again, the search intensity among younger workers is so high that it results in more job shifts.

Mobility rates decomposed by detailed educational levels

As mentioned above, the educational level of employees is expected to have a positive influence on mobility rates in the majority of cases. However, for some minor sub-groups, this may not be the case, although, on average, the differences caused by the sub-groups may equal out. Less educated employees have lower start-up costs, but also lower incomes. Hence, they may be easy to replace but difficult to attract at the proposed wages, *i.e.* the sum of high and low mobility rates. Similarly, the less well-educated have less to offer a new employer; therefore, their successful search activity may be low, *i.e.* indicating low mobility rates. The opposite may well be the case for the highly educated; employers may be willing to pay more to keep their expertise since they are difficult to replace. On the other hand, highly educated employees have a lot to offer a new employer, so mobility rates may be high.

Figure 5. **Inflow job-to-job mobility rates by age and educational level in Denmark, 1988-97**

Percentages

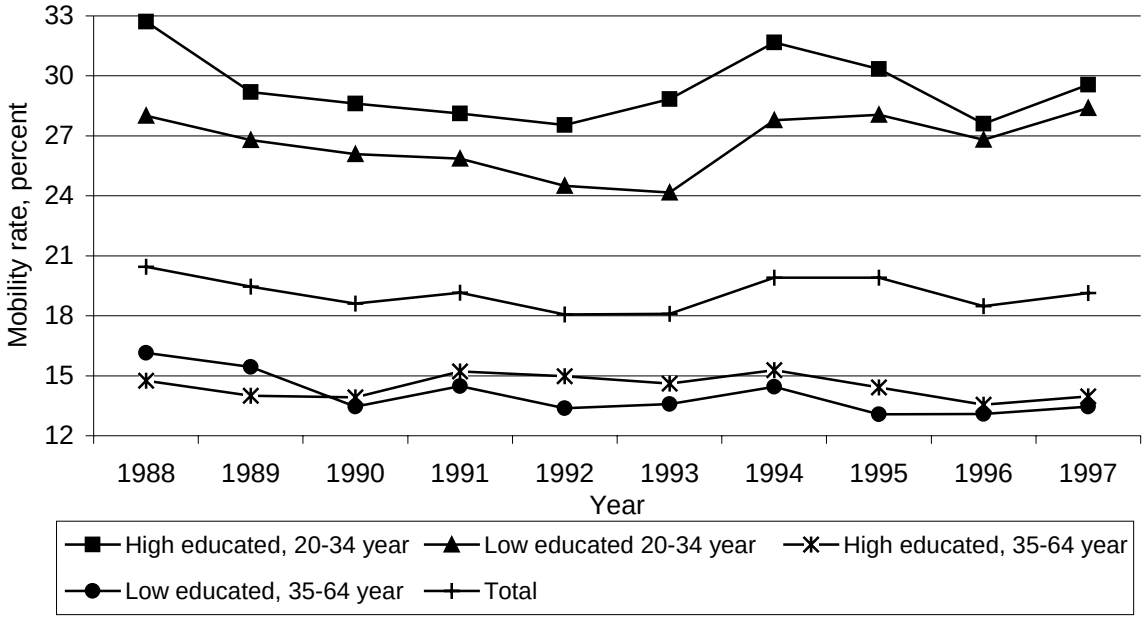


Figure 6. **Inflow job-to-job mobility rates by age and educational level in Finland, 1988-98**

Percentages

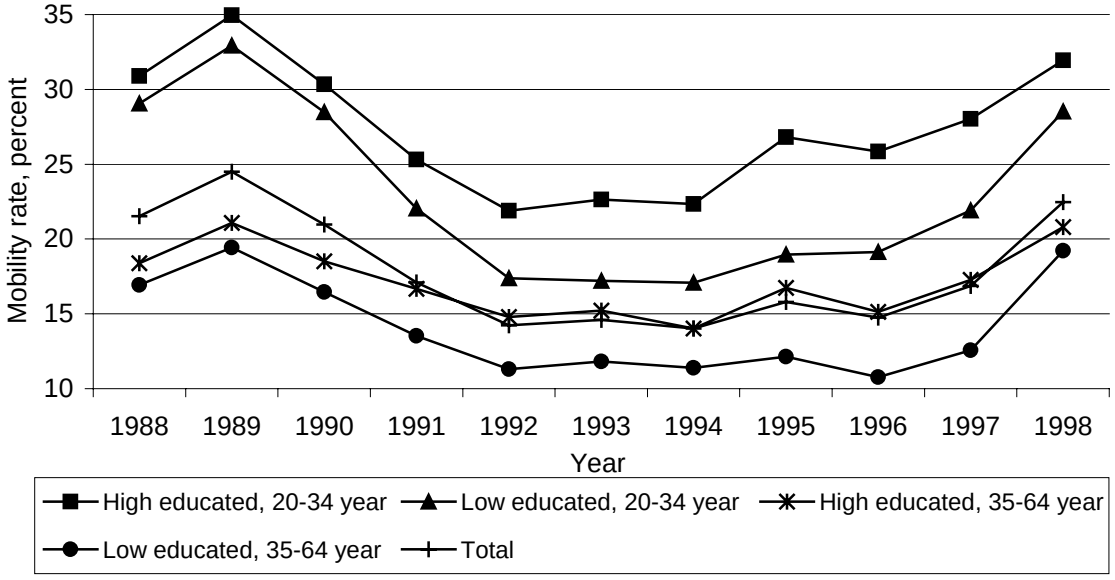


Figure 7. **Inflow job-to-job mobility rates by age and educational level in Norway, 1988-98**
Percentages

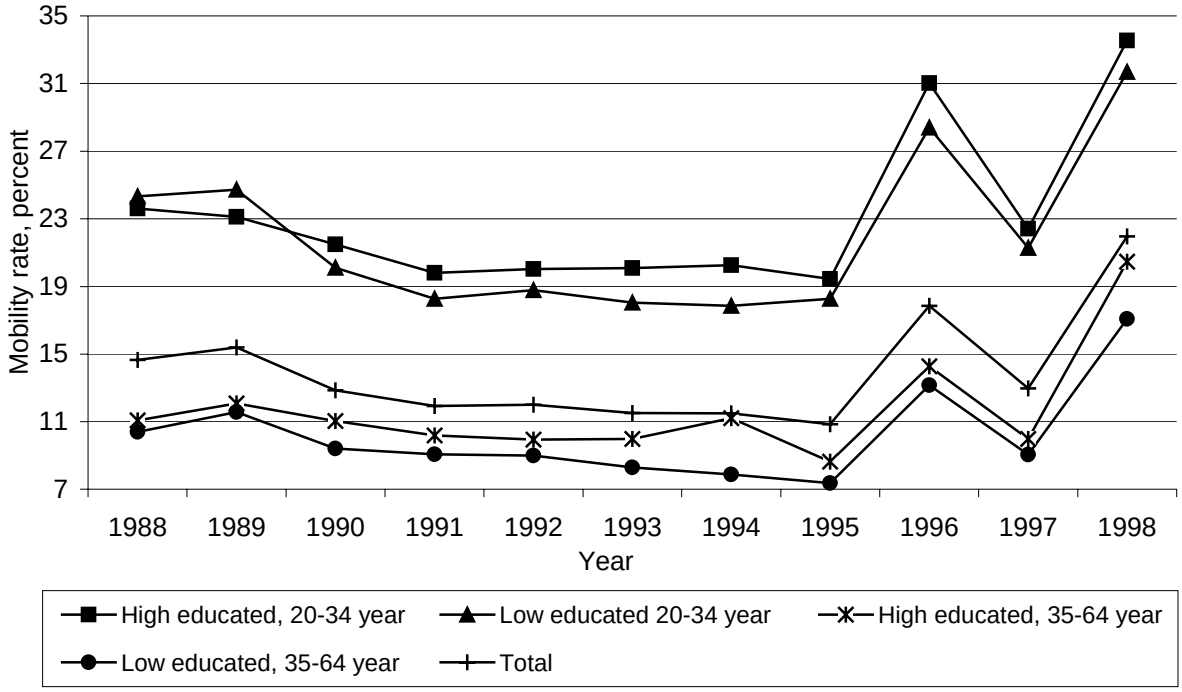
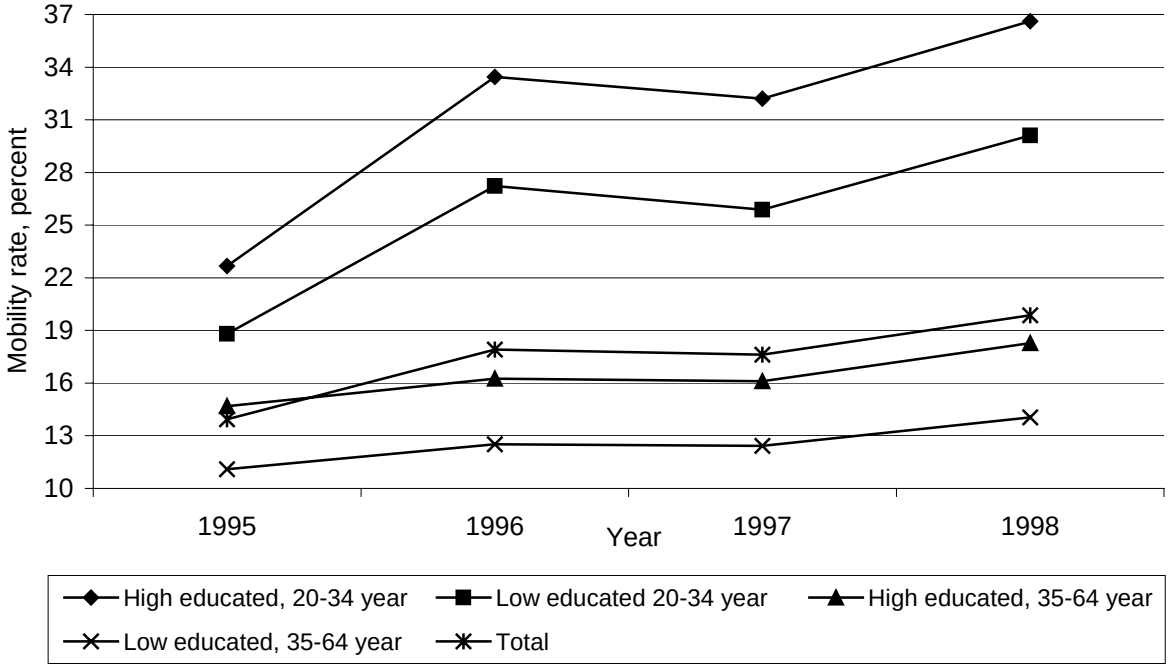


Figure 8. **Inflow job-to-job mobility rates by age and educational level in Sweden, 1995-98**
Percentages



In downturns, the inflow of less educated employees may be reduced since downturns reduce the demand for products to a greater extent than the demand for services and R&D. In contrast, the inflow of less educated employees may increase during economic upturns as production sectors expand. For highly educated employees, the mobility rates are expected to be less production-influenced and more stable over time. Hence, they may be less stable over time for the less educated than for the higher educated. Job-to-job inflow mobility rates for the Nordic countries were calculated, decomposed by four educational levels defined according to ISCED'97.[16]

The expected pattern can be found, at least to a certain degree, for Denmark. Employees with high and medium levels of education have an equally weakly u-shaped pattern over time. This indicates a weak business cycle effect. The case for the employees with low education levels is more complex. The level is considerably lower than for the other groups, although there does not seem to be any business cycle fluctuation. PhDs have a high mobility rate, except for the years 1993-94.

For Finland, the pattern clearly indicates that the recession led to a decrease in mobility rates, regardless of employees' educational level. However, the higher the education level, the quicker the recovery in the mobility rate. In the case of the less educated, the decrease is parallel, but the increase is postponed.

In Norway, the ordering of the low, medium and high levels of education shows clearly that mobility rates increase with educational level. The volatility in the rates is highest for employees with low education levels. Hence, the mobility of the less educated decreases most during economic downturns and recovers more slowly in upturn periods. PhDs in Norway demonstrate an extreme pattern with high volatility but with a less clear link to the business cycle.

Mobility rates increase with education levels to a certain degree in Sweden too. However, the pattern may be rather bell-shaped, since the medium educated group has the highest rate while PhDs and low education groups have the lowest rates. Hence, the most significant knowledge transfers are taking place among medium-high educated employees.

Mobility rates decomposed by establishment size[17]

Another well-established stylised fact in the literature is that larger workplaces have higher internal recruitment and therefore have smaller inflow mobility rates from other workplaces. Job-to-job mobility rates by workplace size for the Nordic countries have been estimated using a common decomposition used by Eurostat and the EU, among others. In general, the figures show a u-shaped tendency, such that the inflow mobility rates are high for small and very large workplaces and smaller for medium-sized workplaces.

The mobility rate is calculated as the total number of movers over the total number of employees, so the fact that a change of one employee is relatively more significant for small establishments than for large ones does not matter in the rates calculated here.

The size difference may be caused by several other factors. One is the higher opportunities for internal recruitment mentioned above. Another is the fact that establishments that increase in size will usually have a higher inflow mobility rate. Thus, small establishments may have a higher growth rate in terms of numbers of employees. A third reason may be that new firms usually begin their lives as small firms; in the first year, all the employees are counted as inflow mobility. A fourth reason may be that small establishments are easier to merge, buy, move or radically change in other ways. This, again, creates possibilities for higher mobility rates among small establishments.

Denmark clearly shows a decreasing inflow mobility rate depending on workplace size. Small workplaces have by far the highest mobility rates, followed by medium-small workplaces. Medium and large workplaces have the lowest mobility rates, although ranking of these is difficult. The average mobility rates lie a little below the rates for the medium-small workplaces. All groups display a weak u-shaped mobility rate over time, indicating that all workplaces, whatever their size, are influenced by the business cycle. An exception may be very large workplaces where the u-shape is arguable.

In the Finnish case, mobility rates decrease as firm size grows larger. However, the differences between the group averages are smaller than in the Danish case. Again, the business cycle effect dominates clearly over the analysis period.

The ranking of workplace sizes by mobility rates is as would be expected. The larger the work place, the lower the mobility rates. All groups have a weak u-shaped pattern, indicating that they are all influenced by the business cycle.

The ordering of the mobility rates according to establishment size in Sweden follows the ordering in the other countries. Except for employees in the smallest establishments, the ordering is very straightforward: the larger the establishment, the lower the inflow mobility rate. In contrast to the other Nordic countries, the mobility rate for employees at small establishments is only second highest in Sweden.

Tendencies and trends in the Nordic mobility rates

The calculated decomposed mobility rates commented in the present section show differing levels, depending on country, sector, age and educational level of the worker, as well as establishment size. The definition of inflow mobility rate chosen also influences the conclusions (Graversen, 2000). As mentioned above, the chosen job-to-job mobility rates are lower than, for example, the overall mobility rates.

However, it is possible to extract some very clear tendencies and trends based on the data. These are summarised in Table 2. There appear to be some stylised facts for the Nordic countries. The inflow job-to-job mobility rates fluctuate pro-cyclically with the business cycle in all four countries. Similarly, the theoretical expectations that mobility decreases with age and workplace size, and increase with educational levels seem to be fulfilled. The sectoral differences are less clear.

Evidence on cyclicality of mobility rates

From a policy point of view, it is interesting to know whether mobility rates are pro-cyclical or counter-cyclical. The possibility of targeting different policies at different group at different times is to be highly recommended, especially in the new knowledge-based economies. A number of theoretical studies have tried to model the relationship between the business cycle and mobility rates. Unfortunately, the results predict either pro-cyclicality or counter-cyclicality, depending on the choice of model. Hence, an empirical study is needed to put forward stylised facts in order to determine the dominant direction, which may vary between sub-groups (Graversen, 2000).

Table 2. **Trends in inflow job-to-job mobility rates by background characteristics for the Nordic countries**

Background characteristics	Tendency and trends in the ordering and cyclicality
Sector	• The sector effect is not clear. The HEI sector seems to have low mobility rates, the ICT sector seems to have high rates. In between, it appears to matter for the mobility rates whether the sectors are shrinking (agriculture) or expanding (trade). • The business cycle matters, most volatile for the younger employees, least volatile for the HEI and the ICT sectors.
Age	• The age effect is dominant. In all the Nordic countries, the mobility rate decreases with age. • The business cycle matters for all age groups, although apparently it is most volatile for the younger age group.
Education	• The educational effect is clear. The mobility rate increases as the educational level rises. • The business cycle matters for all groups, although apparently it is most volatile for the low educated groups.
Size of workplace	• Workplace size clearly matters. The mobility rate decreases as the size of the workplace increases. • A business cycle effect is seen for all firm sizes, but is apparently most volatile for small workplaces.

In this chapter, we use two general measures as indicators for the business cycle, namely the inverse unemployment rate and the real GDP growth rate. Unemployment is high when the business cycle is low, and *vice versa*, so the inverse unemployment rate follows the business cycle directly. Similarly, the GDP real growth rate indicates the business cycle conditions in each year. The correlation between these two measures and the mobility rates determines whether the mobility is pro- or counter-cyclical in relation to the business cycle. In this section, correlation is found in two ways. First, a non-parametric correlation is estimated between the inflow job-to-job mobility rates and the national unemployment rate and GDP real growth rate, respectively (Figures 1-3). These results are shown in Table 3. Second, a parametric logistic model is used that allows a control for other background characteristics. These results are presented in Table 4.

The first part of Table 3 shows consistent pro-cyclicality in the Nordic countries regarding the inflow as well as the outflow (out-of-job) job-to-job mobility rates when the unemployment indicator is used. The cyclicality is most clear in the Finnish and Norwegian cases. Unfortunately, the pro-cyclicality is less clear when the correlation between the mobility rate and the real GDP growth rate is used. The outcomes vary from clear pro-cyclicality in Finland through weak pro-cyclicality in Denmark to clear counter-cyclicality in Norway. However, in general, the pro-cyclicality of the inflow job-to-job mobility rates can be said to dominate.

Cyclicality evidence from a logistic probability model on mobility

Another way to determine whether the mobility rates are pro- or counter-cyclical is to estimate a logistic model on the mobility of employees. For simplicity's sake, a model where the time series data is pooled is used. The sign and significance of the coefficient to the unemployment variable or the GDP real growth variable determines the cyclicality trend. Table 4 shows the estimation results for the Nordic countries. The unemployment rate is used directly in the estimations. Hence, a negative parameter estimate to the unemployment variable indicates pro-cyclicality, as does a positive parameter estimate to the GDP real growth rate. The parameter estimates to the background variables correspond very well to the pictures drawn above. In particular, the age variables explain a large part of the mobility variation in Table 4. Generally, the ordering found in the figures is revealed and

quantified in the empirical model estimation. The choice of explanatory variables is determined by the desire to build comparable and reputable variables that can be reproduced in other countries using, for example, the LFS.

Table 3. **Cyclicality of job-to-job mobility rates in the Nordic countries**
Correlation coefficients in parentheses

Business cycle indicator	Worker inflow	Worker outflow
Unemployment rate		
Denmark	Pro-cyclical (-0.27)	Pro-cyclical (-0.27)
Finland	Pro-cyclical (-0.86)	Pro-cyclical (-0.66)
Norway	Pro-cyclical (-0.62)	Pro-cyclical (-0.84)
Sweden	Pro-cyclical (-0.32)	Pro-cyclical (-0.59)
GDP real growth rate		
Denmark	Pro-cyclical (0.01)	Pro-cyclical (0.47)
Finland	Pro-cyclical (0.50)	Pro-cyclical (0.88)
Norway	Counter-cyclical (-0.44)	Pro-cyclical (0.88)
Sweden	Pro-cyclical (0.64)	Pro-cyclical (0.49)

Note: The Spearman rank correlation coefficient is used in this section since the non-parametric rank correlation best fit the conditions required for inference studies on the correlation between two measures with no clear distributional assumptions. However, due to the short time period of data, ten years, it is difficult to find significant rank correlations from the empirical data. A 10% significance level requires a correlation coefficient of at least 0.56.

The pro-cyclicality is confirmed for Denmark in Table 4. Both indicators are significant and reliable. The coefficient to the unemployment rate indicates that a 0.5% decrease in unemployment will increase the mobility rate by 1%. A 2.1% increase in the GDP real growth rate will have the same effect.[18]

In Finland, the pro-cyclicality of the mobility rates is confirmed, no matter which of the two indicators are used. The coefficients indicate that a 2.9% decrease in the unemployment rate or a 2.1% increase in the GDP real growth rate will increase the mobility rate by 1%. The coefficients to the other background variables confirm the findings presented in Table 2.

For Norway, the coefficients to the business cycle indicators reveal the same as in Table 3; namely, pro-cyclicality when the unemployment rate is used, and counter-cyclicality when the GDP real growth rate is used. Moreover, the parameter estimates are very high, indicating that the mobility rates will increase by some 20% or 5% when the unemployment or GDP indicators decrease by 1%, respectively. Hence, the estimation results in Table 4 point to large (inexplicable) reactions in mixed directions in the Norwegian case.

In the Swedish case, the model also estimates pro-cyclicality when the unemployment rate is used and counter-cyclicality when the GDP real growth rate is used. Again, the parameter estimates are very high, indicating that the mobility rates will increase by approximately 14% or 6% when the unemployment or GDP indicators decrease by 1%, respectively. The estimation results in Table 4 again indicate large (inexplicable) cyclicality reactions in mixed directions.

Table 4. **Logistic model of the inflow job-to-job mobility of employees in the Nordic countries**

Explanatory variable	Denmark		Finland		Norway		Sweden	
Unemployment rate	**-0.005***		**-0.029**		**-0.196**		**-0.136**	
Real GDP growth rate		**0.021***		**0.021**		**-0.045**		**-0.062**
Constant	-1.545	-1.643	-1.165	-1.573	-0.807	-1.607	-0.781	-1.654
Gender								
Male	0.186*	0.185*	0.016	0.009	-0.007	-0.005	0.077	0.076
Age group								
20 -24 years	1.184*	1.186*	0.904	0.934	1.102	1.095	1.138	1.131
25-29 years	0.668*	0.667*	0.532	0.546	0.678	0.678	0.634	0.631
30-34 years	0.320*	0.320*	0.244	0.244	0.333	0.335	0.337	0.338
45-54 years	-0.334*	-0.337*	-0.192	-0.218	-0.333	-0.321	-0.280	-0.279
55-64 years	-0.604*	-0.606*	-0.441	-0.451	-0.673	-0.756	-0.540	-0.537
64+ years	-0.486*	-0.485*	-0.595	-0.600	-1.080	-1.093	-0.317	-0.318
Educational level								
Low	-0.040*	-0.039*	-0.295	-0.272	-0.066	-0.086	-0.285	-0.288
Medium	0.006*	0.006*	-0.172	-0.171	-0.243	-0.250	-0.192	-0.189
PhD	0.182*	0.175*	0.357	0.354	0.292	0.303	0.108	0.108
Sectoral group								
HEI and R&D	0.149*	0.149*	0.335	0.316	0.026	0.021	0.468	0.462
ICT	0.197*	0.200*	0.725	0.690	0.266	0.260	0.790	0.790
Trade, hotels, etc.	0.159*	0.159*	0.407	0.394	0.196	0.194	0.509	0.505
Community services	0.243*	0.242*	0.392	0.372	0.207	0.209	0.600	0.594
Size of workplace								
10-49 employees	-0.158*	-0.158*	-0.162	-0.175	-0.091	-0.089	-0.014	-0.014
50-99 employees	-0.219*	-0.220*	-0.174	-0.186	-0.156	-0.155	-0.109	-0.109
100-249 employees	-0.166*	-0.167*	-0.181	-0.190	-0.172	-0.172	-0.156	-0.156
250+ employees	-0.279*	-0.277*	-0.283	-0.298	-0.311	-0.314	-0.346	-0.349
Share of current prediction	0.639	0.639	0.622	0.616	0.548	0.550	0.531	0.531
Cyclicality	***Pro***	***Pro***	***Pro***	***Pro***	***Pro***	***Counter***	***Pro***	***Counter***
Mobile share	20.7		17.7		14.4		18.0	
Observations/year	2 062 643		17 811 225		16 536 522		14 475 622	
Number of years	10		11		11		4	

Note: The cyclicality trend is measured by unemployment rate or the GDP real growth rate. * means significance at least at a 1% level. No * are given for Finland, Norway and Sweden since the sample equals the population. The reference individual (or excluded categories) is a woman, aged 35-44, highly educated, and employed in the manufacturing, etc., sector at a workplace with 1-9 employees.

The general tendency is that the male mobility rate is equal to or higher than the female mobility rate; that the mobility rate is highest among the youngest workers, that the mobility rate increases with educational level; and that the mobility rate decreases with size of workplace. The sectoral differences are more mixed, but seem to favour the HEI, ICT and service sectors and disfavour the production sector. In particular, the age group variables explain a large fraction of the variation in mobility rates; more than two-thirds of the prediction power in Table 4 is explained by the age group variables.

Conclusion

The present chapter provides trends and illustrates differences in the inflow job-to-job mobility rates for the Nordic countries. The mobility rates are based on the unique linked employee-employer register data available in these countries. Although other types of knowledge exchange exist, the mobility of employees between establishments serves as a vital knowledge carrier in the economy. The chapter aims to provide a benchmark and explanation of the optimal mobility rate that secures economic growth. At the same time, the paper illustrates that such a benchmark is highly dependent on the business cycle, *i.e.* economic conditions, and on the group of employees or firms under study. Several supply and demand characteristics such as employee age, employee education, and establishment size influence the inflow job-to-job mobility rates.

The comparison of the Nordic countries confirms a long list of similarities. Although the levels differ between the countries, tendencies are equal and similar. The Nordic countries all seem to have experienced the lowest downturn around 1993, where mobility rates were also at their lowest. Hence, in general, the findings point towards a pro-cyclicality in the inflow job-to-job mobility rate. Among the other results common to all four countries was the fact that the mobility rate decreases with age, increases with formal education and decreases with establishment size. The research sectors and the ICT sectors have high inflow mobility rates among younger workers, but low rates among the older workers, especially in the research sectors (which include universities).

The chapter reveals that the knowledge flows in the Nordic countries are remarkably high; there are few signs of binding rigidities in the labour markets. From an innovation point of view, it is worrying that the higher education institutions sector has such a low inflow mobility rate among the older employees but this is partly caused by the job structures at these institutions. From the knowledge transfer point of view, it is noteworthy that the amount of knowledge embodied in employees who change jobs varies considerably. Hence, high mobility rates in the economy do not necessarily indicate high knowledge transfers. A decomposition of the mobility rates by background variables is necessary before such a relationship can be confirmed.

Longer time series of data will naturally improve and validate the conclusions drawn in the present chapter. Ten years of data is not long enough for analyses of business cycle influences and mobility rate stability over time. This would be a project for future research when longer series of data become more easily available.

NOTES

1. The present chapter is a reduced version of a paper which is a part of a larger Nordic study of the human capital job mobility rates in the Nordic countries. The full paper can be obtained from The Danish Institute for Studies in Research and Research Policy (EG@afsk.au.dk). The project is partly financed by to the Nordic Industrial Fund, partly by the project participants. The project analyses, benchmarks and decomposes job mobility rates using register data for the Nordic countries.

2. Knowledge transfers, other than labour mobility, include, for example, co-operation, temporary exchange and replacements of staff, hiring of experts and consultants, outsourcing, some types of network, buyer-supplier relationships, R&D collaborations, and internal education and upgrading, among others (Nås *et al.*, 1998b).

3. There is no relationship that tells what the optimal mobility rates are. Common sense tells that it must not be to small or to large, but what the optimal level actually should be varies according to several of the features treated in the present paper.

4. See, for instance, the survey by Dale-Olsen and Rønningen (2000) for a comprehensive empirical and methodological comparison of Norwegian results with results from a long list of studies performed in the 1990s, or work by Nås *et al.* (1998a, 1998b) and Graversen (1998).

5. For example, Bingley *et al.* (1999) had access to register data on the entire population for the period 1980-95. However, they cannot identify shifts in work positions or whether a hired employee replaces another or takes a new position; therefore they define job mobility as a change in the total number of employees at the workplace, no matter what internal shifts have taken place, *i.e.* upgrading of the workforce. In any event, their method requires at least a representative sample of establishments.

6. In certain years, typically 1988 or 1998, data are missing for some of the participating countries. For example, no data for 1998 are accessible for Denmark. Although more recent data exist, we have decided that newer or more comprehensive data will not be included in this project. Iceland has not yet been able to deliver comparable figures and is therefore not included (although we generally refer to the Nordic countries).

7. Figures showing the job mobility rates over time for each country decomposed by the characteristics are included in the main paper, but excluded here due to space limitations.

8. A case study of Denmark in the main paper of the project shows that cyclicality may differ between sub-groups on the labour markets. Although total employment is pro-cyclical, the ICT sector shows counter-cyclicality, *i.e.* an expansion, even during the recession which took place in Denmark in the early to mid-1990s. Similarly, the large public sector in Denmark also shows a counter-cyclical pattern, which indicates that the community service sector has a stabilising employment effect on the economy. Such a result is also found in Bingley *et al.* (1999). Hence, in a country comparison of mobility rates as indicators for knowledge transfer, some of the variations may arise from country-specific structural differences. Even in a comparison of the Nordic countries, which have a great deal in common, institutional set ups and structural differences need to be included to explain the observed trends.

9. To illustrate the consequences, and for comparison, some figures for the overall inflow rates are shown in the Appendix of the main paper of the project. The overall inflow mobility rate includes employees who were not employed in the previous year.

10. The unemployment rate is taken from the ILO's *Yearbook of Labour Statistics*, *i.e.* they are based on LFS data. The unemployment rate is expected to correlate negatively with the business cycle, *i.e.* an increasing unemployment rate indicates a declining business cycle. GDP is taken from the OECD *National Accounts*. Growth in real GDP is used as the indicator, since nominal GDP includes inflation as well as level effects. The growth in real GDP is expected to correlate positively with the business cycle.

11. The Danish and Finnish data have been corrected for artificial changes such as mergers, take-overs, spin-offs, or splits of establishments following a few basic rules. These are, for example, that the establishment is the same if only the owner shifts, that the establishments is the same if at least 30% of the original employees are still employed the following year, etc. See, for example, Emerek *et al.* (1991) for further explanations.

12. It can be argued from other studies that there should be three age groups, namely 20-29, 30-54 and 55-69, but there exists no commonly used grouping of ages.

13. Åkerblom (2000) suggests a corresponding 20-sector classification, which is excluded for expositional reasons. The 20-sector decomposition shows that larger differences exist between the Nordic countries as the decomposition becomes more detailed.

14. Overall mobility rates for similar sub-groups have also been calculated. The job-to-job inflow mobility is a sub-sample of the overall inflow mobility, where the latter includes newcomers, not previously employed. The overall mobility rate is, by definition, larger than the job-to-job mobility rate since the relative increase in movers is larger than the relative increase in employees in the latter mobility rate. The differences between the overall mobility rates and the job-to-job mobility rates also point to those sectors that have a high recruitment of young workers (*e.g.* the HEI sector) or those sectors that are shrinking (*e.g.* agriculture in Finland).

15. High educated = ISCED'97 (5+6), medium-low educated = ISCED'97 (1+2+3+4+missing).

16. Educational levels are broken down into PhDs (ISCED'97 6), high educated (ISCED'97 5), medium educated (ISCED'97 3+4) and low educated (ISCED'97 1+2+missing).

17. Size of workplace is calculated as the total number of employees in the first week of November.

18. A sensitivity study of some alternative specifications of the estimation model reveals that the parameter estimates to the included variables in Table 4 seem to be very stable although especially the inclusions of married and cohabiting statuses lower the educational parameters significantly. In the sensitivity study, both low and medium educated employees have significantly lower mobility rates than high educated. This is not the case in Table 4. The inclusion of a few extra explanatory variables only marginally increases the model fit. Hence, the model specification in Table 4 is valid for an analysis of business cycle variations in mobility rates.

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Chapter 8

HUMAN CAPITAL MOBILITY INTO AND OUT OF RESEARCH SECTORS IN THE NORDIC COUNTRIES

by

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Introduction

Peregrinatio academica – an academic pilgrimage – was the Medieval Latin term for the students' and teachers' journeys to the places where they could acquire wisdom. Today's educational system functions as the provider of these places of wisdom, and individuals extend their knowledge base by journeying through this system. At the end of their travels, they have obtained their final level of formal education, bet it lower, middle or higher education. Those that successfully obtain the highest level of education correspond to the Medieval notion of "learned" or "wise". Of course, the share of the population with higher education is considerably higher today than it was in the Middle Ages.

In addition to formal education, tacit and informal knowledge gained through experience and on-the-job training during the individual's working life adds to that his ability stock. However, this informal, specific knowledge or ability is an unknown part of human capital. In practice, it is difficult to formalise and measure tacit knowledge, particularly in terms of entire populations, and the formal level of education is often used as a proxy for these "hidden" abilities, especially for the higher educated.[1]

The purpose of the present chapter is not to describe the flow of students or graduates from the higher educational system into the production or service sector of the economy, but rather to describe the flow of employees into and out of this system from and into the surrounding economy. Such employees are, or will become, the links between the places where wisdom is acquired and the sectors which contribute to and benefit from that wisdom.

Flexibility, mobility shares and the ability to circulate knowledge in humans are vital elements of national innovation systems (NIS). In this chapter, estimates of these elements are made and compared for higher educated human resources in the four Nordic countries, Denmark, Finland, Norway and Sweden, using available register information. The analysis aims to shed light on similarities and

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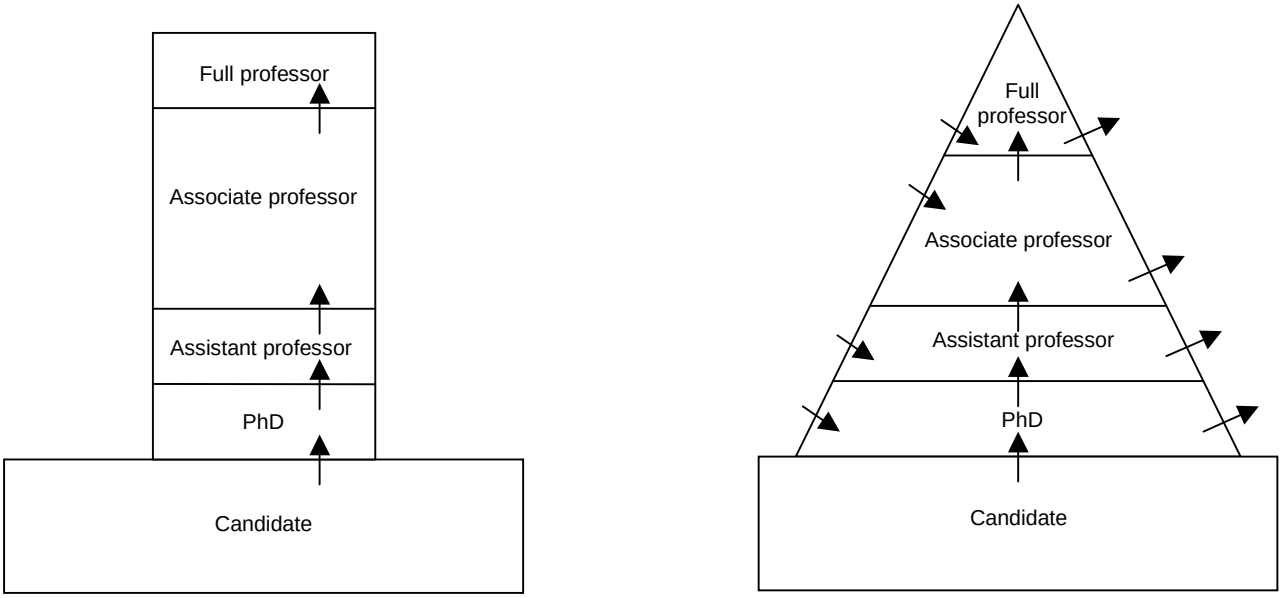
differences in stock and flow figures for the research sectors, research and development institutions (R&D), and higher education institutes (HEI), of the Nordic countries.

The stock of formal knowledge is used as an indicator of the innovation potential of the economy and the mobility rates of workers are assumed to reflect knowledge circulation and exchange. Similarly, the flow or mobility rates between the research sectors and the remaining sectors are used to describe the way in which knowledge spreads from the "towers or pyramids of wisdom" to the rest of the economy (Figure 1).

Figure 1. **The "tower" and the "pyramid" research environments**



Note: The arrows do not show natural retirement due to age or disability.

Motivation

A research environment in which recruitment is based solely on internal promotion of selected candidates to PhD, assistant professorship, associate professorship and finally to full professorship corresponds to a research sector with no mobility in and out of the workplaces. Free positions are caused by death and are filled through internal promotions. This type of research sector can be illustrated as a tower in Figure 1. Conversely, high rates of mobility at all levels points to the exchange and circulation of the knowledge acquired in the workplace. This is illustrated in Figure 1 as a pyramid: mobility occurs into the research environment from the surrounding economy and from abroad and *vice versa*. Mobility can also cover returns or circulation of individuals.

From the point of view of the national innovation system, the pyramid shown in Figure 1 creates the greatest innovation potential in the economy as a whole, giving rise to several platforms for R&D. However, excessively high mobility leads to losses; it takes time to acquire knowledge and it takes time before an individual is able to bring that knowledge to the next workplace. The tower in Figure 1 does not necessarily illustrate a disastrous situation, although there is a serious risk of missing out on opportunities for knowledge exchange with the surrounding economy. There is also a danger that

knowledge creation inside the tower may suffer due to the missing inflow of new knowledge – although the tower may facilitate the creation of unique clusters of highly specified knowledge.

The tower model illustrates an extreme world in which the research sectors, *i.e.* the higher education sector, educate candidates and send the unusable stock back into the surrounding economy. The best and the brightest are kept as a pool for future recruitment as positions become available. The chosen few who join the sector never leave it.

In contrast, the pyramid model illustrates a world in which a market outside the higher education institutes offers opportunities for mobility at all levels. In such a situations, skill requirements alone determine whether or not a person is employed in a given job. In this world, there can be more PhD positions than needed internally, resulting over time in an oversupply of qualified individuals at all levels. Mobility into and out of sectors illustrates knowledge circulation throughout the economy.

A mapping of mobility patterns into and out of the higher education institutions (HEI), and the research and development institutes (R&D), provides a picture of the demand and supply for highly qualified researchers in the surrounding economy. Higher mobility means greater knowledge circulation and a wider national knowledge base. However, extremely high mobility is undesirable since it takes time for individuals to accumulate a significant additional knowledge stock.

The justification for an economy which resembles the pyramid model rather than the tower model lies in society's desire to have academic researchers work with other non-university research environments on finding solutions to problems of public interest. This can be, for example, the desirability of significant private sector research, the need for ministerial "analysis", advisory or consultancy functions, etc.[2] Over and above these motives, there is also the need to ensure that the competitiveness of the national research environment benefits the researchers, the research institutes and the community as a whole. The larger number of employees entering and leaving job positions in the pyramid model permits greater flexibility in the choice of research themes and widens the ability of universities to address topical areas of research. The desire for active exchange between researchers of the "publicly" financed research environment, higher education institutes, and R&D institutions, is increasing both nationally and internationally.

Methodology and state of the art

The present analysis is primarily based on results from Graversen (1999) and Nås *et al.* (1998). The unit used is employees and their job mobility between different labour market positions. Although this is an imperfect measure of the amount of formal and informal knowledge in the community, it is a reliable indicator for knowledge in relation to innovation (see Nås *et al.*, 1998, for a discussion). The stock of and mobility rates for the highly educated provide an estimation of the dimensions of national as well as international economic performance and long-term growth.

The Nordic countries collect empirical data on the entire population through a number of public registers. The data collected include occupational status of employees and information on employers; they enable mobility of individuals between establishments to be tracked in detail. If the stock of human capital is assumed to represent the base, then the flows can represent the links between establishments. Mobility between two organisations, two sectors, or two research institutions indicates that there is knowledge transfer and that there is a common knowledge base.

Following this assumption, mobility is defined as outflow from the workplace, *i.e.* the employee does not continue to work at the same workplace the following year. The mobility rate is calculated as the stock of movers from year t to year t+1 over the stock of employees in year t.

Data from 1994 or 1995 is used for four Nordic countries. A more comprehensive discussion of the advantages and disadvantages of various mobility measures, the use of register data, etc., can be found in Graversen (1999) and Nås *et al.* (1998).

Table 1 presents outflow mobility rates for all employees and for highly educated employees in four Nordic countries. The "wide" mobility rate, which includes individuals leaving the labour force, is typically lower than average for highly educated employees. However, when the "narrow" mobility rate is taken, which includes only individuals leaving to take up another job, the opposite seems to hold. This indicates a lower than average probability of leaving employment for highly educated individuals.

Table 1. **Outflow mobility rates in four Nordic countries**

Type of employees and period of data	Wide mobility rate	Narrow mobility rate
Denmark 1995-96		
All employees	27.2	18.2
Highly educated employees	21.8	16.4
Sweden 1994-95		
All employees	24.0	16.2
Highly educated employees	23.4	19.5
Norway 1995-96		
All employees	20.1	12.4
Highly educated employees	18.6	12.8
Finland 1994-95		
All employees	23.3	11.5
Highly educated employees	23.9	17.9

Note: The highly educated are defined as employees whose highest obtained educational level is equal to ISCED 6 or above. The wide definition of mobility includes persons leaving the active workforce while the narrow definition of mobility excludes these.
Source: Graversen (1999) and Nås *et al.* (1998).

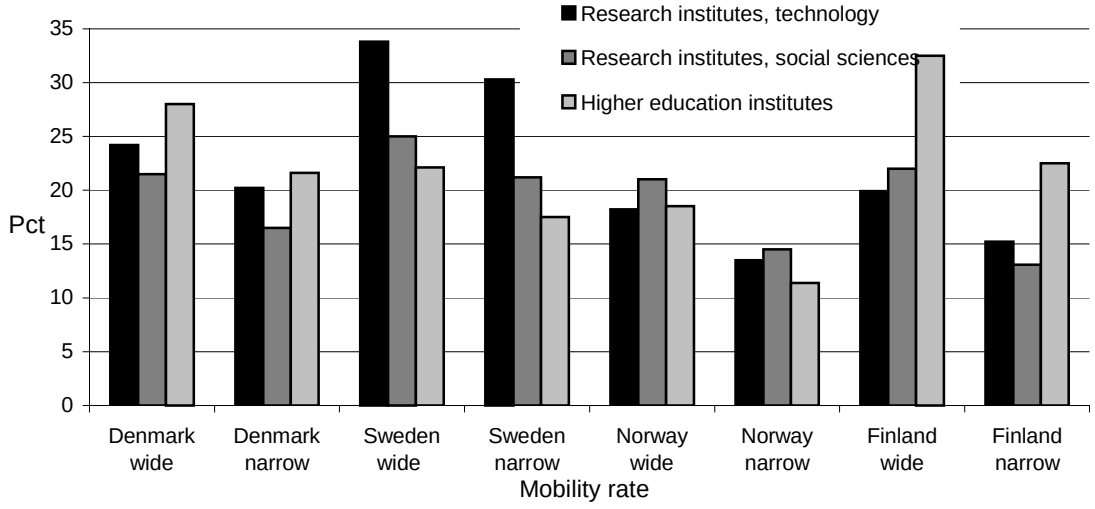
Mobility of highly educated employees in R&D institutions and higher education institutes

The first indicator used to estimate the degree of co-operation which takes place among the R&D sector, the HEI sector and the surrounding economy is a comparison of mobility rates for these sectors, focusing on highly educated employees in the research sectors. Although not all such workers perform research, the majority do. Those that do not perform research are employed in administrative jobs, etc. Figure 2 shows the mobility rates for highly educated employees in three research sectors for four Nordic countries, using both the wide and narrow definitions of mobility. The mobility rates do not distinguish between mobility to other research sectors and mobility out of the research sectors.

Norway has the lowest mobility rate out of the research sectors, Sweden the highest. The mobility rates for the three research sectors shown in Figure 2 are approximately equal in Norway. This is not the case in the other three countries. In Sweden, the mobility rates in the two R&D sectors are higher

than the mobility rate in the HEI sector. The opposite holds for Finland, while Denmark is situated in between. The overall average mobility rate out of the research sectors is highest in Sweden, followed by Finland and Denmark, with Norway presenting the lowest level. Hence, all the countries have research sectors that interact with the surrounding economy, but there are remarkably significant national variations, which to a large degree can be explained by different national institutional set ups.

Figure 2. **Outflow mobility rates for highly educated employees in the R&D and HEI sector in four Nordic countries**



Note: The wide definition of mobility includes persons leaving the active workforce while the narrow definition of mobility excludes these.
Source: Graversen (1999) and Nås *et al.* (1998).

Mobility of highly educated employees in R&D and HEI, by delivering and receiving sector

The next indicator of co-operation between the research sectors and the surrounding economy is the mobility rate from these sectors, broken down by delivering and receiving sector. The share of the mobility rate which represents internal recruitment within the sectors indicates which of the two figures in Figure 1 explains best the status quo.

Table 2 presents the decomposed inflow mobility rate for employees in the research sectors by delivering sector for the four Nordic countries. The number of employees in the R&D sector is close to 25% of employees in the HEI sector (with the exception of Norway, where it is close to 50%). The overall inflow mobility rate in the research sectors is approximately 20%-30%, although there are large variations among the four countries. A weighted average of the "inflow mobility rate" for the research sectors gives for Denmark, 31.9%; for Sweden, 23.2%; for Norway, 17.9%; and for Finland, 36.9%. The inflow mobility rate for the R&D sector dominates in Sweden, while the opposite is true for the other countries. The differences in mobility rates can partly be explained by expanding research sectors. A comparison with Table 3 shows that higher "inflow mobility rates" than "outflow mobility rates" indicates that the sector is expanding sector, as measured by the number of employees.

Approximately one-third of employees entering the research sectors come from segments of the population that were not employed on the national labour market; *i.e.* from education, abroad,

unemployment, leave, retirement, disablement, etc. A notable deviation is the considerably lower share in the Swedish R&D sector and the larger share in the Finnish HEI sector. This is caused by a much larger recruitment from the HEI sector in Sweden, and a smaller number of effective recruitment sectors in Finland.

In general, the R&D sector recruits larger numbers of employees from the private sector than does the HEI sector. The opposite is true for the public sector and the non-public service sector. However, the largest differences between the countries occur in internal recruitment. In Sweden, the R&D institutes recruit mainly from the HEI sector, while, in Finland, the R&D institutes recruit among themselves. The HEI institutes recruit only one-third of new employees from other parts of the research sectors. A large proportion of new employees are recruited from the public sector, especially in Sweden and Norway.

The mobility rates in Table 2 point to widespread co-operation and knowledge circulation in the research sectors in the Nordic countries, although there is little contribution from certain parts of the private sector. This finding is not unexpected and is due to the traditionally clear-cut borders between publicly financed R&D and private R&D and production.

Table 2. **Distribution of mobile highly educated employees in the R&D and HEI sectors in four Nordic countries, by delivering sector**

Delivering sector / Receiving sector	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services real estate	Business services	R&D institutions	Higher education institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Total	Number of persons employed	Mobility rate "in"
Denmark 1995-96																
R&D institutions	0.1	3.7	0.3	2.7	0.6	0.6	6.5	16.3	18.4	13.7	5.2	0	32.0	100	3 420	21.3
HEI institutes	0.1	1.8	0.1	2.1	0.8	0.3	3.7	4.6	25.5	19.3	5.9	0	36.0	100	12 886	34.7
Sweden 1994-95																
R&D institutions	0	7.7	0.6	1.7	0.7	0.5	4.8	7.3	55.6	5.9	1.3	0.4	13.5	100	6 457	39.1
HEI institutes	0.3	2.8	0.2	1.5	0.5	0.7	4.2	3.1	19.7	28.9	3.8	1.1	33.2	100	27 029	19.4
Norway 1995-96																
R&D institutions	1.7	2.8	0.4	2.4	1.0	0.6	5.4	20.4	11.5	16.3	2.7	2.8	32.0	100	5 110	13.9
HEI institutes	0.3	1.5	0.3	1.6	0.7	0.7	2.4	6.6	20.8	29.0	2.6	0.8	33.3	100	11 781	19.7
Finland 1994-95																
R&D institutions	0.3	3.3	0.1	0.9	0.1	0.5	3.0	38.4	8.9	10.6	1.0	0.7	32.2	100	3 625	21.9
HEI institutes	0.1	1.1	0.1	0.9	0.1	0.3	1.3	1.4	31.2	16.7	2.1	1.0	43.7	100	11 508	41.6

Source: Graversen (1999) and Nås *et al.* (1998).

Table 3 presents the decomposition of the outflow mobility rates from the research sectors in the four Nordic countries. The numbers illustrate the knowledge flow from the research sectors to the surrounding economy. The overall mobility rates out of the research sectors are approximately equal to the inflow mobility rates to the sectors, with the exception of the R&D sector in Sweden and the HEI sector in Finland. On average, less than one-third of job movers leave the active labour market (to retire, go abroad, become unemployed, etc.).

With a rate of over 35%, Finland shows the largest share of internal mobility within the research sectors. For the HEI sector, the situation is similar in Denmark. In Norway and Sweden, the share for the HEI sector is around 20%. Compared to Finland, the share for the R&D sector in the other countries ranges between one-third and one-half. Cross-deliveries between the R&D and HEI sectors are highest in Denmark and Sweden, and lowest in Norway and Finland.

Compared to the other countries Sweden has the highest share of personnel who move to the private sector, in particular to manufacturing, business services, transport, etc. The other three countries show the same pattern, although to a lesser extent. Finally, it is noteworthy that the public sector receives a fair share of the mobile employees from the research sectors, with the largest component coming from the HEI sector.

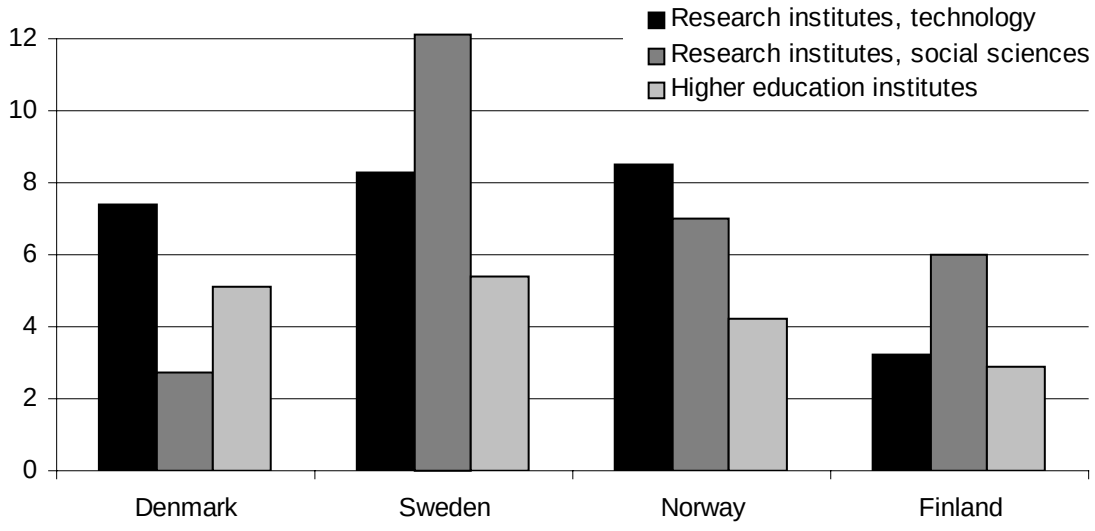
Table 3. **Distribution of mobile highly educated employees in the R&D and HEI sectors in four Nordic countries, by receiving sector**

Receiving sector / Delivering sector	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services real estate	Business services	R&D institutions	Higher education institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Total	Number of persons employed	Mobility rate "out"
Denmark 1995-96																
R&D institutions	0.3	3.6	0.3	2.0	16.5	0.3	3.9	13.1	22.7	15.6	2.1	0.0	19.5	100	3 505	25.9
HEI institutes	0.3	4.3	0.3	1.3	0.8	0.4	9.2	3.5	29.5	17.5	6.5	0.0	26.6	100	14 524	26.7
Sweden 1994-95																
R&D institutions	0.1	23.5	0.8	4.0	7.1	0.7	12.4	13.8	12.4	7.9	1.3	1.3	14.7	100	5 266	23.0
HEI institutes	0.1	6.8	0.4	1.3	0.6	0.5	6.6	22.8	16.8	18.3	3.1	2.0	20.7	100	27 938	21.8
Norway 1995-96																
R&D institutions	3.2	4.8	0.9	3.1	0.6	1.3	17.2	14.0	14.6	11.6	1.2	0.6	26.9	100	5 438	19.1
HEI institutes	1.0	4.2	0.5	1.5	0.4	1.0	4.5	3.8	22.4	19.6	2.8	0.3	38.0	100	11 618	18.5
Finland 1994-95																
R&D institutions	1.5	9.9	0.5	1.4	0.4	0.3	4.8	39.2	8.5	7.3	1.0	0.5	24.7	100	3 830	20.3
HEI institutes	0.1	5.3	0.1	0.9	0.2	0.2	3.3	1.6	34.5	11.4	0	0.5	26.3	100	13 098	33.0

Source: Graversen (1999) and Nås *et al.* (1998).

Looking at the numbers in Table 3, it is difficult to distinguish the effective receiving sectors. This points to a need for a third indicator on knowledge circulation; that is, the number of sectors that receive a "significant" number of employees from the research sectors. The following findings are the effective number of receiving sectors out of a possible 42 (Nås *et al*., 1998). The number of "significant" receiving sectors is then calculated by the inverse of the Herfindahl index. Figure 3 shows the findings for the four Nordic countries (the findings in Figure 3 support those presented in Table 3).

Figure 3. **The number of effective receiving sectors for the R&D and HEI sectors in four Nordic countries**



Note: The number of effective receiving sectors is calculated using an inverted Herfindahl index based on a 42 sector input-output matrix for each country.
Source: Graversen (1999) and Nås *et al.* (1998).

The index indicates that the Swedish R&D sectors co-operate with the largest number of other sectors, closely followed by the Norwegian R&D sectors. The highest number is found for Swedish research institutes in social sciences. In both Sweden and Finland, this sector co-operates with a higher number of sectors compared with the research institutes in technology sciences. The opposite is true for Norway and, very clearly, in Denmark.

The number of receiving sectors for the HEI institutes is lower than that for the R&D institutes in all of the countries, with the exception of research institutes in social sciences in Denmark. Sweden again has the highest number, followed by Denmark, Norway and Finland.

The overall picture shows a higher than average number of receiving sectors in Sweden, an average number in Denmark and Norway, and a lower than average number in Finland. However, all the research sectors have a significant number of co-operating sectors into which they deliver knowledge in the form of employees.

Conclusion

This chapter uses formal education in four Nordic countries, Denmark, Sweden, Norway and Finland, to determine the knowledge flow into and out of the national research sectors. The flow rates show the degree of dispersion and circulation in the national innovation system. A high mobility rate indicates that the national research environment co-operates with the surrounding economy. However, a very high rate would not represent an optimal situation, due to the fact that knowledge accumulation takes time. A world in which moderate mobility flows take place in and out of all sectors is preferable. This corresponds to the pyramid model of the research sectors.

The four Nordic countries are characterised by significant mobility rates for highly educated personnel as well as for all employees. If mobility is defined as all outflows over the stock of employees, the rate is over 20%. If it is defined as the flow to new employment over the stock of employees, the resulting rates are some 5-10 percentage points lower. The highest mobility rates for highly educated employees are found in Sweden and Finland, followed by Denmark and, finally, Norway.

Focusing on highly educated employees in the three research sectors covered by research institutes in technology, research institutes in social sciences and higher education institutes, reveals similar patterns although Denmark presents higher mobility rates than Finland. National variations and institutional differences explain the variations found in Figure 2.

A more detailed decomposition of the inflows and outflows from the R&D and HEI sectors shows that the sectors deliver and receive employees to and from a number of other sectors. Even though there is significant intra-sectoral mobility, inter-sectoral mobility is even higher.

Calculating the effective number of receiving sectors (out of 42) reveals that the research sectors deliver employees to a significant, although low, number of sectors. Again, Sweden shows the largest dispersion of knowledge into approximately eight sectors on average, followed by Norway with an average of six, Denmark with five, and Finland with four effective receiving sectors on average.

All in all, the findings show that the research sectors in the Nordic countries function more like the pyramid model in Figure 1 than like the tower model. Hence, there is evidence of high and widespread co-operation with the surrounding economy, with a strong potential for synergy effects in the national economic growth. Sweden appears to have the largest knowledge circulation into and out of the R&D and HEI sectors, followed by Denmark, Finland and Norway (although the order changes depending on the measure used). Even though a clear ordering of the three last countries is impossible, they all show evidence of significant knowledge circulation.

Whether the degree of knowledge flow is large enough is difficult to determine and depends on the national institutional set up. However, the findings show that mobility from receiving sectors and to delivering sectors lack significance in some sectors in some countries. This situation can only be changed by shifts in priorities in national research policies. Whether this is desirable is beyond the scope of the present chapter.

NOTES

1. These measures are already collected in the Nordic countries, in the national registers of the statistical bureaux. Hence, analysis can be carried out without having to collect additional information from individuals and companies.

2. The OECD (1996) reports that more than 50% of GDP in the major OECD countries is knowledge-based. Hence, approximately 50% of GDP stems from efficient mobility and distribution of human resources. OECD (1996) also finds that "investment in knowledge and capabilities are characterised by increasing (rather than decreasing) returns" since knowledge increments increase the return from other production factors.

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PART III

HIGH-SKILLED RESOURCES AND MOBILITY IN EUROPE

Chapter 9

USING THE COMMUNITY LABOUR FORCE SURVEY TO DEVELOP MOBILITY RATES ON HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY

by

Ibrahim Laafia and Alex Stimpson*

Introduction

A rapidly changing economic environment and a growing emphasis on the knowledge-based economy has given rise to mounting interest in the role and measurement of skills. Meeting the demands of this knowledge economy is a fundamental policy issue and has a strong bearing on the social, environmental and economic well-being of the population. Knowledge, embodied in human capital, dictates to what degree innovative potential is translated into technological and innovative practice.

Recognition of the role of human capital in growth is reflected in recent research undertaken by national governments, by the European Commission and by other institutions such as the OECD. It is important to measure not only a country's stock of knowledge (undertaken for several years as part of Eurostat research into R&D and S&T indicators), but also the degree to which this knowledge is transferred between employment activities and/or countries.

As science and technology become less constrained by international boundaries, so too are mobility flows among Europe's population of human resources in science and technology (HRST), with governments, institutions and organisations following active policies to encourage the diffusion of knowledge.

The migration of highly skilled workers has been well documented in terms of its potentially beneficial or detrimental effects for the sending and recipient countries. Progress made towards developing comparable and harmonised quantitative and qualitative measurements of international mobility is documented elsewhere in this publication. By using survey data on the labour market, this chapter focuses instead on knowledge transfer at the national level, providing internationally comparable measurements of job-to-job mobility of HRST for the European Union and beyond.

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It takes as its building blocks previous studies conducted for Eurostat (Eurostat, 1997; 2000) on the stocks and flows of human resources in science and technology as well as the more recent feasibility study on compiling internationally comparable mobility indicators of highly qualified personnel. One of the conclusions of the latter was that the Community Labour Force Survey (CLFS) could be used to construct rather *aggregated* indicators on domestic mobility (Akerblom, 1999).

Within the context of the NIS focus group on mobility of human resources, this chapter aims to provide some information towards *benchmarking internal mobility rates across the participating countries*. Against the backdrop of the previous feasibility study, the main objectives of this research are summarised below:

- To extend the data series both temporally, to include 1999, and geographically, to include the EFTA and candidate countries.

- To extend the sectoral analysis to reflect recent definitional/methodological developments within Eurostat.

- To conduct some initial investigations into developing mobility indicators for highly innovation-relevant occupations (scientists and engineers) as well as, separately, according to age.

Achieving these objectives would necessarily entail disaggregating to quite a significant degree the data extracted from the CLFS, not to mention assimilating data from the EFTA and candidate countries never previously extracted. With this in mind, the reliability and suitability of the CLFS needed to be regularly evaluated. And, indeed, close scrutiny of the data has revealed some unexplained fluctuations that will require further research beyond this NIS focus group.

With these points in mind, after introducing the type of data requested and received as well as providing some definitions, the purpose of this chapter will be two-fold:

- To underline some of the key results that arise from the mobility analysis.

- To highlight a few anomalies in the data.

Data requested and received

Data for the analysis conducted in this chapter are extracted from the CLFS at Eurostat. The main statistical objective of the CLFS is to divide the population of working age (15 years and above) into three mutually exclusive and exhaustive groups: persons in employment, unemployed persons and inactive persons.

The CLFS, like all surveys, is based upon a sample of the population. Therefore, the results are subject to the usual errors associated with sampling techniques as well as a number of other non-sampling errors, for example, inability or unwillingness to provide the correct response (non-response), mistakes made by interviewers when filling in the documents, miscoding, etc. However, it is generally accepted that at the national level the survey information is sufficiently accurate provided that the analysis is confined to a certain size.

In the context of this study, a request was made for the following data:

- *Countries:* EU-15, plus EFTA countries, plus candidate countries where available.
- *Time scale:* 1994 to latest available year.

The breakdowns requested and subsequently analysed were: gender, age, educational attainment, occupation, sector of activity by NACE (in year t), working status (in year t) and the year in which the person began their current job. In order to obtain job-to-job mobility rates, information on working status in year t-1 was further requested.

Summary of data received

As is apparent from Table 1, the data received were by no means comprehensive. The column "available years" displays the years for which data have been supplied to the CLFS, but this by no means guarantees that mobility rates can be built up. Where any of the columns "ISCO", "ISCED", "working status 1 year before" or "started current occupation in year t-1 to t" are highlighted, it is not possible to calculate mobility rates for highly qualified persons in the relevant years.

Even when all the necessary variables are available, the calculated data cells do not always appear to be reliable (these anomalies are discussed below).

Table 1. **Summary of available data and possible breakdowns**

	Country	Available Years	Occupation (ISCO)	Education (ISCED)	Working status 1 year before	Started current occupation In year t-1 to t?	Breakdown by sector (NACE)
	B	94 - 99					
	DK	95 - 99					
	D	95 - 99		Except '98			
	EL	94 -98					
	E	94 - 99					
	F	94 - 99					
	IRL	94 - 99	Except '98 & '99	Except '98 & '99		Except '98 & '99	
EU-15	**I**	94 - 99					
	L	94 - 99		Except '98			
	NL	94 - 99					
	A	95 - 99				Except '98 & '99	
	P	94 - 99					
	FIN	95 - 99	Except '95 & '96				
	S	95 - 99	Except '95 & '96				
	UK	94 - 99		Except '98			
	IS	95 - 98					
EFTA	**NO**	95 - 99	Except '95				
	CH	96 - 99			No data on students for any year		
	CZ	97 - 99			No breakdown in '97		
	EE	97 - 99		Except '96			
CEC	**HU**	96 - 99					
	PL	97 - 99					No breakdown for any year
	RO	97 - 98	At 1 digit level only in '98		No breakdown in '97	No data for any year	
	SI	96 - 97			No breakdown in '98		

Note: For country codes, refer to Annex.
Source: Eurostat (CLFS).

Some definitions

Human resources in science and technology (HRST) is defined according to the "Canberra Manual" (OECD and European Commission, 1995) as a person fulfilling one of the following conditions:

- Successfully completed education at the third level in a S&T field of study.[1]

- Not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required.

HRST by virtue of education

In order to minimise cultural differences in education systems and to increase cross-country comparability, HRST analysis uses the International Standard Classification of Education (ISCED) developed by UNESCO (1976; 1977).

Due to an increasing demand for internationally comparable indicators on education and a mounting complexity in the educational programmes on offer in different countries, the original standard, developed in 1976, was revised and updated in 1997.

As a result of this revision, HRST data in this chapter up to and including 1997 are built up utilising the original classification (ISCED '76). From 1998, ISCED 1997 is employed.

Prior to 1998, therefore, HRST consists of those persons belonging to ISCED categories 5, 6 and 7. ISCED 5 is comprised of people involved in studies at the third/tertiary level, first stage, that leads to an award not equivalent to a first university degree. ISCED 6 refers to education that leads to a first university degree or the equivalent, whereas ISCED 7 refers to education that leads to a postgraduate university degree or equivalent.

Under the new ISCED classification, HRST consists of those persons belonging to categories 5b, 5a and 6. ISCED 5b refers to programmes that are practical/technical/occupationally specific; 5a refers to programmes that are largely theoretically based/research preparatory or that provide access to professions with high skill requirements; 6 refers to programmes which lead directly to an advanced research qualification, such as a doctoral degree.

HRST by virtue of occupation

Occupations relevant to S&T are classified according to the International Standard Classification of Occupation (ISCO), developed by the International Labour Organisation (ILO, 1988). Recommendations in the "Canberra Manual" identify certain occupation groups as HRST, irrespective of whether the person has a formal education qualification or not. The major group "professionals" (ISCO major group 2) is defined as occupations which mostly require skills at the fourth ISCO level, which is considered equivalent to ISCED '76, categories 6 or 7, *i.e.* university level HRST. Similarly, ISCO 3 ("technicians") is defined as requiring skills that correspond to ISCED '76, level 5.

For this reason, both these groups are comprehensively included. Professionals are sub-divided into four sub-major groups: physical, mathematical and engineering science professionals; life science and health professionals; teaching professionals; and other professionals. In previous studies, certain managerial occupations were included in order to incorporate those that seemed of specific interest to HRST, such as R&D managers. Specifically, this included people in ISCO 122, 123 and 131 ("production and operations department managers", "other department managers", "general managers").

A pilot survey conducted in 1995 tested the validity of the original definitions for HRST laid down in the "Canberra Manual". The results indicated that, for the EU, including these managerial occupations distorted the results significantly due to variations among countries in the treatment and

classification of managers. Subsequent studies performed for Eurostat have therefore excluded legislators and managers (ISCO 122, 123 and 131) unless they have attained education at the third level.

What is employment?

The definitions of employment used in the CLFS closely follow those adopted by the 13th International Conference of Labour Statisticians: the employed comprise all persons above a specified age who during a specified brief period, either one week or one day, were in the following categories:

- Paid employment.
- Self employment.

where, for operational purposes, employment is interpreted as at least one hour of work.

Mobility of employed HRST

The type of mobility considered in this chapter is job-to-job mobility. This means that people are only counted if they were employed in both reference years. It does not consider inflows into employment from a previous position of unemployment or even inactivity, *i.e.* students. Thus, mobility indicators of employed HRST, for example, would be constructed as follows:

- The numerator in the mobility rates would be equal to HRST employed both years, but having started a new job between year t_{-1} and t.
- The denominator would be equal to total HRST employed in both years.

where HRST employed both years considers all those persons that either work in an S&T occupation (any ISCED level) or work in another profession but have a tertiary level education.

Results

Before highlighting some of the key aggregated results, consideration should be given to how the results are to be interpreted. At the aggregate level, the mobility rates allow an insight into the labour market flexibility of both highly qualified individuals and overall employment in a national economy. From the mobility of highly skilled individuals, we can gain an insight into the degree of knowledge transfer.

In general, higher mobility rates will indicate an increasing degree of knowledge transfer/diffusion. However, it is necessary to underline that this rests upon the assumption that a significant wealth of knowledge has been built up in previous employment activities. Too high a mobility rate may indicate that an economy is excessively flexible in terms of the knowledge it is able to generate and therefore diffuse.

Moreover, because of the way the mobility rates are calculated and the amount and type of information that is available from the CLFS, there are further deficiencies. One is that there is no information on the length of time that the person who has changed employment activities in the last

year spent in their previous occupation. If the mobile knowledge workers are to diffuse their know-how then they need to have built up this know-how in previous work experience. Without information concerning the length of time spent in the previous occupation, it is impossible to differentiate between those workers that may rapidly bring added value to a new research activity/company and those that may not.

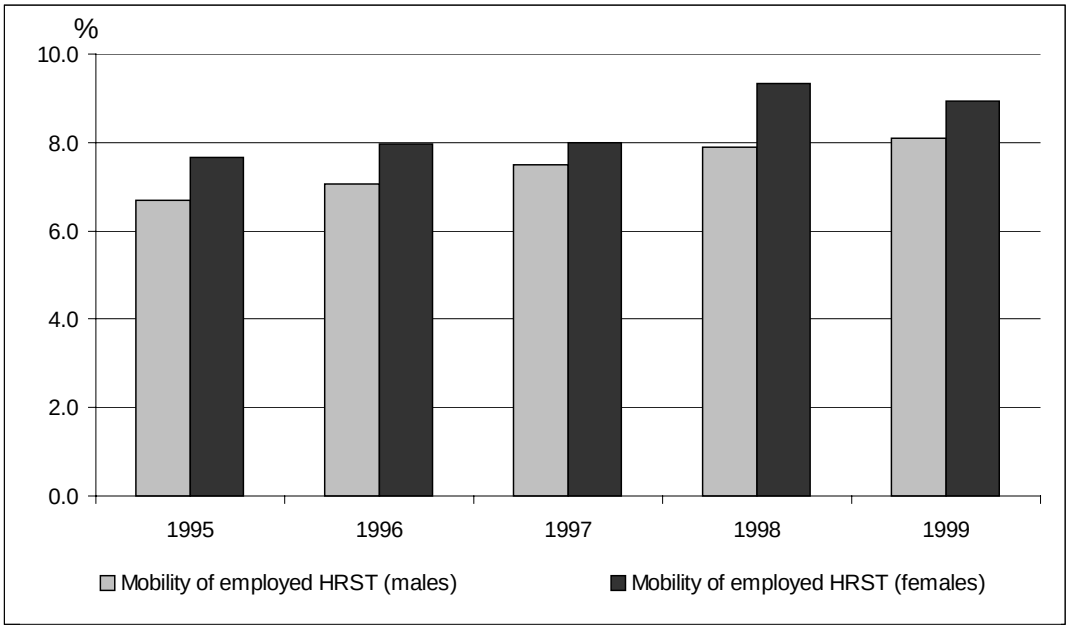
Another is that building up mobility rates requires several variables. A result of this is that sample sizes can quickly become too small to be reliable following the guidelines of the CLFS. Caution is therefore called for. As far as the comprehensiveness of the results is concerned, a lack of data provision or the required breakdowns and sometimes questionable reliability has meant that the years and countries for which indicators are available are incomplete.

Finally, to facilitate the presentation of some general trends, many of the results are presented at the EU-15 level even though it is not always possible to calculate mobility rates for all EU countries for all years. In general, this does not significantly alter the results. Appropriate caution is suggested where it might do so.

Overall EU mobility

Figure 1 reveals the increasing degree of mobility for employed HRST in the five-year period under review. For the whole of the time period in question, mobility is higher for women than it is for men.

Figure 1. **Trends in EU mobility of employed HRST**
1995-99, males, females



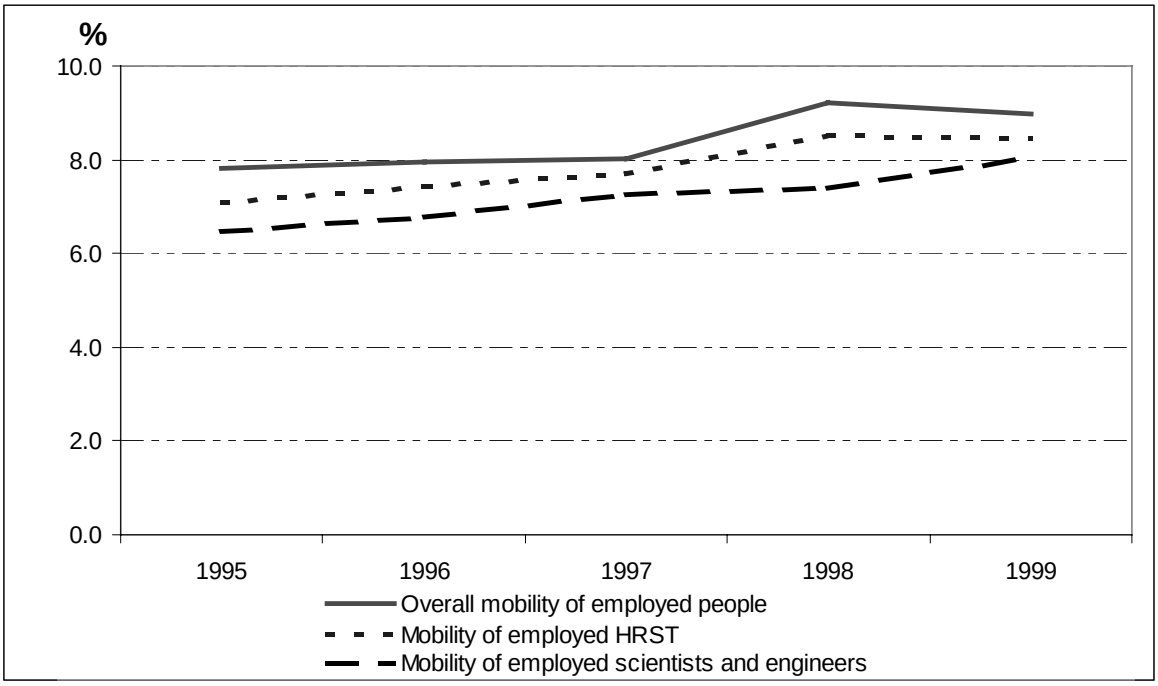
Note: Incomplete data series mean that mobility rates are calculated for all those countries that are available. 1995 excludes P, FIN, S; 1996 excludes P, FIN, S; 1997 excludes A, P, FIN; 1998 excludes D, IRL, L, A, UK; 1999 excludes EL, IRL, A.
Source: Eurostat (CLFS).

Data for 1998 should be treated with special caution. As is discussed below, the changeover of ISCED led to a higher than usual level of non-response to the question on educational attainment for many countries, with some countries providing no breakdowns whatsoever on this question.

Mobility of scientists and engineers

Looking at Figure 2, which shows trends in the mobility rates of scientists and engineers (ISCO 21 and ISCO 22), employed HRST and the overall workforce, we can see that scientists and engineers (S&E) are the least likely to change jobs in any of the given periods. HRST are more likely to change jobs than scientists and engineers, but less likely than employees in general. This indicates that there may be a negative correlation between level of qualification (in terms of education or profession) and mobility. One should recall, however, that mobility rates include a number of less stable or part-time jobs with little required training, where hire and fire policy can be more distinct. Nevertheless, with the exception of 1998, where HRST data should be treated with caution, mobility rates seem to be converging a little.

Figure 2. **Trends in EU mobility: total employment, employed HRST, S&E, 1995-99**



Note: Incomplete data series mean that mobility rates are calculated for all those countries that are available. 1995 excludes P, FIN, S; 1996 excludes P, FIN, S; 1997 excludes A, P, FIN; 1998 excludes D, IRL, L, A, UK; 1999 excludes EL, IRL, A.
Source: Eurostat (CLFS).

Mobility at the national level

Table 2 displays, where available, the various rates of mobility in the EU, EFTA and candidate countries. As can be seen, there are a number of gaps in the data series. In certain cases, the remaining series show some rather peculiar trends, not least Spain where mobility rates halve between 1998 and 1999. Some of these issues are discussed below.

These caveats aside, mobility rates are higher in the Nordic countries and the United Kingdom, and lower in Italy and Greece. In most cases, mobility increases over the observation period. In 1999, mobility rates are higher for women than they are for men in all of the EU Member States with the exception of Portugal and Sweden.

Table 2. **National mobility rates of employed HRST in the EU, EFTA and candidate countries, according to gender**
1994-99, males, females

	Mobility rates of employed HRST (%)											
	Males						Females					
	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999
B	5.5	5.8	6.3	6.4	8.1	7.4	6.1	6.8	7.1	7.0	9.3	7.8
DK	9.4	11.2	11.2	8.9	10.9	11.8	13.0	11.4	11.3	9.9	11.8	12.6
D	6.5	5.5	6.0	6.1		7.2	6.9	6.5	6.9	6.0		7.8
EL	4.3	3.6	3.9	3.2	4.9		4.4	4.6	4.1	4.4	5.6	
E	11.6	12.6	12.0	12.0	12.0	6.1	16.6	16.2	16.1	17.2	17.2	8.4
F	5.9	6.5	6.5	7.0	7.3	8.0	7.0	6.5	6.5	6.7	7.8	9.1
IRL	7.9	8.1	9.5	9.8			8.9	11.0	11.7	11.8		
I	2.5	2.4	2.7	2.8	4.1	4.4	3.5	3.4	3.5	3.6	5.3	5.4
L	4.8	3.7	4.7	3.8		5.9	5.4	6.3	4.9	5.1		6.5
NL	6.6	6.5	5.8	7.1	9.9	8.8	7.4	7.8	6.8	7.0	11.0	9.6
A		5.6	5.9					5.9	6.3			
P					7.3	7.9					8.8	7.6
FIN					10.4	11.9					12.3	12.3
S				7.0	8.9	10.2				7.2	7.8	8.0
UK	8.9	9.5	10.3	11.7		11.9	10.0	10.6	11.2	11.8		12.2
IS		13.8	10.4	11.9	12.6			10.9	12.1	12.4	15.8	
NO			10.4	9.3	13.3	7.6			11.2	8.2	12.7	8.1
CH			9.3	8.4	10.5	10.6			11.5	10.2	11.2	10.3
CZ					6.6	4.6					5.2	3.7
EE				12.5	13.5	11.8				9.3	8.6	10.3
HU				6.4	6.9	5.7				5.0	5.2	4.7
PL				5.1	5.6	3.5				4.1	3.2	2.5
RO					0.0						0.0	
SI			6.5	6.5					4.7	4.2		
EU-15	**6.7**	**6.7**	**7.0**	**7.5**	**7.9**	**8.1**	**7.8**	**7.7**	**8.0**	**8.0**	**9.3**	**8.9**

Source: Eurostat (CLFS).

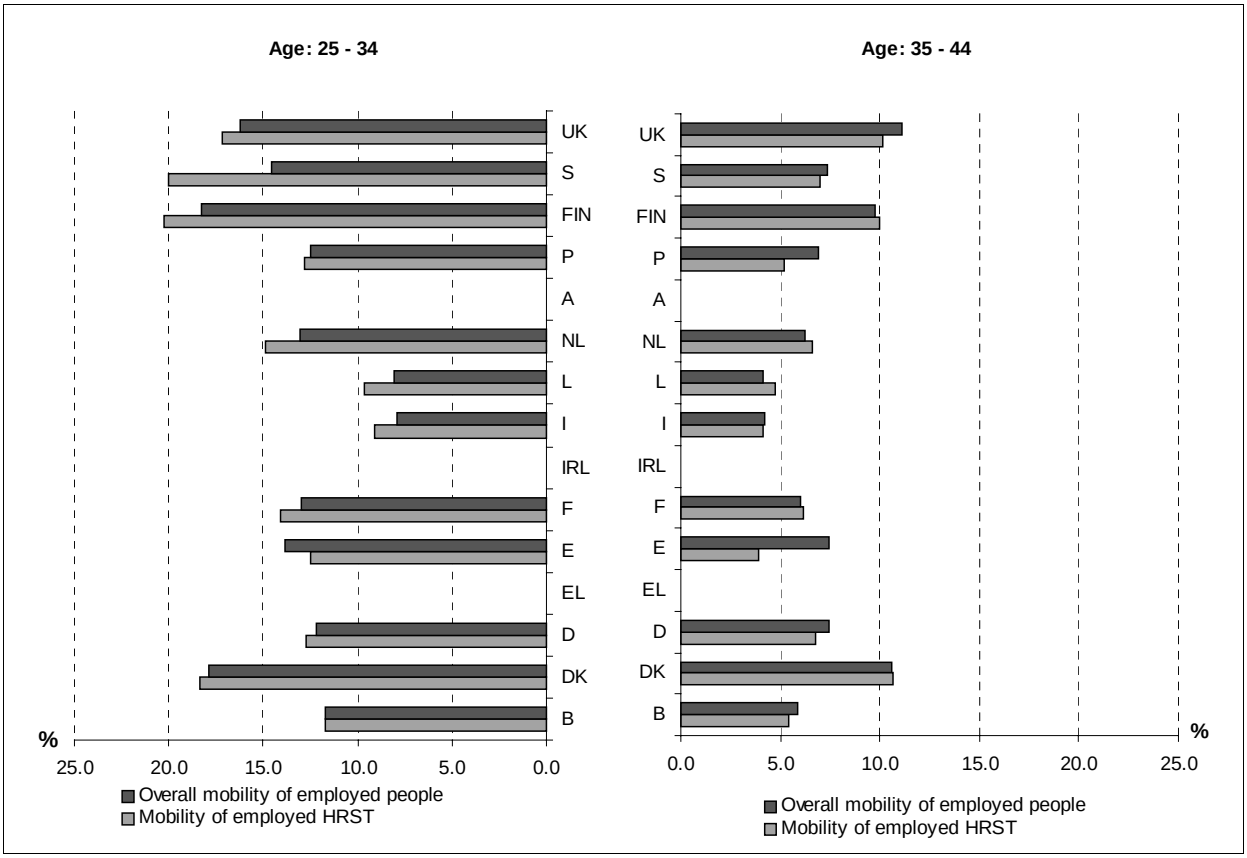
Mobility according to age

A snapshot of two age groups is provided in Figure 3. The chosen groups are ages 25-34 and 35-44, two age groups for which one would expect higher employment mobility.

The first thing to note is the difference in mobility rates between the two groups: mobility for people aged 25-34 is roughly double that for those aged 35-44. This is hardly surprising since one would expect the mobility rate to fall as people grow older and develop stronger ties with their environment – be it job security, family, etc.

It is also noteworthy that in spite of the fact that total mobility is higher than HRST mobility (see Figure 2), the opposite seems to hold true for people in the 25-34 age group (exceptions are Spain and Belgium). One possible explanation for this is that this age group contains a number of recent university graduates who are just beginning their working lives and may be more prone to changing jobs. In the 35-44 age bracket, results are not so clear-cut: in five of the twelve EU Member States for which data are available (Denmark, France, Luxembourg, the Netherlands, Finland), HRST mobility remains higher than overall mobility.

Figure 3. **Total mobility and employed HRST mobility by age, 1999**



Source: Eurostat (CLFS).

Sectoral mobility

Figure 4 shows, for 1999, mobility rates at the national level in two principal sectors: knowledge-intensive services and manufacturing. These two sectors have been chosen since they do not involve disaggregating the CLFS data to the extent that would be required for high-technology manufacturing sectors, for example, but still give a good comparison of mobility between "old" economy sectors and "new" economy sectors. Mobility for the economy as a whole is added as a benchmark.

Using the NACE two-digit level, "Manufacturing" includes NACE 15-37, while "Knowledge-intensive services" (KIS) include:

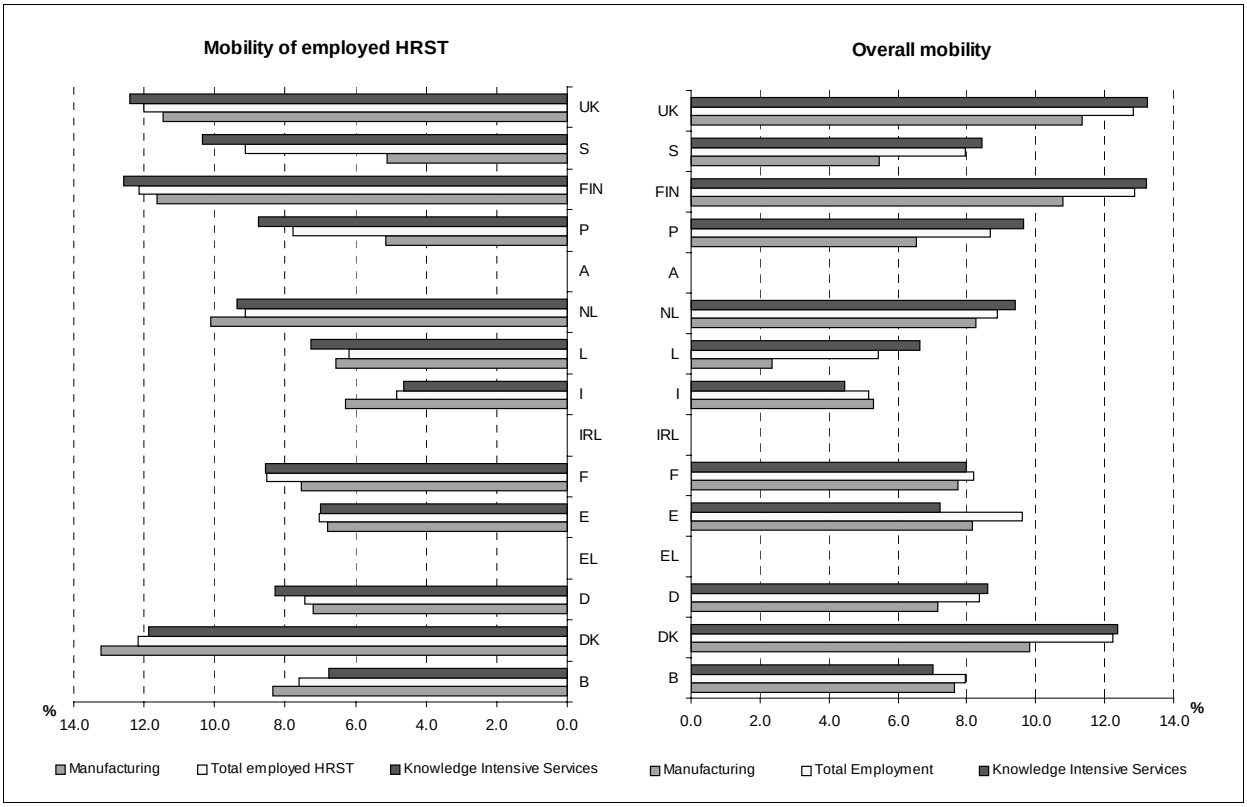
- Water transport (61), Air and space transport (62), Post and telecommunications (64) (parts of Section I).
- Section J: Financial intermediation.[2]
- Section K: Real estate, renting and business activities.[3]
- Section M: Education (80).

- Section N: Health and social work (85).[4]

- Recreational, cultural and sporting activities (92), *i.e.* motion picture and video activities, radio and television activities; libraries, archives, museums, etc.

In most of the observed cases for both employed HRST and overall mobility, knowledge-intensive services display higher mobility than does manufacturing. The exceptions are Belgium, Denmark, Italy and the Netherlands for employed HRST, and Belgium, Spain and Italy for the overall workforce.

Figure 4. **Total mobility and employed HRST mobility by sector, 1999**



Source: Eurostat (CLFS).

Nevertheless, these results do not indicate which sector people have moved from, only which sector they have moved to. The sample size limitations of the CLFS dictate that any results displaying this type of information would be extremely unreliable. However, although we cannot document in any detail the sending sectors, tests (with reliable sample sizes) have shown that a significant degree of mobility is *intra*-sectoral.

Some caveats

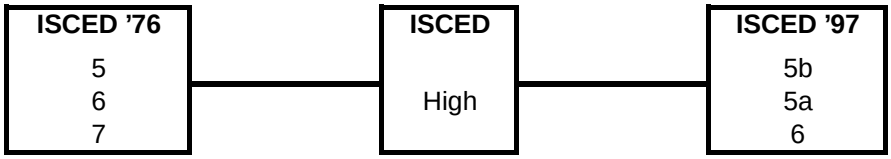
This section considers some aspects regarding the quality of the data. First, the consequences of the introduction of the new version of ISCED are assessed. Then, after a few words on miscoding, the

reliability of the question in the CLFS concerning a person's working status in year t-1 is briefly appraised.

Revision of ISCED

The revised version of ISCED has sought to more accurately categorise separate education classifications. However, this means that data over the time series are collected according to different methodological definitions. As a result, Eurostat and UNESCO have each conducted research into the comparability of the two versions. Both have recommended that comparison between new and old versions should take place by creating an ISCED "high", grouping subset within this category. For ISCED '76, this consists of levels 5, 6 and 7. For the 1997 version, this is composed of 5b, 5a and 6. The starting point for data using ISCED '97 in the CLFS is 1998.

Figure 5. **Grouping of ISCED "high"**



Source: Eurostat.

A cursory inspection of Table 3 reveals for the EU as a whole quite how much difficulty the Member States faced in mapping national education systems to the 1997 version of the international classification (ISCED) system, especially when it was first introduced to the CLFS in 1998.

Table 3. **Problems encountered in the CLFS as a result of the changeover of ISCED at the EU level**

ISCED level	1995	1996	1997	1998	1999
Total H *('000s)*	40 502	41 210	43 070	24 296	44 479
Total L + M *('000s)*	245 602	246 047	246 588	156 285	222 894
Total blanks *('000s)*	77 099	79 591	77 855	188 473	92 254
Proportion of blanks (%)	21.2	21.7	21.2	51.1	25.7
Of which: inactives (%)	97.9	97.6	98.0	62.5	92.7
Of which: working (%)	1.9	2.2	1.7	34.4	6.7
Of which: ISCO 2 / 3 (%)	0.5	0.6	0.5	9.6	0.7

Source: Eurostat (CLFS).

While there are generally some problems with classifying level of education, for all but 1998, most of these are attributable to the inactive category, and thus will have little effect on the quality of the mobility analyses.

It is recognised that greater focus on the most highly educated individuals (PhD holders) is desirable. In addition, it may be possible to construct aggregated indicators for those groups as separate case studies or as part of a more global analysis. However, in order to build up any time series

and ascertain the main trends – one of the main aims of the project – it is recommended that comparison using both ISCED '76 and ISCED '97 concentrates more on ISCED "high" than on the individual codings. Nevertheless, it may be the case that as the research continues and more years become available, some indicators can be built up that differentiate those people that hold an advanced research qualification (ISCED '97, level 6) from those that have an education that is more technical/occupationally specific (ISCED '97, level 5b).

Miscoding

Another problem that has been encountered is miscoding. For some countries, years and age groups, data have been received for ISCO categories that do not exist, *i.e.* for Denmark in 1998 data were provided for ISCO 20. Research with the Labour Force Survey Unit of Eurostat ascertained that these occurred through lack of precision at the Member State level. Further investigation has revealed that these data are negligible.

Main status one year before

While, with the exception of 1998, the ISCED changeover should not have too negative an effect on the quality of the results, inspection of the data series brought to light a number of peculiar results in the mobility analysis. One of these is the sudden drop in mobility in Spain between 1998 and 1999, from around 14% to 7%. Closer scrutiny of the data has revealed other strange results in the absolute figures, although the mobility rates may not change significantly. These results seem to be related to the CLFS question "What was your working status one year before?", for which accuracy is less likely to be high.

Currently, the LFS unit in Eurostat is conducting some research into this variable, which is important in order to obtain narrow mobility rates, *i.e.* excluding inflows into the labour force. The following points can be noted:

- In Ireland the question was dropped when the continuous survey was implemented (Q4 1997). The main reasons for this decision were response burden and poor quality of the information collected.

- Retrospective questions are not asked in Sweden. In this country, individuals are kept in the sample for two years and are interviewed eight times. The data provided to Eurostat concern only the part of the sample that was already interviewed one year before and the information provided is in fact the answer given to the question "Main status" (*i.e.* employed, unemployed, inactive) in these preceding interviews – only one-third of the sample. This is why there is a high degree of non-response in Sweden (see Table 4).

Table 4. **Item non-response rate in the CLFS, 1999**
Percentages

	B	DK	D	EL	E	F	IRL	I	NL	L	A	P	FIN	S	UK
Main status one year before	0	17	5	0	0	0	100	0	0	0	100	0	0	63	5

Source: Eurostat.

From Table 4, it is not possible to say to what degree non-response is responsible for data peculiarities: a non-response of 0% is more strange than a non-response of 100%. To this end, it will be necessary to begin a process of exchange with those parties responsible for the Labour Force Survey data, highlighting problem areas and seeking to reach some conclusions on how to improve the reliability of the results.

Some conclusions and next steps

This chapter has given an overview of mobility rates in the European Union and, to some extent, EFTA and the candidate countries over the time period 1994-99, where data are available. Main trends have been presented by gender, age and sector. Analysis has considered not just employed HRST, but also scientists and engineers and overall mobility rates. The second section briefly looked at some anomalies in the data and non-response.

The sectors of activity available do not allow a breakdown of researchers in terms of institutional sectors in the sense of the *Frascati Manual* – Business Enterprise Sector, Government Sector or Higher Education Sector. Nor can we look at researchers in the Frascati sense of the term. To this end, it is difficult to measure whether there is a growing interaction between the public sector and the private sector and a suitable pooling of knowledge.

Another limitation is that the data do not provide any information on the length of time that the person who has changed jobs spent in their former occupation. It is therefore difficult to gain much understanding of to what degree knowledge diffusion, in the case of highly skilled individuals, will have occurred as a result of a change in occupation.

So, while there is greater mobility over the time period, no causal factors are identified. It will be necessary to look more closely at the data in conjunction with country-specific growth rates, administrative barriers and other idiosyncrasies to learn any more on this matter. First, however, explanations for the fluctuations in the absolute figures are needed. Only once these have been understood, can research progress in this area.

NOTES

1. According to the "Canberra Manual" (OECD and European Commission, 1995, §71), the seven broad fields of study are Natural Sciences, Engineering and Technology, Medical Sciences, Agricultural sciences, social sciences, humanities, other fields.

2. Including: Financial intermediation, except insurance and pension funding (65), Insurance and pension funding, except compulsory social security (66) and Activities auxiliary to financial intermediation (67)

3. Including: Real estate activities (70), Renting of machinery and equipment without operator and of personal and household goods (71), Computer and related activities (72), Research and development (73), Other business activities (74).

4. Including: Human health and veterinary activities, Social work activities.

Annex

COUNTRY CODES

B	BELGIUM	S	SWEDEN
DK	DENMARK	UK	UNITED KINGDOM
D	GERMANY	IS	ICELAND
EL	GREECE	NO	NORWAY
E	SPAIN	CH	SWITZERLAND
F	FRANCE		
IRL	IRELAND	CZ	CZECH REPUBLIC
I	ITALY	EE	ESTONIA
L	LUXEMBOURG	HU	HUNGARY
NL	NETHERLANDS	PL	POLAND
A	AUSTRIA	RO	ROMANIA
P	PORTUGAL	SI	SLOVENIA
FIN	FINLAND		

Note: EU countries are listed according to the name of the country in that country's official language(s).

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Chapter 10

FIRST EXPLORATION OF THE BELGIAN HRST DATA: A STUDY BASED ON REGISTER DATA

by

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Introduction

Highly skilled human resources are essential to the continued development and diffusion of knowledge and constitute "a crucial link between technological progress and economic growth, social development and environmental well-being". To this end, the OECD and the European Commission have encouraged researchers to collect information on the mobility of the highly skilled.

To comply with a request to monitor the labour market position of this group, a data set was established, comprising information on the (labour market) careers of highly educated people in Belgium. The results of the 1991 Belgian Decennial Census were combined with information from the rich administrative databases of the Belgian Social Security System (technical assistance was provided by the Kruispuntbank Sociale Zekerheid). The data set was completed at the end of 1999 and this chapter presents an exploratory analysis using these data.

The OECD manual, "The Measurement of Scientific and Technological Activities. Manual on the Measurement of Human Resources Devoted to S&T – Canberra Manual", published in 1995, provides guidelines for the measurement of human resources devoted to science and technology (HRST) and the analysis of HRST data. The following section of this chapter describes the Belgian data set and investigates the extent to which the OECD "Canberra Manual" recommendations on HRST could be met in constructing the Belgian data set.

The third section presents initial results for the Belgian HRST study. The first series of tables and figures focus on differences in HRST mobility over a short period (one year) and over a longer period (four years). For this longer period, 1993-97, the mobility patterns of groups with varying characteristics are explored, taking into consideration differences in gender, age, qualification, occupation and region.

A second series of tables documents the flow of highly qualified human resources across industries. These tables concern only those people who changed firms between 1996 and 1997. The results of this analysis are compared with those of the 1998 Nås study on labour market mobility of highly qualified personnel in three Scandinavian countries.

The Belgian HRST sample

Content

The Decennial Census gathers information on all Belgian residents and is the unique source of information on occupations (using the ISCO classification) and qualifications (using the ISCED classification). The most recent, 1991, Decennial Census was used to select people for the HRST sample. A first filter, based on the highest qualification and occupation of Belgian residents, allowed the identification of all highly educated persons. A second, age-specific, filter reduced the sample to all men between 20 and 63 years of age (in 1991) and all women aged between 20 and 58 (in 1991).[1]

This group of 270 000 persons (some 3% of the total population) was retraced in the databases of the four main institutions of the Belgian Social Security (RSZ, RSZPPO, RSVZ, RVA)[2] at end-December 1993, 1994, 1995, 1996, and end-March 1997. For each of the five observations, data-linking allows information to be collected on, for example, presence/absence of information about individuals in the social security databases, time worked (part-time or full-time employees), number of jobs held by each person, sector and size of the employees' company, plus information on whether the individual had changed firms since the preceding observation, whether the respondent is self-employed or receives unemployment benefits linked to early retirement. Using this information, the socio-economic position of the "stock" can be documented for the five observation periods. It is also possible to reconstruct the career of each individual covered by the HRST survey, and to draw mobility patterns for all highly educated Belgians. A number of checks were run to verify whether the Belgian HRST population meets the recommendations set out in the OECD "Canberra Manual".

The Belgian HRST sample vs. *the "Canberra Manual" recommendations: coverage*

The "Canberra Manual" provides guidelines for the measurement of human resources devoted to science and technology (HRST) and the analysis of HRST data.

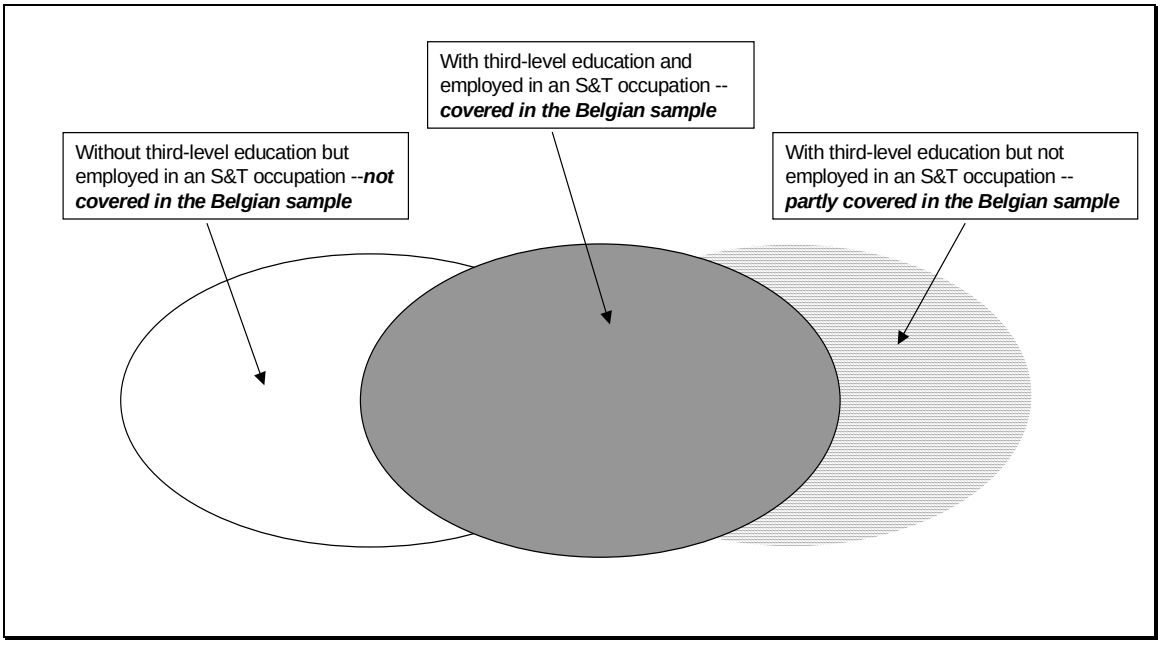
The "Canberra Manual" definition of HRST applies to both supply of and demand for HRST. Demand for HRST, *i.e.* the number of people who are actually required in S&T activities at a certain level, is covered by taking into account all those working in a "HRST occupation". Supply of HRST is estimated by taking into account all persons with a "HRST qualification". *The Canberra Manual proposes a definition of HRST as people who fulfil one or other of the following conditions:* (a) *successfully completed education at the third level in a S&T field of study, or* (b) *not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required.*

The Belgian HRST definition largely matches this definition, albeit not perfectly. There are three main differences.

First, the Belgian HRST sample was not created in line with the above "or-or" definition, but rather in accordance with an "and-and" definition; the Belgian HRST sample covers all those who: *(a)* are qualified to the high HRST standards, and *(b)* were employed at that particular moment of time in a specific occupation. Therefore, people with a HRST qualification who are employed in other occupations are not covered in the Belgian sample. People with low qualifications, but who nevertheless are employed at the higher HRST level, *e.g.* IT professionals, are also excluded from the sample. The coverage of the Belgian HRST sample is presented in Figure 1 (based on that used in the "Canberra Manual").

The Belgian HRST sample covers what is known as the "core coverage" of the HRST definition, *i.e.* those people who are both qualified and work in HRST (the dark-shaded area of Figure 1). The left-hand oval comprises those individuals who meet only the occupation condition; they are not qualified at ISCED level 5 or higher, and are thus not included in the sample. The right-hand oval comprises those individuals who meet only the qualification condition; they are not employed as HRST and are thus are only partly[3] covered in the sample.

Figure 1. **Principal categories of HRST**



Source: Canberra Manual, Steunpunt WAV.

The second remark concerns the breakdown of the sample in terms of *qualification*. A distinction is made between university-level HRST (ISCED 6 or 7) and technician-level HRST (ISCED 5). A more detailed statistical breakdown of the Belgian HRST is not possible. This means that *we can only divide HRST into the broad classes* proposed by the "Canberra Manual". Two detailed breakdowns proved impossible: *i)* provision of information on individuals qualified at a level lower than ISCED 5; and *ii)* the breakdown between the upper part of ISCED 7, the lower part of ISCED 7, and ISCED 6.

Third, the possibilities for research are limited by the occupation breakdown. Specifically, the sample contains all persons who declared in the 1991 Census that they were employed in an occupation with the ISCO code 211, 212, 213, 214, 221, 222, 244, 311 or 312.[4] It also covers those who in 1991 declared themselves as inactive or unemployed, and those with unknown labour market status. The only information missing concerns those people who gave an occupation category other than those listed above.

As was the case with the qualification breakdown, we *can detail the suggested minimum minimorum* concerning the occupation breakdown, *i.e.* the core coverage proposed in the "Canberra Manual". This core coverage concerns ISCO occupational groups 21 (Physical, mathematical and engineering science professionals) and 22 (Life science and health professionals). In terms of the proposed extended coverage, information is only available for a fraction of the suggested occupations.

Table 1. **Comparison between the Belgian HRST sample and the "Canberra Manual" recommendations**

Occupation	Qualification		
	ISCED level 6+7	ISCED level 5	Less than ISCED level 5
ISCO 21 + 22	**100%**	**100%**	0%
ISCO 122+123+131 + 23 + 24 + 31 + 32 + 33 +34	Only 244, 311, 312	Only 244, 311, 312	0%
All other occupations	0%	0%	0%
Unemployed	100%	100%	0%
Out of the labour force	100%	100%	0%

Key: Recommended core coverage.
Extended coverage.

Source: Steunpunt WAV.

Table 1 summarises the comparison between the "Canberra Manual" recommendations and the Belgian HRST sample. The sample answers the most essential descriptions of the Manual: those persons that are in the centre of the HRST definition are completely covered by our data. Where the "Canberra Manual" suggests extensions, the sample usually falls short of expectations. On the other hand, all non-active persons are excluded from the sample.

The Belgian HRST sample vs. *the "Canberra Manual" recommendations: possible breakdowns*

The "Canberra Manual" not only proposes coverage of a specific category of the population in defining a group of persons for the HRST analysis, it also suggests the use of a specific set of statistical breakdowns. This section will verify whether we can meet these breakdowns in terms of qualification, occupation, labour market status, economical sector of employment, type of activity, gender, age, national origin and ethnicity.

As noted above, HRST by *qualification* can be easily broken down into two categories, ISCED 6+7 and ISCED 5. A more detailed classification (PhDs, other ISCED 7, ISCED 6, ISCED 5, lower than ISCED 5) cannot be analysed with the Belgian data set.

In terms of HRST by *occupation*, the "core coverage" is excellent. The Belgian data set allows this group (ISCO 21 and 22) to be broken down into more detailed occupational categories; namely, ISCO 211 (Physicists, chemists and related professionals), 212 (Mathematicians, statisticians and related professionals), 213 (Computing professionals), 214 (Architects, engineers and related professionals), 221 (Life science professionals, *e.g.* biologists and pharmacologists), 222 (Health professionals, *e.g.* medical doctors and veterinarians).

A broader list of other occupations is difficult to produce. Only a limited number of occupations in the "extended coverage" – ISCO 244 (Social science and related professionals), 311 (Physical and engineering science technicians), and 312 (Computer and associated professionals) – are covered in the Belgian data set.

A final remark about these two variables is called for. Information on the level of qualification and on occupation are derived from the 1991 Census. All other data – on both *stocks* and *flows* – originate from other sources, and refer to the period 1993-97. This implies that the data set registers a person who changed his occupation between 1991 and 1993, as being in the same occupation he held in 1991, and ignores anyone who qualified at a HRST level after 1991.

HRST can be divided by *labour force status* using social security data. Anybody recognised in the RSZ database ("the Public Service for Social Security"), is considered an employee. Persons registered with RSZPPO, a similar but smaller institution for the social security of local government employees, are also considered employees. People registered by RSVZ ("the Public Service for the Insurance of the Self-employed"), are labelled as self-employed. Finally, the RVA, an institution responsible for the payment of unemployment benefits, defines the number of unemployed. Labour market status becomes less clear for individuals who are not recognised by any of these social security institutions. The most obvious approach is to consider such persons as inactive. On the other hand, he/she could also have emigrated or died. This group with unknown labour market status in the five consecutive observations represents 70 000 of the 270 000 persons covered in the Belgian HRST sample.

HRST by *sector of employment* can only be shown for those individuals recognised by RSZ, the (almost entire) group of employees. RSZ uses the NACE classification, at the two-digit level; this implies that most of the suggested sectoral breakdowns are possible.

Any breakdown of HRST by *type of activity* is impossible since, in Belgium, information on the functions (or activities) of people is lacking.

The Belgian HRST data set contains information on the most important characteristics of HRST, *i.e. gender* and *age*. However, since the sample contained those people who were over 20 years old and under 58/63 years old in 1991, the small group of older people that are still active after retirement age cannot be distinguished. Undoubtedly, the exclusion of the youngest group on the labour market poses a more serious problem: the youngest person in our sample was aged 26 in 1997. This is because we were obliged to use 1991 data (from the Decennial Census) to select people meeting the HRST standards in the "Canberra Manual", and 1993-97 data (from administrative sources) to obtain information on the labour market mobility of this population.

Nationality and *ethnicity* of the sample is unknown.

Initial results

The survey contains information on 272 930 persons. For 70 290 of these, social security records contained no information in any of the five observation periods. The socio-economic position of this group is vague. The majority of these persons are older persons, and women are more strongly represented than men. It is therefore plausible that many of these persons left the labour market. On the other hand, they may also have emigrated or died. Since this "unknown" group has never been part of the officially active population, they have been excluded from the analysis. This implies that, in this first step, the scope has been limited to all highly educated persons in HRST occupations active on the Belgian labour market between 1993-97 – *i.e.* 202 640 persons.

Definition of mobility

The definition of labour market mobility has two aspects: *i) Period of time*. The HRST database contains information on five consecutive observations, at (almost) one-year intervals. Consequently, labour market mobility can be analysed both for a short period (one year) and for a medium-term period (four years). Both approaches will be considered in this chapter. *ii) Definition of mobility*. To obtain the best view of the labour market transitions of the HRST group, we have broken mobility down into *four distinct types*:

I. *Mobility of people between various employers or firms*. This definition covers mobility in the narrow sense and includes only movements between different employers. Persons in this group have been employees at two consecutive observations, but have changed firms between observations.

II. *Other mobility of people at work*. People in this group have been in employment at two consecutive observations, but changed their labour market status in one way or another. Possible transitions are full-time/part-time, employee/self-employed.

III. *Mobility in out of the labour force*. These transitions include the movements to and from unemployment or inactivity to employment and vice versa.

IV. *Other transitions*. These transitions include changes in the administrative databases out of the workforce. An example would be a non-active person who decides to register himself for unemployment.

Rest. *No mobility*. All persons who are registered the same way in two consecutive observations.

Table 2 illustrates the two approaches.

The number of mobile persons is clearly on the increase when the period is widened from one to four years. The number of persons in mobility (types I to IV) more than doubles when looking at the situation in 1993-97 instead of looking at one year. The "consistent" part of the survey falls from about 80% to 56%.

Table 2. **HRST on the labour market in 1993-97 and their situation regarding different types of mobility**

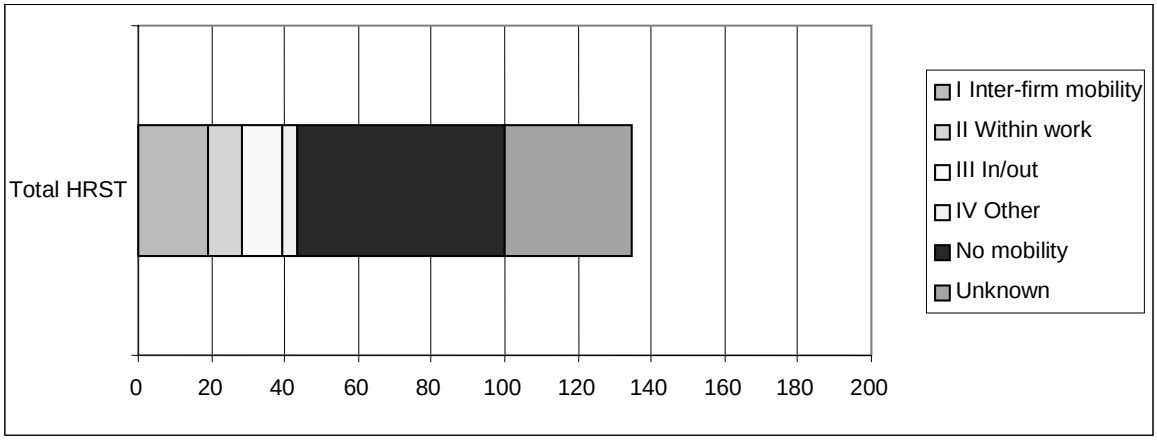
	I. Inter-firm mobility	II. Within workforce	III. In/out of work	IV. Other transitions	Stability	Total
Number (n)						
Period 1993-97	38 615	18 539	23 008	8 198	114 280	202 640
Dec. 1993 – Dec. 1994	15 062	8 505	12 090	5 147	161 836	202 640
Dec. 1994 – Dec. 1995	16 805	8 154	11 203	4 523	161 955	202 640
Dec. 1995 – Dec. 1996	13 148	8 406	9 616	4 330	167 140	202 640
Dec. 1996 – Mar. 1997	6 500	5 106	5 472	2 267	183 295	202 640
Percentage (%)						
Period 1993-97	19.1	9.1	11.4	4.0	56.4	100.0
Dec. 1993 – Dec. 1994	7.4	4.2	6.0	2.5	79.9	100.0
Dec. 1994 – Dec. 1995	8.3	4.0	5.5	2.2	79.9	100.0
Dec. 1995 – Dec. 1996	6.5	4.1	4.7	2.1	82.5	100.0
Dec. 1996 – Mar. 1997	3.2	2.5	2.7	1.1	90.5	100.0

Source: KSZ, HRST data set (Steunpunt WAV).

Of the 200 000 persons on the labour market, 38 600 (19%) experienced mobility, in the narrowest sense of the definition (I), between 1993-97, having changed jobs at least once. When the definition is broadened to cover all transitions made by working people (II), mobility rises to 28% of

the HRST population. When movements into and out of work are added (III), almost 40% of all active HRST can be considered mobile. Figure 2 summarises these findings.

Figure 2. **HRST and four types of mobility, 1993-97**



Note: 100% = all persons registered at least once between 1993-97.
Source: KSZ, HRST data set (Steunpunt WAV).

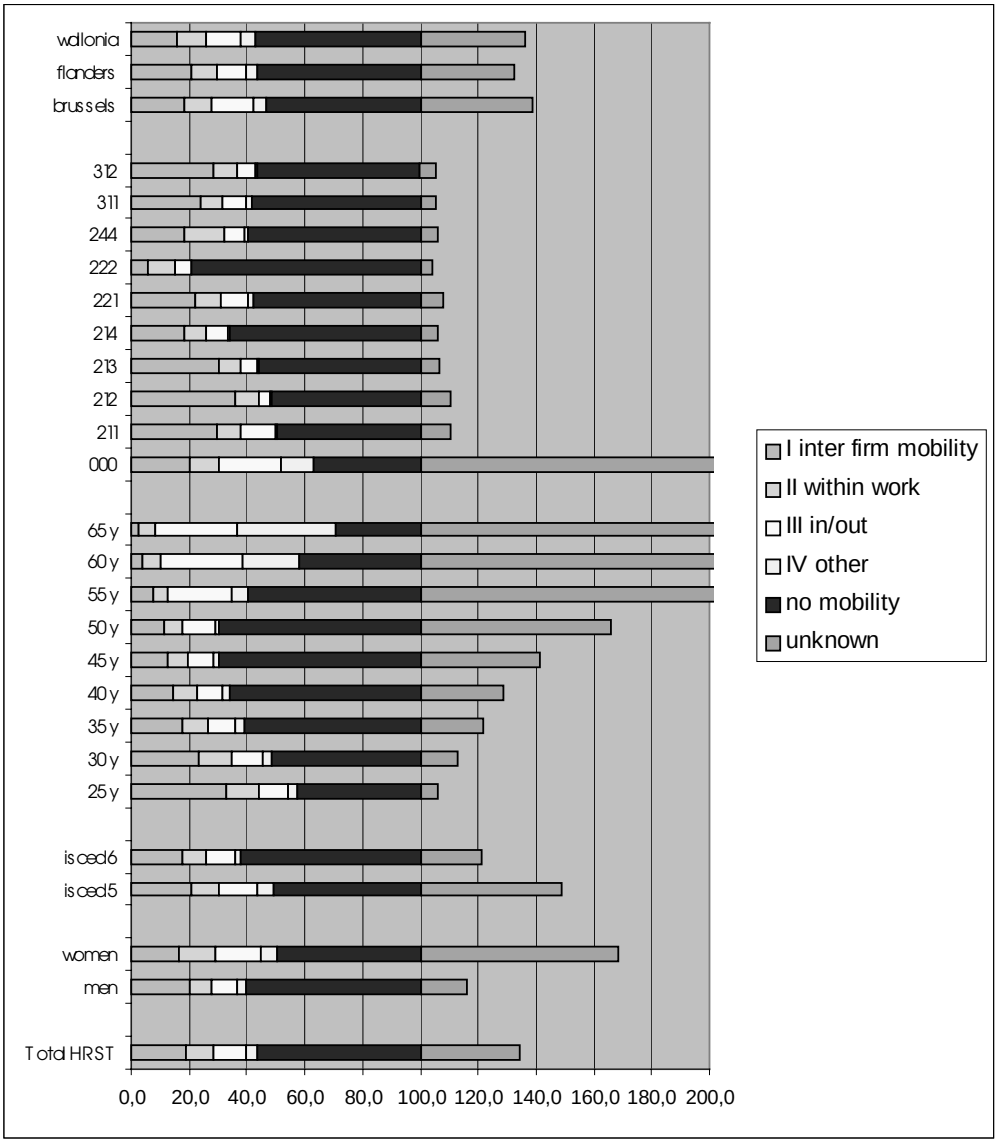
Patterns and characteristics of mobility

This global view of the mobility of the group between 1993-97 can be further broken down by various characteristics: region, ISCO occupation, age, qualification and sex. The population registered in the social security files at least once between 1993 and 1997 is always equal to 100. This group is divided into those persons who changed employers (I), those that changed their work status (II), those who moved into or out of the working population (III), those who underwent another transition (IV), and, finally, into the share of the population that did not change labour market status, *i.e.* whose situation in the labour market remained stable.

Differences between Belgian *regions* and *qualification* levels are small. Technician-level HRST appear to undergo more transitions than do university-level HRST, although differences between the mobility levels of the two groups are small.

Mobility patterns show greater differences in terms of *gender*. In the narrow sense of the word, HRST men tend to be more mobile on the labour market than are HRST women. When only changes between firms (I) are taken as transitions on the labour market, mobility looks very much like a men's affair – the job-hopper has a male profile. However, when the definition of mobility is broadened to include other transitions within the group at work (II) and/or in/out work (III), the profile becomes increasingly female. This is explained by the significant number of women who opt for reduced working hours and/or interrupt their careers to enable them to juggle with family and work.

Figure 3. **HRST and four types of mobility, 1993-97**
By region, ISCO-code, age, qualification level and gender



Note: 100% = all persons registered at least once between 1993-97.
Source: KSZ, HRST data set (Steunpunt WAV).

There is also an important difference in mobility patterns of HRST by *age*. In the most rigid sense of mobility (I), the young undergo more transitions than the old. Even when the definition of mobility is enlarged to include mobility type II, mobility remains primarily a "young" phenomenon. Mobility is easier for the young, both in terms of changing employers and starting up a business. At a later stage in the career, this seldom happens. The transitions of the older group are different in nature: people of over 50 years of age register more outflow movements (III) and "other" mobility (IV). At the end of one's career, it is often convenient to opt for early retirement (an example of mobility type III) and, in a second phase, to leave the labour market completely by swapping early retirement for a (regular) pension (mobility type IV).

There are also significant differences in mobility patterns of HRST by *ISCO occupation*. "Health professionals" (ISCO 222) demonstrate very little mobility: doctors rarely changed jobs over the study period. By contrast, mobility is far more frequent among natural scientists; between 1993-97, one-third of all computing professionals (213), computer associate professionals (313), physicists (211) and statisticians (212) changed employers at least once.

Number of transitions (mobility type I), and major characteristics

The focus in this section is on mobility type I. Questions raised include: Is there a difference in the number of changes between various employers by gender or age? Who is changing four times in a row? This analysis is based on the 38 615 persons identified in Table 2, *i.e.* those who changed employers at least once between 1993 and 1997. Table 3 describes the number of transitions (type I) by major characteristics. The maximum number of changes is four (the case for a person who had a different employer at every observation).

Table 3. **HRST registered at least once as employee between 1993-97**

By the number of years a transition of mobility type I occurred, and by region, ISCO code, age, qualification level and gender

	No transition (%)	One transition (%)	Two transitions (%)	Three transitions (%)	Four transitions (%)	All employees (n)
Total	71.2	21.0	6.1	1.5	0.2	134 229
Men	69.8	22.2	6.2	1.6	0.2	88 306
Women	73.9	18.7	5.8	1.4	0.2	45 923
IISCED 5	72.2	20.3	5.8	1.5	0.2	73 288
IISCED 6	70.1	21.9	6.4	1.5	0.1	60 941
25 years	61.9	26.3	9.3	2.2	0.3	31 850
30 years	68.4	22.9	6.6	1.9	0.2	33 611
35 years	72.5	20.3	5.6	1.4	0.2	22 899
40 years	75.3	18.9	4.6	1.1	0.1	17 231
45 years	79.6	15.9	3.7	0.8	0.1	13 347
50 years	80.3	15.9	3.0	0.7	0.0	7 237
55 years	83.8	13.4	2.4	0.2	0.1	4 987
60 years	88.4	9.9	1.3	0.3	0.1	2 655
65 years	88.8	10.2	0.7	0.2	0.0	412
000	67.6	22.1	7.9	2.0	0.3	37 048
211	67.9	25.1	5.1	1.6	0.3	686
212	61.5	22.4	14.6	1.5	0.0	205
213	67.4	23.9	6.3	2.4	0.1	20 397
214	73.8	20.4	4.7	1.0	0.1	20 341
221	70.3	24.1	5.2	0.4	0.0	809
222	76.2	17.0	5.5	1.1	0.2	8 523
244	76.1	17.5	5.1	1.2	0.2	14 682
311	73.0	20.8	5.1	1.0	0.1	30 681
312	69.9	23.5	5.6	0.9	0.1	857
Brussels	71.0	20.9	6.1	1.7	0.3	15 388
Flanders	69.7	21.9	6.6	1.6	0.2	79 895
Wallonia	74.4	19.2	4.9	1.3	0.1	38 946

Source: KSZ, HRST data set (Steunpunt WAV)

The last column on the right, the "total group", does not comprise not the whole group of 200 000 persons. Rather, it concerns those persons registered at least once as an employee, *i.e.* 134 000 persons, since this represents the only group where people *could* change between various employers.

Differences in mobility patterns become even more clear when we go beyond the simple fact of mobility to look at the number of transitions in 1993-97 – men, the young, statisticians and IT professionals are more likely to undergo several transitions.

Mobility by delivering and receiving sectors, 1996-97

This section will attempt to illustrate movements of mobile workers between different industries. Before presenting the results of the analysis, we briefly list some of the decisions that had to be made to obtain these tables. First, we concentrate on the period between 1995 and 1996; sectoral shifts in other periods give similar results. Second, we only look at data on *persons who changed between various employers between 1995 and 1996* (the 13 148 persons of mobility type I in Table 2), *added to the persons that entered or left the group of employees in this period*. Third, we only consider that share of the population with a university degree (ISCED 6+7). By limiting the survey to university-level HRST, we obtain an analogous sample to that used by Nås *et al*. to construct similar tables showing sectoral shifts in Norway, Sweden and Finland.

First we present the sectoral shifts on the Belgian labour market, before going on to show an international comparison between mobility on the Belgian and Scandinavian labour markets.

Table 4 indicates how the transitions of university-level HRST have changed the sectoral distribution of this highly qualified group:

- A remarkably *high percentage of mobile persons leaves the wage-earning population*. Of all those who left their jobs in 1995, 31.2% were not working for another employer in 1996. Of course, this does not mean that they have all become unemployed. Only 17% out of these 2 923 were registered as unemployed in 1996 (although this is not shown in the table). A much bigger share have started their own business and are now self-employed (30%). There is also an even larger – female – group that has moved back into inactivity, either because of retirement or to do the housekeeping.

  There are considerable differences between mobility patterns by economic sector. The size of the group leaving the labour market is important (*i.e*. 40% of all "moving" persons) in public services such as education, public administration or health services. On the other hand, when R&D people resign or lose their jobs, they quickly find alternative jobs with another employer: one year later, only 15% of this group is no longer part of the wage-earning population.

- *Intersectoral shifts* are fairly significant as can be seen from the share of mobile persons who continue to work in the same sector as one year before (numbers shown in bold italics in Table 4). It is often the case that highly qualified HRST personnel not only change employers, but also change sectors. Between 1995-96, the *degree of closeness* was most significant in the "utilities and construction" and in the "R&D institutes". In these two sectors, almost half of "moving" persons continued to work in the same sector.

Table 4. **Mobility (*i.e.* change of employer) of university-level HRST, 1995-96**

Receiving sectors (1996)	Delivering sector (1995)															Persons moving	Persons employed	Mobility rate in
	1	2	3	4	5	6	7	8	9	10	11	12	**Total work-force**	13	Total			
1. Primary sectors/mining	***20.4***	0.0	0.6	0.1	0.0	0.0	0.2	0.0	0.1	0.1	0.0	0.0	**0.2**	0.7	0.3	30	177	16.9
2. Manufacturing	2.0	***41.8***	6.5	9.8	5.8	3.5	12.8	5.6	2.6	0.9	2.3	0.0	**11.8**	9.0	11.4	1 259	12 306	10.2
3. Utilities and construction	2.0	2.0	***48.1***	0.8	0.5	0.5	1.5	0.0	0.2	0.1	0.5	0.0	**2.4**	2.3	2.4	265	1 999	13.3
4. Trade, hotels, restaurants	4.1	8.9	2.3	***41.0***	2.6	4.9	9.5	3.8	0.9	0.7	3.8	0.0	**9.3**	11.1	9.6	1 063	6 211	17.1
5. Transport, storage, comm.	4.1	2.2	0.6	2.8	***35.3***	3.0	3.3	1.0	0.4	0.4	2.0	0.0	**2.5**	3.6	2.6	292	2 174	13.4
6. Financial services, real estate	0.0	0.9	1.6	1.6	2.1	***35.3***	4.1	1.0	0.6	0.9	0.9	0.0	**2.9**	4.1	3.1	343	2 892	11.9
7. Business services	6.1	13.9	6.5	12.0	12.6	16.6	***37.6***	5.6	4.1	2.5	9.7	0.0	**13.8**	21.2	14.9	1 652	7 346	22.5
8. R&D institutes	0.0	0.7	0.0	0.4	0.0	0.5	0.6	***47.6***	2.1	0.5	1.1	0.0	**2.3**	1.6	2.2	242	951	25.4
9. Education institutions	2.0	1.4	1.3	0.8	3.2	1.4	2.0	14.3	***38.1***	6.0	5.0	21.6	**10.1**	18.4	11.4	1 257	5 907	21.3
10. Public adm., health, social	8.2	0.8	1.3	1.2	2.6	3.8	2.6	5.6	9.6	***42.0***	8.4	16.2	**9.7**	20.0	11.2	1 244	10 105	12.3
11. Other public services	2.0	0.9	1.3	1.3	2.1	0.8	2.0	0.0	1.7	6.7	***26.9***	2.7	**3.4**	7.8	4.1	449	2 183	20.6
12. Unknown sector	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.6	0.3	0.2	***40.5***	**0.4**	0.3	0.4	44	351	12.5
Total workforce	**51.0**	**73.3**	**70.0**	**72.3**	**66.8**	**70.4**	**76.3**	**84.6**	**60.9**	**61.2**	**60.7**	**81.1**	**68.8**	**100.0**	**73.6**	**8 140**	**52 602**	**15.5**
13. Out of workforce (non-employee)	49.0	26.7	30.0	27.7	33.2	29.6	23.7	15.4	39.1	38.8	39.3	18.9	**31.2**	0.0	26.4	2 923	2 923	100.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	11 063		
Total number of persons moving	49	1 522	310	1 188	190	368	1 762	286	1 871	1 354	443	37	**9 380**	1 683	11 063			
Total number of persons employed	196	12 561	2 043	6 343	2 079	2 915	7 464	993	6 581	10 195	2 174	298	**53 842**	1 683				
Mobility rate out	25.0	12.1	15.2	18.7	9.1	12.6	23.6	28.8	28.4	13.3	20.4	12.4	**17.4**	100				

Key: **1.** Primary sectors/mining = NACE 1-14. **2.** Manufacturing = NACE 15-37. **3.** Utilities and construction = NACE 40-45.
4. Trade, hotels, restaurants = NACE 50-55. **5.** Transport, storage, comm. = NACE 60-64. **6.** Financial services, real estate = NACE 65-71.
7. Business services = NACE 72, 74. **8.** R&D institutes = NACE 73. **9.** Education institutions = NACE 80. **10.** Public adm., health, social = NACE 75, 85.
11. Other non-public services = NACE 90-95, 99. **12.** Unknown sector = NACE 98.
Source: KSZ, HRST-data set (Steunpunt WAV).

These intersectoral shifts complete the existing picture of a sector. For example, the table shows that two sectors differ in this context: "business services" and "R&D", both of which are booming. As noted above, "R&D job hoppers" usually remain in the same sector. When they do change, we often find them working in "education institutes". People leaving "business services" jobs tend to move across to "manufacturing", "trade" and, to a lesser degree, "transport" and "financial services".

- The bottom row of the last column shows *mobility rates*, *i.e.* the share of inflow and outflow in the total number of employees. Remarkably, the total outflow mobility rate of highly educated HRST (17.4%) exceeds the inflow mobility rate (15.5%). This contrasts with the knowledge that, throughout the 1990s, highly qualified personnel increased their share in the total (Belgian) workforce, year after year. This contradiction is due to the way in which the data were gathered. The methodology used could not integrate young people who graduated between 1991-96, and consequently entered the labour market. Labour Force Survey data show that this group concerns a couple of thousand young people per year, which will increase the inflow mobility rate to some extent. We also know that this group (after entering the labour market in their first job) goes through more labour market transitions than do other groups. Therefore, withdrawing them from the survey will affect not only the inflow mobility rate, but will also underestimate the outflow mobility rate.

  It can be seen that high inflow mobility rates are often combined with high outflow mobility rates. Sectors with a high mobility profile include "business services", "R&D" and "education institutes". In Belgium, a low mobility profile is shown by "manufacturing", "utilities and construction", "transport", "financial services" and "public administration".

- Nås *et al.* (1998) have published comparable data – based on administrative data – on the delivering and receiving sectors of highly educated personnel in three Scandinavian countries, Norway, Sweden and Finland. We try to extend this international comparison on intersectoral flows with the Belgian data.

- Some differences between the Belgian and Scandinavian data need to be highlighted: *i)* the Belgian definition of mobility is based on change of employer, while the Scandinavian definition refers to change of establishment;[5] *ii)* the Belgian sample is limited to highly educated employees working in specified HRST occupations, while the Scandinavian data reflect the situation of all highly educated employees; *iii)* the definition of the "(higher) education institutes" and "public administration" sectors differs owing to the fact that we unable to distinguish higher education institutes from other education institutes; and *iv)* the analysis period differs slightly: the Belgian and Norwegian data refer to 1995-96, the Finnish and Swedish data to 1994-95.

Table 5 presents a comparison of the sectoral "mobility rates" for the four countries.

Table 5. **Inflow and outflow mobility rates, by sector and country**

	Mobility rate IN				Mobility rate OUT			
	Belgium	Sweden	Norway	Finland	Belgium	Sweden	Norway	Finland
1. Primary sectors/mining	16.9	19.7	16.1	17.1	25.0	20.8	19.9	13.1
2. Manufacturing	10.2	19.5	22.3	34.2	12.1	17.0	20.7	24.4
3. Utilities and construction	13.3	15.2	20.3	30.4	15.2	16.5	18.8	22.5
4. Trade, hotels, restaurants	17.1	23.1	27.8	28.0	18.7	23.7	26.5	21.9
5. Transport, storage, comm.	13.4	17.0	25.2	27.1	9.1	16.1	22.7	21.0
6. Financial services, real estate	11.9	14.3	15.4	31.6	12.6	15.2	16.0	34.5
7. Business services	22.5	21.9	26.8	27.8	23.6	19.3	23.2	21.2
8. R&D institutes	25.4	41.7	13.9	21.9	28.8	23.0	19.1	20.3
9. Education institutions	21.3	17.5	19.7	41.6	28.4	21.8	18.5	33.0
10. Public adm., health, social	12.3	14.6	15.7	28.4	13.3	15.0	16.7	25.6
11. Other public services	20.6	31.4	20.8	10.1	20.4	27.1	20.3	18.9
Total workforce	**15.5**	**17.0**	**18.4**	**28.5**	**17.4**	**16.7**	**18.5**	**24.7**

Source: KSZ, HRST data set (Steunpunt WAV); Nås *et al.* (1998).

At first sight, there are many differences in the mobility of highly educated HRST by country and by sector. The country most comparable to Belgium in terms of labour market mobility is Sweden. Both countries report the lowest mobility figures for “construction”, “transport”, “manufacturing”, “financial services” and “public administration”. Mobility seems to peak in “trade”, “R&D”, “business services”, “education institutes” and “other public services”.

The comparison between Belgium, on the one hand, and Norway and Finland, on the other, shows no clear common patterns. Norway has a similar total mobility rate, although the sectoral dispersion is completely different (for instance, “manufacturing” and “transport” are rather mobile sectors in Norway).

In Finland, there is not only a very different sectoral dispersion in the mobility rates of highly educated HRST, but also a much higher total share of employees changing establishments than in Belgium (as well as Sweden and Norway).

Conclusion

The share of university-level HRST that change employers seems to hover around the 20% mark when data for Belgium, Sweden, Norway and Finland are compared. However, the sectoral dispersion of these mobility rates is very different. This different sectoral dispersion could reflect the reality, but it is also possible that they are due to methodological differences. That is why efforts to improve these results are useful. It should be borne in mind that this is only a first exercise on the Belgian database. In addition, fine-tuning between the Belgian methodology, on the one hand, and the Scandinavian expertise on the analysis of mobility with administrative databases, on the other, may lead to better results.

This first exploration of Belgian data shows that the quality of the HRST database permits a wide range of interesting analyses to be carried out. The database contains information on the core target group described in the “Canberra Manual”. In addition, the whole of this group (with the exception of the youngest generation) is covered by the database. Furthermore, a large amount of information is

available on the labour market position at five subsequent observation periods for all of the individuals concerned.

We conclude with some results from these first tables. Mobility rises rapidly as the scope of the analysis is enlarged from an interval of one year to a period of four years. Between 1993-97, 20% of HRST personnel that were at least once on the Belgian labour market, changed employers. If we broaden the definition of mobility to include: *i)* all those who changed situation within the working population; and *ii)* those people who entered or left the working population, mobility over the four-year period rises to 40% for this group.

The mobility pattern of the population differs according to gender, age and occupation. If the definition of mobility is limited to change of employer, mobility is mainly experienced by men, youngsters and employees with an occupation in the "hard" sciences. When inflow and outflow around the working population are included in the definition of mobility, a higher number of transitions occurs in the female and older group.

Finally, information on intersectoral shifts of HRST produced some interesting findings. It is clear that intersectoral shifts are fairly substantial within the group of highly educated HRST. Those people who change employers are more likely to change sectors. In Belgium, "business services", "R&D" and "educational institutions" were shown to be mobile sectors, although, as was noted above, there does not appear to be any international pattern.

NOTES

1. These sampling restrictions and other "filters" have been used to reduce the costs of the data-linking.

2. *Rijksdienst voor Sociale Zekerheid* (RSZ) gathers information on almost all employees working in Belgium; *Rijksdienst voor Sociale Zekerheid van de Plaatselijke en Provinciale Overheden* (RSZPPO), holds supplementary information about local government employees; *Rijksinstituut voor de Sociale Verzekering der Zelfstandigen* (RSVZ) documents the self-employed living in Belgium; while *Rijksdienst voor Arbeidsvoorziening* (RVA) has information on all benefits paid through the unemployment system.

3. The sample includes not only those persons working in a specific number of (HRST) occupations, but also those who were not working. Only those people active in an occupation that is not in the HRST shortlist were eliminated. See below.

4. ISCO 211 (Physicists, chemists and related professionals); ISCO 212 (Mathematicians, statisticians and related professionals); ISCO 213 (Computing professionals); ISCO 214 (Architects, engineers and related professionals); ISCO 221 (Life science professionals); ISCO 222 (Health professionals, except nursing); ISCO 244 (Social science and related professionals); 311 (Physical and engineering science associate professionals); 312 (Computer associate professionals).

5. This indicates that mobility in Belgium is probably under-estimated. Enterprise-to-enterprise mobility is much lower than establishment-to-establishment mobility.

Chapter 11

LABOUR MARKET ENTRY AND MOBILITY OF YOUNG FRENCH PhDs

by

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Introduction

This chapter describes recent trends in young French PhDs' entry into the labour market against the background of the economic recovery which has taken place in France over the last few years. Despite the increase in the number of graduates, employment prospects remain good. However, successful entry of PhDs on the labour market depends both on their field and on the links built up between students and firms during the period spent writing their thesis. During the first years of activity, there is no mass exodus out of France and PhDs seldom remain abroad after their post-doctoral fellowships. Among PhDs, labour market entry conditions for men, in general, and for engineers, in particular, are better and wages are higher.

The job market for PhDs is changing

Most higher education streams are expanding, while the number of doctoral theses has stagnated

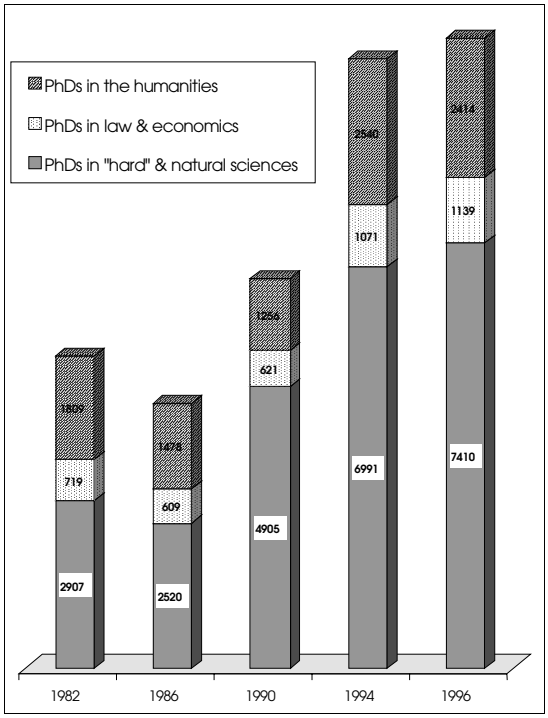
The number of French secondary-level students obtaining their *baccalauréat* has increased considerably since the early 1980s (The *baccalauréat*, or *Bac*, is a French upper secondary diploma similar to the *Abitur* in Germany or A-levels in United-Kingdom). In the most recent cohorts, the majority of young people leave school having attained *Bac*-level education. The French Government, in conjunction with firms and families, has encouraged this rise in secondary education levels. Virtually all students who obtain a *Bac* in general or technological studies now go on to higher education (HE). Along with increased enrolments in the first cycle of further studies have come an improved examination success rate and an increase in the average length of study. A larger percentage of graduates of IUTs ("University Institutes of Technology") and STSs ("Advanced Technician Sections") are going on to university. The development of studies at ISCED level 5 has led to a vast increase in the number of students enrolling in long education cycles. The number of graduates from

* This chapter draws on the results of one of the surveys included in the CEREQ Observatory on Entry into Working Life. The survey was conducted in 1999 and covers the three first years of professional lives of higher education graduates. Some 10 000 graduates were interviewed, including 2 000 PhDs. The Observatory is now organised around a central survey carried out every three years. The results of the ongoing survey will be available in early 2002.

short HE cycles (IUT and BTS) has doubled since 1980, while that of graduates from long HE cycles (universities, engineers and commercial schools) has quadrupled: in 1996, 287 000 students graduated from HE, compared with 110 000 in 1980.

The rise in the number of university graduates has been particularly sharp. Between 1984 and 1996, the number of students coming onto the labour market after completing long university studies more than tripled, from 38 000 to 120 000. The number of university graduates in the "hard" and natural sciences has grown steadily, especially in third cycle studies. In fact, in these areas of study there are more third-cycle graduates than there are students leaving after the second cycle. In recent years, however, the most rapid growth in university studies has taken place in the social sciences (law, economics) and the Humanities. For all fields of study combined, the number of third-cycle graduates has grown most significantly. The increase has been somewhat smaller in the case of state-approved business schools, engineering schools, IUTs and STSs, with outflows from each of these streams rising by a factor of 2.5 between 1984 and 1996.

Figure 1. **Number of theses submitted, by field of study**



Source: Ministry of National Education

While outflows from most HE fields have risen sharply, the number of doctoral theses has remained stable since 1994 (Figure 1). The number of science doctorates has continued to rise, but the number of theses in the Humanities has declined and now accounts for only 22% of all doctoral dissertations (compared to 32% in 1986). The stagnation in the number of theses has two main causes. First, the number of DEA (*Diplôme d'études approfondies* – Degree in Advanced Studies) graduates increased only marginally in the early 1990s, as the majority of Masters' degree holders switched to the DESS (*Diplôme d'études supérieures spécialisées* – Degree in Specialised Higher Studies) programme. Second, fewer DEA holders have been going on to write theses.

The number of theses is unlikely to change significantly over the medium term. The number of students beginning a dissertation has already receded as a result of the decline in post-DEA studies. In

contrast, the number of people abandoning their theses may fall due to increases in the financial assistance available.

Occupational trends are mixed

The managerial and intellectual professions have been attracting sharply rising numbers of graduates since the early 1980s. In particular, the numbers of teachers, engineers and business managers have risen considerably. In recent years, growth in private sector management jobs has mainly benefited the under-30s. In that age group, over the last twelve years, the number of computer engineers has tripled while the number of design engineers has doubled.

Recruitment of primary and secondary school teachers was massive until the mid-1990s, although the level has been declining slightly in recent years. In HE and public research, recruiting of young graduates was stable between 1996 and 1999. Doctoral students who graduated in 1996 have had to face relatively unfavourable job market conditions. However, their successors may be more lucky: owing to the age pyramid for teachers and researchers, large numbers of people will be reaching retirement age in the medium term. If public research budgets remain stable, recruitment of young PhDs could rise considerably.

Young PhDs are enjoying some of the benefits of the economic upswing

Labour market entry conditions remain favourable for PhDs

PhDs have derived some benefits from the French economic recovery. They continue to be more successful than other university graduates in entering the labour market (Table 1). Their salaries are significantly higher than those of holders of Master's degrees.

Table 1. **Labour market entry of PhDs compared to other HE graduates**

Training	Indicator							
	First job insecure		Unemployed for over six months before first job		Unemployment rate three years after completion of studies		Median salary[1] three years after completion of studies	
	1997	1999	1997	1999	1997	1999	1997	1999
PhDs in science	44%	54%	11%	17%	9%	7%	12 000	12 000
PhDs in Humanities/ social sciences	31%	30%	4%	13%	6%	6%	12 400	12 500
CIFRE	21%	22%	11%	13%	3%	5%	13 500	14 200
All PhDs	**40%**	**44%**	**10%**	**16%**	**8%**	**7%**	**12 000**	**12 300**
Engineering school	22%	17%	12%	16%	5%	2%	12 000	12 500
DEA-DESS	34%	38%	15%	17%	10%	8%	10 500	10 500
2nd cycle university	34%	41%	12%	19%	12%	11%	9 000	8 700
DUT-BTS	51%	47%	14%	20%	9%	11%	7 000	7 000
Total HE	**37%**	**39%**	**13%**	**19%**	**9%**	**9%**	**8 900**	**9 000**

1. Net monthly salary in current FRF, including bonuses.
Source: CÉREQ.

However, graduates of engineering schools and leading business schools are now finding first jobs more readily than PhDs. Graduates of the *Grandes Écoles* are reaping the full benefits of the upswing in private sector executive recruitment. On the other hand, PhDs, a majority of whom continue to seek work in the public sector, are suffering from that sector's recruitment standstill.

Increasingly, PhDs' first jobs tend to be post-doctoral fellowships or corporate-sponsored research contracts. In 1996, 54% of PhDs in science had fixed-term first jobs, compared with 44% in 1994. These temporary jobs ensure that the majority of PhDs are able to avoid beginning their careers with a period of unemployment. After the initial fixed-term jobs, the situation for PhDs improves significantly. After just three years in the labour market, only 7% are unemployed and their salaries are relatively high (averaging FRF 12 300 net per month in 1999, including bonuses). The salaries of PhDs who have written theses under the CIFRE (*Convention industrielle de formation par la recherche* – Industrial Agreement on Training through Research) were up on 1997, rising to FF 14 000.

PhDs are reaping the benefits of the upswing in private sector recruitment. The 1996 cohort were in a slightly more favourable position than those of 1994 after three years in work. In contrast, their first months in the labour market were more difficult. The outlook did not brighten until late 1997, after a fairly bleak year in 1996. The unemployment rate is high for PhDs at the beginning of their careers (15% to 19% in early 1997), but drops rapidly thereafter.

Sharp disparities in labour market entry

Among scientific PhDs, those with degrees in the applied sciences (mechanical and electrical engineering, information technology, etc.) and engineering find work most readily. They find jobs quickly, and their unemployment rates three years out of school are quite low. PhDs in the "hard" sciences (such as mathematics or physics) also do well, although their jobless rates are higher at the beginning of their careers (Table 2).

Table 2. **Labour market entry in 1999 of PhDs graduating in 1996, by field of study**

Field	Indicators									
	Fixed-term first job	Fixed-term job in 1999	Months of unempl. before first job	+6 months unempl. over three years	Unempl. rate in 1999	% of managers in 1999	Net pay[1] in 1999 (1st quartile)	Net pay[1] in 1999 median (FRF/ month)	Net pay[1] in 1999 (3rd quartile)	Number
Mathematics, physics	45%	20%	3.7	27%	6%	93%	11 000	12 000	14 300	1 080
Mech. & elect. engineering, IT	44%	19%	2.1	19%	3%	94%	11 000	12 000	15 000	1 113
Chemistry	63%	29%	4.6	39%	15%	90%	10 390	12 000	14 500	772
Natural and life sciences	62%	39%	2.9	23%	8%	92%	10 300	12 000	13 700	1 915
Total "hard" and natural sciences	54%	28%	3.2	25%	7%	93%	10 800	12 000	14 000	4 880
Law, economics	27%	10%	2.4	21%	6%	95%	11 700	13 600	21 000	965
Humanities	32%	17%	2.3	16%	6%	86%	10 000	12 000	15 000	1 807
Total Humanities and social sciences	30%	14%	2.3	18%	6%	89%	10 500	12 500	16 000	2 772
CIFRE theses	22%	9%	2.8	18%	5%	96%	12 000	14 200	16 000	417
All PhDs	**44%**	**23%**	**2.9**	**22%**	**7%**	**92%**	**10 974**	**12 300**	**15 000**	**8 069**

1. Net monthly salary in current FRF, including bonuses.
Source: CÉREQ.

In contrast, PhDs in chemistry have a rather hard time breaking into the labour market. They have difficulty getting a first job and endure relatively long periods of unemployment early on in their careers. In 1999, some 15% of this group were still without work. Of those who did have jobs, 30%

had fixed-term contracts. Their salaries were about average, however (FRF 12 000). A majority of PhDs in chemistry work in the private sector, the economic difficulties of which probably explain why they do not do better at finding jobs.

The situation is more favourable for PhDs in the natural and life sciences. They find work more quickly than PhDs in chemistry, and the majority escape unemployment. However, many have fixed-term jobs, even after three years of work experience.

Holders of doctorates in law or economics find work quickly and obtain private-sector managerial jobs more readily than was the case in the past. They earn the highest salaries for those leaving higher education, on a par with those of CIFRE PhDs (FRF 14 000 net per month in March 1999). After three years of work, more than 90% of PhDs in law or economics have found work on indefinite-term contracts.

PhDs in the Humanities do not experience major difficulties in breaking into the labour market, although 14% fail to attain managerial or professional status (*e.g.* as an engineer, private-sector manager, researcher or educator with tenure). After completing theses in the Humanities, some PhDs traditionally take on primary or secondary-school teaching jobs. The decline in teacher recruitment at this level probably served to trigger the growth in intermediate occupations for PhDs in the Humanities.

Looking more closely at career paths, it can be seen that two-thirds of PhDs do not experience joblessness during the first three years of their careers (Table 3). Those with doctorates in the Humanities and social sciences, along with CIFRE PhDs, are especially well protected from unemployment. PhDs in the "hard" and natural sciences are less well protected. In particular, PhDs in chemistry experience fairly lengthy spells of unemployment, 40% had sought work for more than six months over the course of the period under study. In contrast, the ease of entry into employment for PhDs in the applied sciences is being confirmed, since the average length of their job search is particularly short. These PhDs are fairly mobile, two-thirds of them having held two or more jobs in the first three years of their careers (Table 4).

A majority of PhDs start out in the public sector

Although recruitment has picked up in the private sector, only 40% of PhDs in the most recently surveyed cohort found jobs there (although the proportion of PhDs entering the private sector has increased by five percentage points in the past two years). PhDs in the Humanities and social sciences, who rarely took up private sector employment in the past, are now beginning to move into that area, although this applies mostly to those with degrees in law or economics.

In 1999, PhDs from the 1996 cohort were more likely than their predecessors to take jobs in public sector research, primary or secondary education and computer engineering. In contrast, fewer took up employment in higher education. Positions in public sector research and HE still account for half of the first jobs held by PhDs.

Table 3. **Average period of unemployment for PhDs during the first three years of their careers**

Field	Unemployment					Average number of months	Number of PhDs
	No period of unempl. %	1-6 months %	7-12 months %	Over one year %	Total %		
Mathematics, physics	66	13	10	11	100	3.8	1 076
Mech. & elect. engineering, IT	69	20	6	5	100	2.1	1 109
Chemistry	54	22	12	12	100	4.6	772
Natural and life sciences	67	18	7	8	100	2.9	1 905
Total "hard" and natural sciences	65	18	8	9	100	3.2	4 862
Law, economics	82	5	7	6	100	2.2	962
Humanities	81	5	6	8	100	2.5	1 794
Total Humanities and social	82	5	6	7	100	2.4	2 756
CIFRE theses	75	12	5	8	100	2.8	415
All PhDs	**71**	**13**	**7**	**8**	**100**	**2.9**	**8 033**
Engineering school	50	34	11	4	100	2.8	17 795
DEA-DESS	57	26	9	8	100	3.4	39 410
2nd cycle university	64	16	8	11	100	3.8	64 971

Source: CÉREQ.

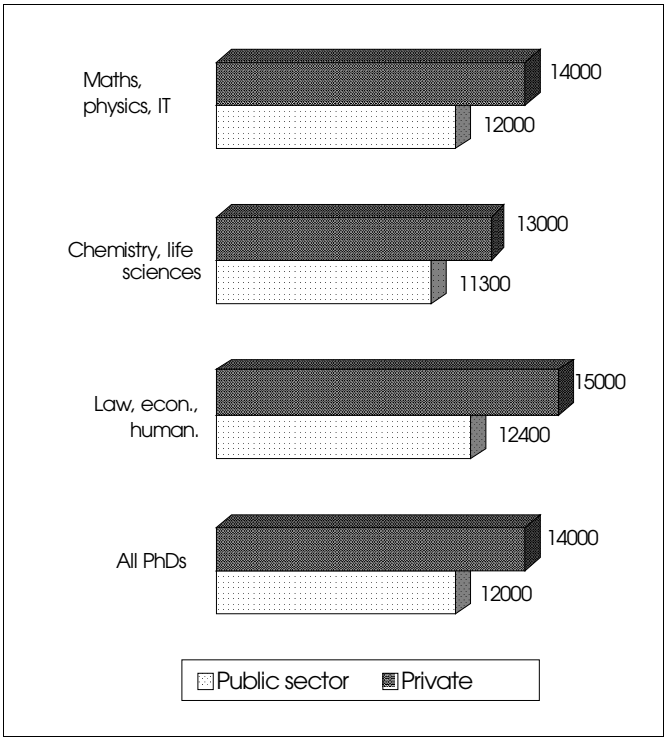
Table 4. **Number of jobs held by PhDs during the first three years of their careers**

Field	Number of jobs						Average number of jobs
	0 %	1 %	2 %	3 %	4 %	Total %	
Mathematics, physics	2	43	38	15	3	100	1.8
Mech. & elect. engineering, IT	2	30	45	16	7	100	2.0
Chemistry	2	39	40	17	3	100	1.8
Natural and life sciences	1	42	41	15	1	100	1.7
Total "hard" and natural sciences	1	39	41	15	3	100	1.8
Law, economics	1	43	37	17	3	100	1.8
Humanities	3	42	35	15	5	100	1.8
Total Humanities and social sciences	2	42	36	16	4	100	1.8
CIFRE theses	2	50	35	12	1	100	1.6
All PhDs	**2**	**41**	**39**	**15**	**3**	100	**1.8**
Engineering school	0	64	27	8	0	100	1.4
DEA-DESS	5	41	37	13	4	100	1.7
2nd cycle university	4	46	30	13	7	100	1.7

Source: CÉREQ.

While the majority of young PhDs work in the public sector, those who have jobs in the private sector enjoy significantly higher pay (in terms of median net monthly salary, including bonuses) (Figure 2). The premium for those working in business in many cases amounted to FRF 2 000 per month in 1999 – a differential that remains relatively constant, irrespective of the field. Private sector salaries are particularly attractive for those completing theses in law or economics, and can attain FRF 15 000 net per month. In all fields combined, PhDs working in the public sector earn approximately FRF 12 000, and those in the private sector FRF 14 000. The high salaries earned by CIFRE PhDs (FRF 14 300) reflect the fact that 80% work in business.

Figure 2. **Salary by field and sector**



The positions available after completion of a thesis obviously depend on the field of study. Doctorate holders in mathematics, physics, life sciences and the Humanities lead primarily to jobs in the public sector, while PhDs in mathematics and physics are split between HE and research. A majority of those with literary degrees become teachers, in some cases outside the higher education sector. A very large proportion (44%) of PhDs in the natural sciences take up jobs in public sector research.

Theses in the applied sciences (mechanical and electrical engineering, information technology), chemistry, law and economics are more oriented towards the private sector, where half of all PhDs find jobs (Table 5). Some 40% of PhDs in mechanical or electrical engineering and information technology become corporate engineers, half of them in IT. In the public sector, many PhDs become teachers. PhDs in chemistry take jobs as corporate research and development engineers or become public sector researchers. Those with doctorates in law or economics become administrative or business managers or engage in one of the professions in the private sector. In some cases, the take on HE or managerial jobs in the public sector. A large proportion of CIFRE PhDs become corporate engineers. Fewer than 20% enter the civil service (Table 6).

Table 5. **Percentage of PhDs working for enterprises three years after completion of their thesis**

Percentages

Field	1997	1999
Mathematics, physics	--	37
Mech. & elect. engineering, IT	--	47
Chemistry	--	57
Natural and life sciences	--	37
Total “hard” and natural sciences	--	42
Law, economics	--	47
Humanities	--	23
Total Humanities and social sciences	15	32
CIFRE theses	85	79
All PhDs	**35**	**40**

Source: CÉREQ.

Ninety per cent of the sectors in which PhDs work involve services. Those whose fields of study are geared most closely to private sector employment (applied sciences, chemistry, CIFRE) are sometimes recruited by industry. They also work in computer service companies or as engineers. PhDs in chemistry are recruited by chemical firms, pharmaceutical companies and related industries, although education remains the main employer of PhDs (except CIFRE PhDs).

Table 6. **Position occupied in 1999 by PhDs from the 1996 cohort**

Percentages

Profession	Field						
	Maths, physics	Mech. & elect. engin., IT	Chemistry	Life/Earth sciences	Law, economics	Humanities	CIFRE
Self-employed	1	0	1	0	0	1	1
Physician, other professionals	0	0	1	8	14	0	3
Civil service manager	1	3	1	1	10	2	3
HE teacher	29	30	17	16	38	43	10
Primary/secondary school teacher	11	5	3	3	3	15	1
Civil service researcher	24	15	26	44	2	15	8
News, arts, entertainment	0	0	1	0	0	7	1
Admin. or business manager	3	2	5	5	24	3	8
R&D engineer	19	19	27	14	3	1	46
Computer engineer	7	19	10	2	0	1	13
Other engineer	1	2	3	1	2	0	5
Intermediate occupation	3	4	7	6	2	12	3
Clerical, labourer	1	0	0	1	0	2	0
Total	100	100	100	100	100	100	100

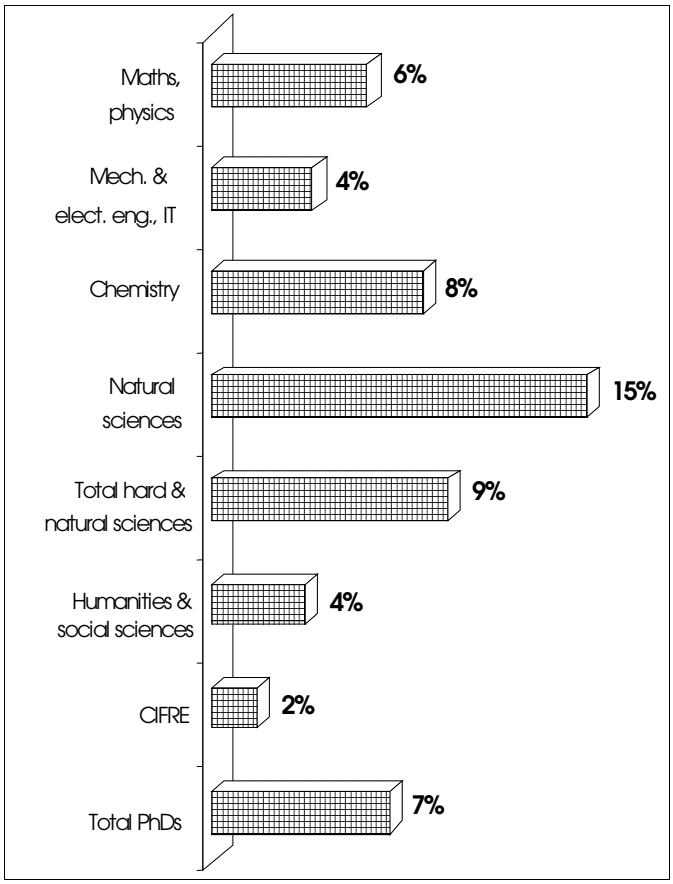
Source: CÉREQ.

PhDs in mathematics, physics, natural sciences and the Humanities are recruited by the research and education sectors. Those with doctorates in law or economics obtain jobs in market services (business, legal and accountancy consulting) or education. During their first three years of work, PhDs do not tend to set up their own businesses and the majority work as dependent employees. In terms of functions, PhDs' first jobs are similar to those they have three years out of school; only the degree of insecurity sets them apart from subsequent jobs.

PhDs seldom remain abroad after their post-doctoral fellowships

Post-doctoral fellowships are becoming more commonplace among PhDs in science, and such fellowships generally take place abroad (Figure 3). Nearly half of all PhDs in chemistry and the life sciences have held a fellowship after three years of work experience. In contrast, post-doctoral fellowships are rare for CIFRE PhDs and those who completed theses in the Humanities or social sciences.

Figure 3. **Percentage of PhDs living abroad after three years of work**



Note: 1996 cohort of PhDs surveyed in 1999.
Source: CÉREQ.

No mass exodus out of France

Despite the development of post-doctoral fellowships among PhDs in science, only a small percentage were living outside France after three years of work. In 1999, 7% of the 1996 cohort of

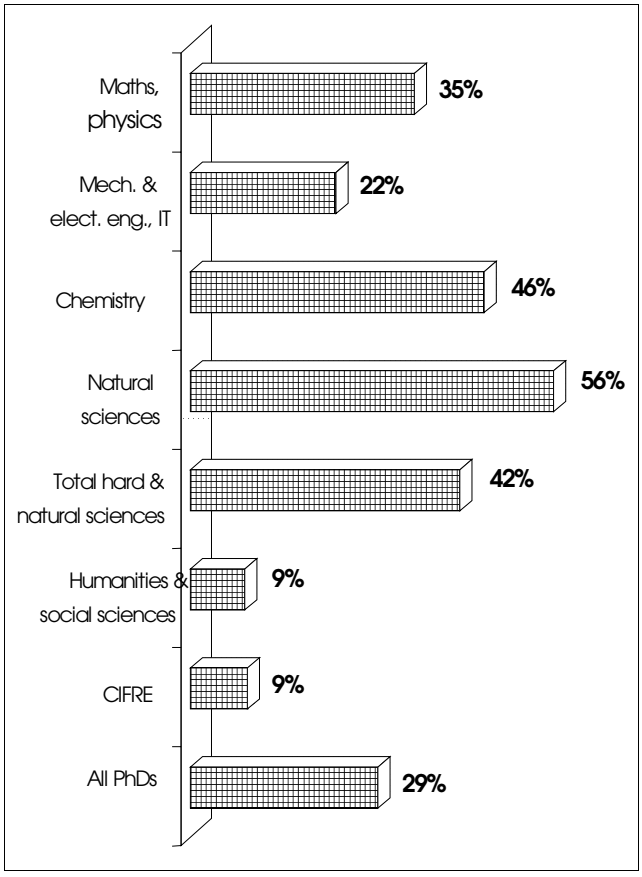
PhDs were abroad (18% of those who had held post-doctoral fellowships and 2% of those who had not). Of the PhDs living abroad in 1999, only 21% did not wish to return to France. Nearly 60% wanted to return as soon as possible or in a year's time.

The circumstances of French PhDs living abroad explain their desire to return home. While a majority of young PhDs working in France had indefinite-term jobs in 1999, 79% of those living abroad were employed on a fixed-term basis – in many cases, on post-doctoral fellowships with satisfactory pay (around FRF 12 500 net per month). A majority of expatriate PhDs will certainly return to France after their fellowships.

PhDs in fields where jobs are hard to come by are most likely to leave the country. Thus, 8% of PhDs in chemistry and 15% of those in the natural and life sciences were living abroad after three years of work. PhDs in the life sciences are probably attracted to North America by the boom in biotechnologies, a sector which is only just starting to develop in Europe.

A post-doctoral fellowship early in one's career makes it easier to obtain a research position

Figure 4. **Percentage of PhDs having completed a post-doctoral fellowship**



Source: CÉREQ.

Post-doctoral fellowships (postdocs) are becoming increasing popular, especially among those who have completed theses in the "hard" or natural sciences (Figure 4). In these fields, the proportion of postdocs rose from 31% to 42% in two years. Half of the PhDs in chemistry and the natural sciences held such a fellowship in the three years following their theses. In most cases, the jobs involved were fixed-term public sector research appointments outside France.

The impact of postdocs on labour market entry has changed in the past two years (Table 7). No longer do fellowships seem detrimental to one's career, in fact fellowships abroad appear to play an extremely useful role in facilitating entry into the civil service. After completing their theses, postdocs are able to find work more rapidly and their unemployment rate is lower three years into their careers. Postdocs are more likely to work in the civil service, which explains why their pay is not quite as high, although many subsequently move on to fixed-term jobs.

Table 7. **Labour market entry with and without a postdoc**

Field	Postdoc or not	Indicator					
		Fixed-term first job	Fixed-term job in 1999	Months of unemployment before first job	Unemployment rate in 1999	Share of private sector jobs	Median salary in 1999 (FRF)
Maths, physics, IT	Without postdoc	28%	10%	3.8	6%	51%	13 000
	Postdoc	89%	48%	1.3	4%	24%	12 000
	Total	46%	21%	3.1	5%	43%	12 500
Chemistry, life sciences	Without postdoc	43%	22%	5.2	14%	49%	12 000
	Postdoc	86%	55%	2.3	9%	34%	12 000
	Total	46%	40%	3.7	11%	41%	12 000
All PHDs	Without postdoc	33%	15%	3.7	8%	41%	12 500
	Postdoc	86%	51%	2.1	7%	31%	12 000
	Total	49%	25%	3.2	8%	38%	12 000

Note: 1996 cohort of PhDs surveyed in 1999.
Source: CÉREQ.

Postdocs have a positive impact on labour market entry, especially if they come at the very beginning of a person's career, in which case they significantly shorten the job search and do not seem to be detrimental to recruitment by business (Table 8). Postdocs very early in one's career often lead to stable jobs. Fellowships held later on have a more negative impact on labour market entry. However, the three-year timeframe of the survey does not afford the long-term perspective required to assess the outlook for PhDs after such fellowships.

Table 8. **Labour market entry by date of postdoc**

Postdoc	Indicator					
	Fixed-term first job	Fixed-term job in 1999	Months of unemployment before first job	Unemployment rate in 1999	Share of private sector jobs	Median salary in 1999 (FRF)
No postdoc	32%	15%	3.6	8%	41%	12 500
Postdoc before 1998	81%	22%	1.2	6%	37%	12 000
Later postdoc	93%	67%	2.7	9%	26%	11 500
All postdocs	**49%**	**25%**	**3.2**	**8%**	**38%**	**12 000**

Today, a postdoc seems to be almost a prerequisite for entering research after writing a thesis in the "hard" or natural sciences. After a fellowship, nearly half of all PhDs become researchers in public sector laboratories. The others teach in the higher education sector, although half of these jobs are fixed-term at the beginning of the person's career, especially in public sector research. PhDs in the "hard" and natural sciences who have not held post-doctoral fellowships tend to get corporate engineering jobs or become teachers. The majority had indefinite-term jobs in 1999.

The advantages of preparing a thesis while being employed in business

PhDs who were employed by a firm while writing their theses earn higher salaries

CIFRE theses are the prime example of doctoral dissertations prepared for a business enterprise. Most (89%) of the PhDs who benefited from a CIFRE agreement worked for a firm while writing their thesis, and 50% of CIFRE PhDs even prepared the bulk of their theses while so employed. As a result, their career paths differ from those of other PhDs (Table 9). Three years after completing their theses, almost 80% of CIFRE PhDs work for business firms, compared to only half that figure for other PhDs. For any given field, salaries are higher in the business world. The salary differential exceeds FRF 2 000 per month, depending on whether the PhD works in the public or private sector three years after his thesis. CIFRE PhDs are more likely to work in the private sector, and their median remuneration is substantially higher than that of other PhDs (FRF 14 200 *vs.* FF 12 000, in March 1999). In addition, the jobs held by CIFRE PhDs are significantly more stable.

Table 9. **Labour market entry and employment by PhDs employed in business enterprises while writing their theses**

Employment during thesis		Indicator					
		Fixed-term first job	Fixed-term job in 1999	Months of unemployment before first job	Unemployment rate in 1999	Share of private sector jobs	Median salary in 1999 (FRF)
Maths, physics, IT	Enterprise	22%	6%	1.7	3%	66%	14 700
	Non-enterprise	51%	24%	3.4	6%	38%	12 000
	Total	46%	21%	3.1	5%	43%	12 500
Chemistry, life sciences	Enterprise	48%	31%	4.1	7%	46%	13 000
	Non-enterprise	68%	40%	3.7	12%	40%	12 000
	Total	66%	39%	3.7	12%	41%	12 000
Law, economics, Humanities	Enterprise	44%	22%	1.9	3%	55%	15 000
	Non-enterprise	37%	17%	2.9	7%	19%	12 000
	Total	38%	18%	2.8	7%	22%	12 000
CIFRE	Total	21%	10%	2.7	6%	79%	14 200
All PHDs	Enterprise	31%	14%	2.5	5%	64%	14 200
	Non-enterprise	52%	28%	3.3	9%	32%	12 000
	Total	49%	25%	3.2	8%	38%	12 000

Among non-CIFRE PhDs, those who have worked for business enterprises tend to do better. Like CIFRE PhDs, those PhDs who worked for a company while writing their theses earn higher salaries, and their jobs are more stable. They are more likely to work in the private sector. PhDs in chemistry and in the life sciences sometimes encounter difficulties, although if they have written a portion of their thesis while working for a business enterprise, they too are better off.

If a business enterprise is the primary location for the preparation of a doctoral thesis, the impact on labour market entry is even greater. In this case, net salaries rose to FRF 15 000 per month in 1999, and a large majority of the PhDs concerned obtained jobs in the private sector. Overall, PhDs who have done the bulk of their theses at university do least well in finding work. Only one-third go on to work in business. PhDs coming from a research institute do somewhat better, despite the insecurity of their initial jobs. PhDs who have written theses at engineering schools are better off, but their situation is not as good as that of PhDs who write their theses while with a business enterprise.

PhDs whose theses are exclusively "academic" have a harder time finding work

Former recipients of research stipends, whose careers are generally oriented more towards the public sector, can in some cases have trouble finding work. Their first jobs tend to be temporary, and they run an above-average risk of unemployment. Their median salaries are lower than those of other PhDs, with many of them being employed in the public sector. Former recipients of research stipends have trouble getting jobs irrespective of the field of their thesis. However, PhDs who have written theses in chemistry or life sciences have problems even if their thesis are applied, due to a lack of job opportunities in the private sector.

PhDs who have been graduate assistants are better off. The teacher training that they receive while writing their dissertations makes it easier to break into higher education and get a job more quickly. Half of all former graduate assistants were teaching at universities three years after their theses, compared with only a quarter of those who had not been assistants. Such appointments are particularly advantageous in finding work if there is a shortage of job opportunities in the private sector (as is the case for chemistry and life science majors).

Development of occupational counselling and orientation sessions

As labour market entry difficulties began to emerge, occupational counselling and orientation sessions were integrated into doctoral programmes. These sessions were subsequently organised in a more formal, structured manner as "Doctoriales". "Doctoriales" were not yet in existence when the 1996 cohort received their degrees, although some had attended occupational counselling and orientation sessions (this term covers all activities organised by doctoral programme officials to assist PhD candidates with their job search and career planning).

Only 15% of PhDs in the 1996 cohort attended such counselling sessions. This is not surprising since the "Doctoriales" did not exist at the time. PhDs who attended the initial occupational counselling and orientation sessions are more likely to be working in business enterprises. In most cases, it was more difficult for them to find work than for others. Their periods of unemployment were longer, and it was harder for them to get their first jobs. These PhDs are less likely to hold managerial positions, and their jobs are more likely to be insecure; their unemployment rate in March 1997 was above average.

It is difficult to gauge the impact of occupational counselling and orientation sessions on the labour market entry of the 1996 cohort of PhDs. Those who did attend them probably had special characteristics. Perhaps they had less chance of breaking into the public sector in a context in which some instructors found such counselling and orientation sessions hard to accept.

Among PhDs, men and particularly engineers do better breaking into the labour market

Even at the highest levels, differentials in labour market entry persist between men and women. Among PhDs, men find work more quickly, are less affected by unemployment and their jobs are less insecure. Their salaries are higher than those of women (at FRF 13 000 compared to FFF 12 000, in median net monthly salary in 1999, including bonuses). These differentials can be seen in all fields of study. They are somewhat lesser for PhDs in mathematics, physics and information technology, where job entry is generally more easy.

Nevertheless, women occupy essentially the same jobs as men. They are a little less likely to have corporate engineering positions (24% of male PhDs had such jobs in 1999, compared with 17% of women).

Pre-dissertation training, and especially the fact that one holds an engineering degree, has an impact on labour market entry. PhD engineers do better than others. They are seldom affected by unemployment or job insecurity, regardless of their field. Their salaries are significantly above average, their profile being especially prized by business enterprises. CIFRE PhD-engineers do remarkably well in their first jobs, earning salaries of around FRF 15 000 in 1999. But other PhD engineers are also able to negotiate favourable initial employment terms. After completing theses in chemistry or the life sciences, they scarcely have any problem finding jobs, whereas other PhDs face greater insecurity.

PhD engineers are more likely than other PhDs to obtain jobs as corporate engineers (44% of them occupy such positions). They are also more likely to work in a public sector laboratory, especially if their theses were in chemistry or the life sciences. On the other hand, it is fairly rare for PhD engineers to go into teaching.

Conclusions

Young PhDs are reaping some of the benefits of economic recovery; labour market entry is relatively favourable for PhD holders. However, sharp disparities can be seen in labour market entry rates, depending on the field of study: thesis holders in chemistry or the life sciences find it less easy to find a job than holders of theses in mathematics, physics and information technology.

Although employment in the private sector is on the rise, a majority of PhDs continue to start out in the public sector. PhDs who worked for a business enterprise while writing their theses earn higher salaries because they are more likely to find jobs in the private sector. PhDs whose theses are exclusively “academic” have a harder time finding work.

PhDs seldom remain abroad after their post-doctoral fellowships; only 7% still live abroad three years after their thesis and the majority will return at the end of their post-doctoral fellowship.

A post-doctoral fellowship early in one’s career makes it easier to obtain a research position, specially for PhDs in the life sciences; the public laboratories need post-doctoral fellowship to recruit PhDs.

Among PhDs, men and engineers are better able to break into the labour market. Fields in which women prevail (chemistry and life sciences) are less appreciated on the labour market than are men’s fields (mathematics, physics and information technology).

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Chapter 12

MOBILITY OF HUMAN RESOURCES IN HUNGARY: AN ANALYSIS AND A PROPOSAL FOR REGULAR COLLECTION OF STATISTICS

by

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Introduction

Although the human resource factor is often referred to in studies on innovation, due to the lack of availability of data the discussion usually goes little beyond general statements about its importance. This chapter presents initial results based on the Hungarian Labour Force Survey (LFS), as an introduction to a discussion of possible ways of collecting statistical data on the mobility of the human resources devoted to science and technology (HRST) in Hungary. First, we review the conceptual background and present the key results of our 1998 pilot study, before going on to propose possible methods for measuring HRST. Finally, the advantages and disadvantages of the proposed methods are summarised in the Annex tables.

Concepts and current state of researches

The study of human mobility from basic statistics is never an easy task. In Hungary, human resource statistics of science and technology development are far from complete; unlike the Nordic countries, Hungary does not collect register data. The Hungarian Central Statistical Office (CSO) collects statistical data on the number of employees with high qualifications, on their sectoral, professional and other structural characteristics, but contains only limited information on changes of workplace and migration. However, mobility of highly qualified workers – not only between but also within companies and institutions (including changes in positions and individual career paths) – is an important catalyst for research and technical development; it is thus reasonable to aim at measurability by statistical methods. The NIS Focus Group on Human Mobility was initiated by the OECD with two aims: *i)* to map how the various OECD countries measure knowledge and the flows of knowledge which are so important for innovation; and *ii)* to obtain statistical measurements which would be comparable across countries.

The internationally recommended measurement methods – including the definition of mobility of human resources – are provided in the so-called "Canberra Manual", compiled by the OECD and Eurostat (1995). According to the Manual, both those people with higher education whose qualifications are considered to be important from the aspect of technical development and those who

work in this field despite having a different educational background, should be considered as the target group for research on the human resource aspects of science and technology development. Statistical analysis of workers with high qualifications is a relatively new topic, not only in Hungary but also in many other countries, and the research projects launched so far have only been able to examine parts of the field.

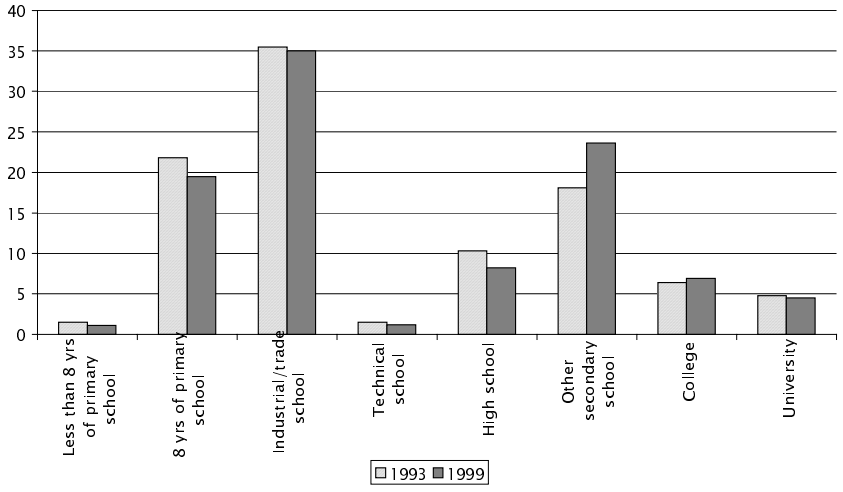
Using the LFS database to measure labour mobility in Hungary

When the EU-harmonised quarterly surveys of the labour force were first launched in Hungary, the main objective was to study the economic activity of households. Thus, mobility was not, and is still not, the focus of these surveys. In 1992, however, a number of amendments were made in the survey structure in line with international recommendations. Accordingly, we can now analyse to what extent the LFS databases are suitable for studying mobility in Hungary. For this study, we have followed the methodological recommendations of the OECD, paying special attention to the study by Mikael Åkerblom on mobility of the highly qualified labour force (Åkerblom, 1999). The findings are presented below.

In 1993-99, employment in Hungary shifted in favour of the young, with an increase in the share of 20-29 year olds entering the labour market. On the supply side, this rise in the most qualified and flexible manpower is a good sign. Nonetheless, the fall in the number of employees in the youngest age bracket indicates that the younger generation increasingly prefers to remain in training and further education. At the same time, expectations for older employees have deteriorated significantly.

In terms of labour force *inflow* by qualification, most of those entering the labour market had completed industrial/trade school and, by 1999, the second largest group comprised those with a specialised secondary qualification ("other secondary school" in Figure 1 below). Thus, a substantial change in employment patterns is currently taking place: the low skilled – regardless of whether or not they have completed primary or secondary education (final examination at a high school) – are increasingly unable to find jobs. In 1993-99, the share of highly qualified employees remained stable among those entering the labour market; this trend contrasts with that experienced in developed economies in the same period.

Figure 1. **Distribution of those entering the labour market**
By highest qualification, percentages

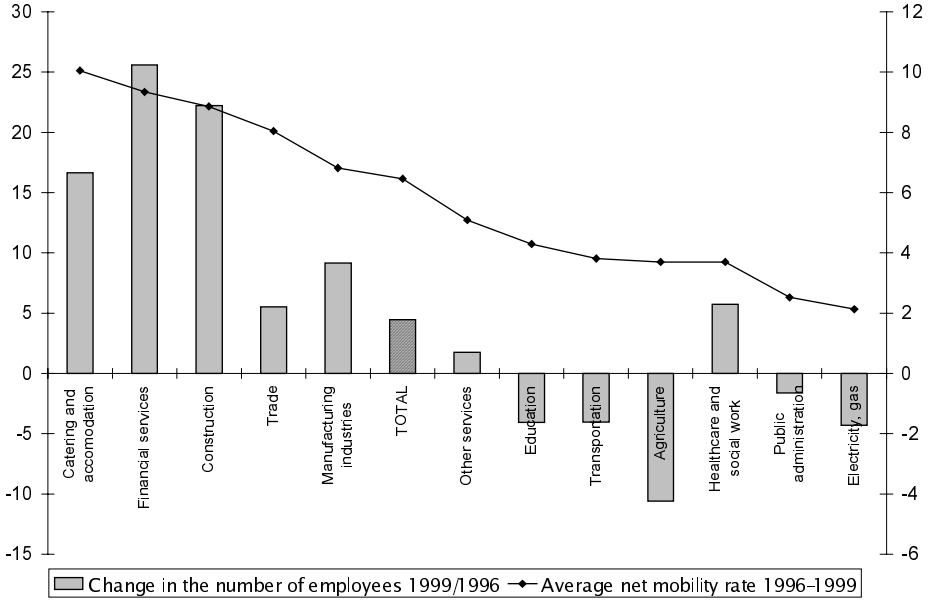


In 1993-99, important sectoral changes took place, the results of which can be seen in the labour force *outflow* figures. The share of employees leaving the labour market decreased in manufacturing and agriculture, but rose sharply in the public sector. There were two main reasons for this: *i)* public administration employees were laid off in an effort to achieve cost-savings; and *ii)* wages in the public sector lag far behind those in the private (business) sector.

The share of those changing their place of work was high in industries where employment was on the rise. One possible reason for this is that the most mobile labour force – the young and skilled – is seeking jobs in the developing industries; these industries also offer greater opportunities for trying out several workplaces. In industries where employment has fallen (education, transport, agriculture, public administration), mobility tends to be fairly low. Low mobility is obviously a drawback with respect to innovative capacities – knowledge flows – since it signals that shrinking sectors also lag behind in terms of human resources, leading to further disadvantages.

Figure 2. **Change in the number of employees and the net mobility rate**

Percentages

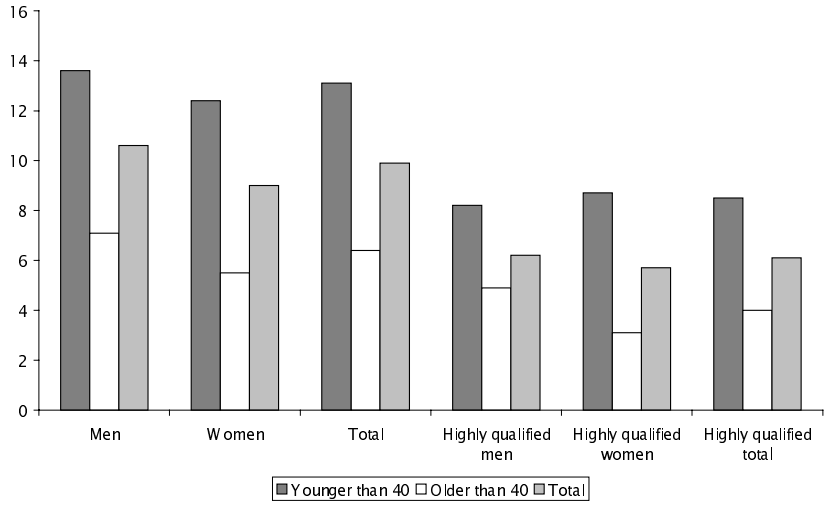


The 1998 database was used to examine the suitability of the LFS for constructing internationally comparable mobility rates. It was concluded that both the "broad" and "narrow" – or "gross" and "net" as termed in the literature – interpretations of the mobility rate could be computed. Broad mobility rates are expressed as the total inflows and outflows for the total number of employees, while narrow rates show the ratio of "job-changers" only (as a percentage of total employees).

In 1998, 10% of employees changed their place of work; this share is approximately in line with the narrow rates of the EU countries. The share for highly qualified workers, at 6.1%, is also similar to that in the developed countries.

Figure 3. **Mobility rates of employee total and the highly qualified, 1998**

Percentages



The breakdown by gender – a basic distinction in international practice – is also available. The figures show that men are more mobile than women, both in the sample and among employees with higher education degrees. The Hungarian figures correspond to known international patterns in other respects as well: the younger generation is more mobile, with no significant variations between genders, while among the older generation, men are more mobile than women. In both age brackets, the highly qualified are less mobile than the unskilled.

In the ICT (high-technology) industry, mobility of the older (more experienced) generation is higher than in other industries, which may mean that the outflow of "knowledge" via mobility is more intensive in this sector. Differences in the inflows and outflows of highly qualified workers reflect the attractiveness and perspectives of a given industry.

Figure 4. **Mobility rates of employee total and the highly qualified labour force, 1998**

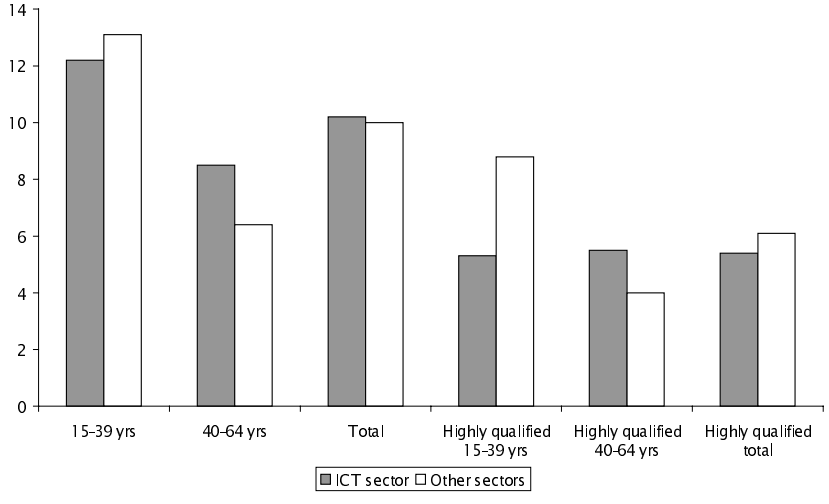
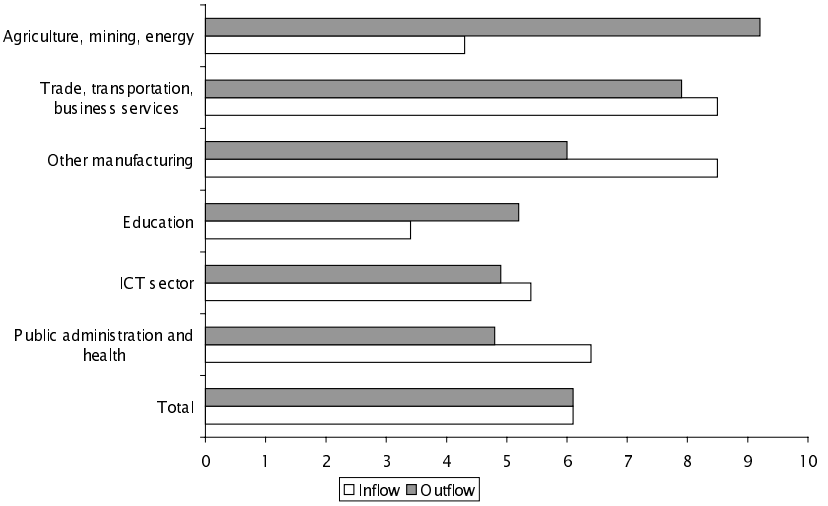


Figure 5. **Rates of inflow and outflow for the highly qualified, 1998**



The higher the rate of outflow, the lower the attractiveness of an industry; higher inflows reflect greater opportunities for the highly qualified. In 1998, education and agriculture had the lowest rates of inflow, while manufacturing and some service sectors (business services – real estate and financial services) had the highest inflow. Agriculture was not attractive to job-starters and experienced a substantial outflow. A similar situation prevails in education, while high rates of both inflow and outflow in services highlight the dynamic changes taking place in this very fast-growing sector.

The share of highly qualified workers reflects knowledge intensity and its growing economic importance; the LFS therefore enables us to track the weight and dynamics of employment among this segment of the labour force.

Figure 6. **Share of employees with higher education degrees, by branch**

Percentages

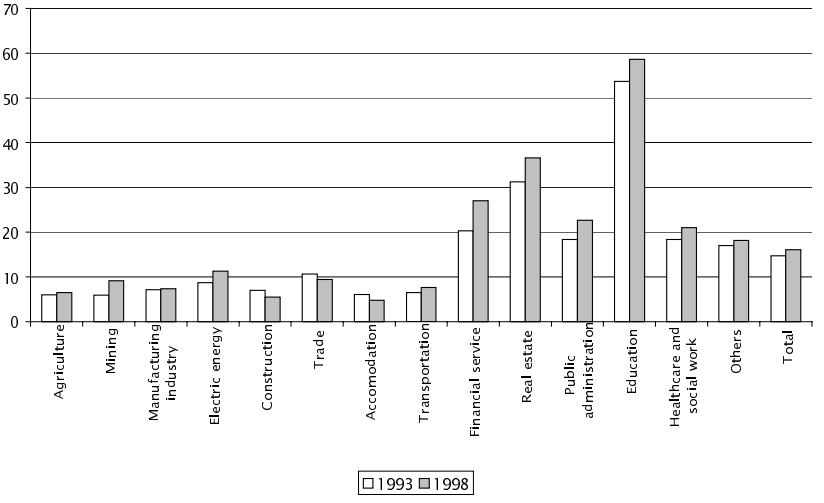
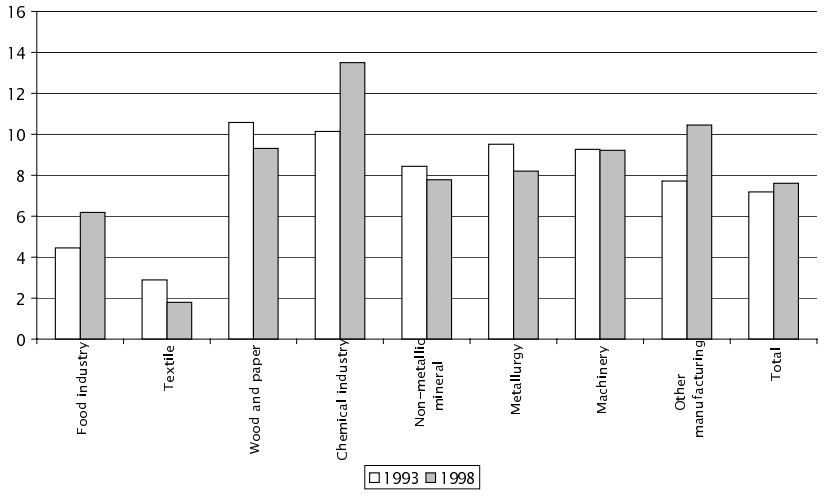


Figure 7. **Share of employees with higher education degrees in manufacturing**

Percentages



In the production sectors and some services (trade, catering and accommodation, transport), the share of employees with higher education degrees is low (10% and less). The public administration and healthcare sectors are more knowledge-intensive, with a share of between 20% and 30%; the business service sector boasts between 30% and 40%. The qualifications of employees in education are outstanding: more than half of those employed in this sector have a higher education degree.

Among the manufacturing industries, the chemical industry leads in terms of the share of employees with higher education degrees, although the food industry has caught up in recent years. However, in engineering – the sector with the highest performance in terms of output, productivity and exports – the share of highly qualified workers remains low at under 10%. These figures also refer to the R&D activity of the respective sectors.

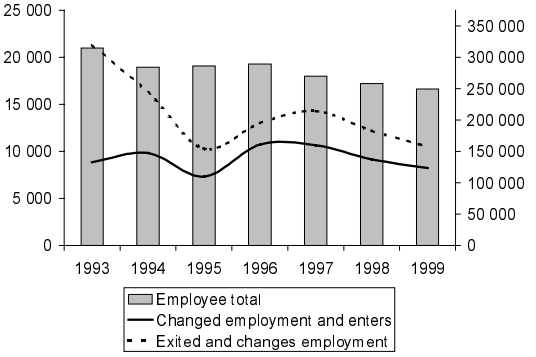
The figures shown below were constructed from the Labour Force Surveys of the Central Statistical Office of Hungary in 2001. Our experimental analysis enabled us to show sectoral differences between the broad and narrow (gross and net) mobility rates of employees. Due to the shortcomings of representativity, however, more detailed analysis using the current methodology of the CSO was not possible. Misleading results would be obtained if, for example, the engineering industry was broken down into its sub-branches and employment categories, although this is clearly a very exciting field for future analysis.

The overall net mobility rate in the 1990s was not high in Hungary, with substantial differences across sectors. The major structural changes which took place in the Hungarian economy explain some of these differences: manufacturing – especially engineering– gained momentum as a result of foreign direct investment and the activities of multinational firms. The most substantial depression took place in agriculture, which has a low mobility rate (4%-5%). Structural changes are still underway in the engineering industry: the broad (or gross) rate of inflows and outflows stabilised at a high of 15% and 10% respectively; more young employees are being attracted to this sector today than was the case in the past.

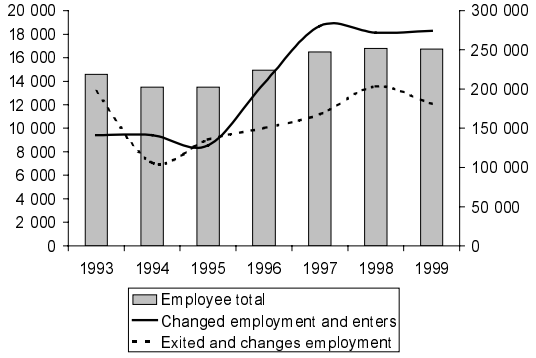
Figure 8. **Number of employees and "job-changers"**

Manufacturing industry

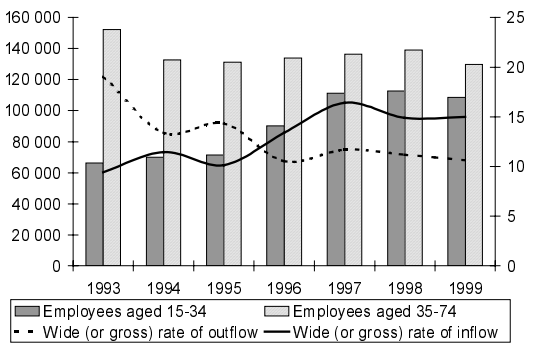
Agriculture



Engineering industry I



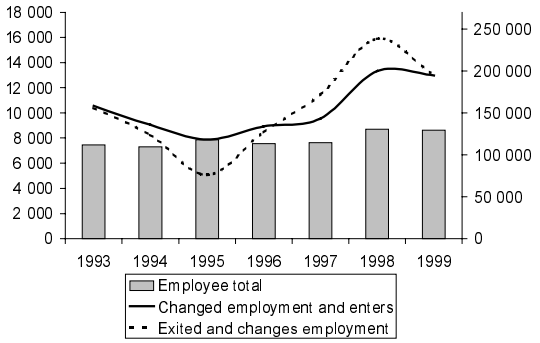
Engineering industry II



Interesting changes are also taking place in some service sectors. In catering and accommodation, the number of employees remained stable. However, as the number of market actors – *i.e.* firms – is rising, mobility has picked up since 1996. In the state-owned, or government-dominated, service sectors – public administration, education, healthcare – outflow is higher than inflow. Nonetheless, the narrow (or net) mobility rate is low due to the fact that these branches comprise many large organisations (especially in healthcare), and intersectoral mobility of teachers and medical professionals is poor. This is the case even though wages in these sectors remain below those in the competitive sphere.

Figure 8. **Number of employees and "job-changers"** *(cont'd.)*

Catering and accommodation



Education

Healthcare

In summary, in order to study human mobility – which is an important factor in explaining the restructuring and innovation processes – there is clearly a need for more detailed statistics. If two- or three-digit sectoral data were available (NACE or SITC) by profession (ISCO) and education/skills (ISCED), very interesting research projects could be undertaken despite the relatively short time series available. To achieve this, the current practice and methodology of Labour Force Surveys need to be revised and developed.

How to generate the HRST database in Hungary?

In principle, the human resources devoted to science and technology (HRST) database should include the highly qualified. Sources of relevant information available in Hungary are the CSO censuses and micro-censuses which contain comprehensive data regarding education, orientation of graduate study and occupation. Censuses are held every ten years. In contrast with some European countries, the other possible registers (social insurance register, tax register, population register) do not contain complex information relevant to this subject of research and thus cannot be considered as a possible frame for sampling (in any event, current Hungarian regulations would not allow their

utilisation). Only the census can provide the basis for the continuous sampling of individuals and households.

In view of the above, we investigated three different implementation methods for developing the Hungarian HRST database:

1. Organising a *panel* from a representative sample of highly educated workers based on census data on the population with appropriate qualifications or occupation.

2. Supplementing the questionnaire of the *Labour Force Circulation* surveys.

3. *Supplementary data collection* of persons with higher education degrees in conjunction with the Labour Force Survey (LFS).

Data collection from a panel of people with higher education degrees

The census enables the compilation of a comprehensive database from which an appropriate sample may be selected and basic information gathered. However, time series could only be generated in one of the following two cases. An extended questionnaire containing questions on the various stages of the individual's career could be added to the census questionnaire. Accordingly, data could be analysed a couple of years after the first questionnaire – which would have to be filled in annually by the same sample population.

Experts say that the questionnaire respondents would not have difficulties in relating their position and workplace changes over the previous ten years of their careers, since in international comparison Hungarians do not change their workplace or position very frequently. The survey should involve at least 10 000 people, representing 1.7% of the total population with higher education degrees. A final decision on the size of the sample, however, would only be possible after tests.

A major drawback to this solution is its high cost: data collection from panels tends to be very expensive. The sample has to be relatively large since a certain number of people are expected to drop out from one year to another. Complicated, time-consuming questionnaires require trained interviewers, which increases the wages to be paid to the interviewers. More importantly, the selection and maintenance of the sample, and the constant development of methods for reconstructing the sample according to the original population properties, increase costs considerably. Furthermore, processing by individual programmes or organisational procedures is more costly than in the case of a simple survey or continuous population survey.

On the other hand, large amounts of data are collected during the census, and this is one of the great advantages of this method. A relatively short supplementary questionnaire would therefore be sufficient, and is more likely to be filled in by the people interviewed. Another advantage is that it is possible to include in the sample those people who were most co-operative during the census, especially during the first interviews.

Supplementing the questionnaire of the Labour Force Circulation surveys

Until 1993, the Central Statistical Office collected data on Labour Force Circulation (LFC) from the institutional labour statistics. Since the late 1980s, however, organisational changes – liquidations, start-ups – have become so frequent that this method can no longer be applied. The reason for the

introduction of a supplementary survey on Labour Force Circulation in the first quarters since 1994 – in conjunction with the Labour Force Survey (LFS) data collection introduced in 1992 – was to make up for this deficiency. Through interviews, the Central Statistical Office collects data on those who quit their employment, liquidated their private enterprise, entered new employment or started a private enterprise during the previous year.

From the basic sample of the LFS, those who have changed employment constitute the sample for the Labour Force Circulation survey; sample sizes of the Labour Force Circulation supplementary surveys ranged from 4 200 to 7 200 between 1994-2000. The sample covered 327 people with higher education degrees. This sample is too small to enable the collection of reliable information on the mobility of people with higher education – only a new survey can provide sufficient data to allow the more subtle characteristics of the mobility of the highly educated to be analysed.

Supplementary questions in the Labour Force Survey

The Labour Force Survey is the largest continuous statistical survey of households in Hungary. The core questionnaire does not include questions on mobility. The related supplementary survey would gather information on the career paths of the highly qualified workers included in the sample and on the motives underlying any change in employment.

The supplementary questionnaires could be distributed together with the core questionnaires – a main advantage of this method. As a consequence, collecting basic information on the selected people or households and on the general characteristics of the labour market would not burden the supplementary survey. Furthermore, the sample of highly educated people belonging to HRST could provide retrospective information on changes in employment and other parameters (sector, position, etc.).

The address register of the Labour Force Survey consists of 12 775 districts of the census performed in 1990, including 751 settlements and 626 000 addresses. Due to its size (approximately 10% of the registered addresses), the sample is representative at regional level (NUTS2) as well.

The current sample of the LFS would enable some 6 000 people with higher education degrees to be interviewed. The LFS contains sufficient data on education to allow groupings according to both the Hungarian classification and the ISCED'97 international categorisation. The occupations of people aged 15-74 are coded on the basis of a detailed description. A three-digit classification of occupation, corresponding to the ISCO'88(COM) international classification system, was introduced in 2000. As of 2001, the Hungarian system will be enlarged to four digits to bring it in line with EU regulations.

Any drawbacks caused by the rotational character of the survey could be eliminated by the introduction of characteristics: 1/6 of the 6 000 people – *i.e.* 1 000 people – would remain in the sample for one and a half years due to the rotating method mentioned above.

In the panel survey, interviewees would answer questions relating to:

- Qualifications and skills.
- Changes in employment.
- Reasons for changing employment:
  - Motives of choosing the new employment.

– Changes in the activities performed at work.

The panel survey would enable researchers to obtain information relating not only to the year in question but also to the professional careers of the respondents, thus facilitating analysis of the direction of knowledge flows over a longer time period.

This method is more cost-efficient than those described above, with only the fees for interviewers and handling of the database calling for additional expense.

Summary: advantages and disadvantages of the proposed survey methods

Although the use of a separate panel (method 1) of people with higher education degrees would enable in-depth analysis of mobility of the workforce linked with innovation, the discontinuity of regular time series and the cost of the surveys make this method less feasible.

Due to the small sample size, the Labour Force Circulation survey (method 2) of those with higher education degrees would yield only superficial information and would neglect the smallest organisations – the segment of the economy in which employment changes are most frequent. Admittedly, this is also a problem in the ongoing data collection on Labour Force Circulation, since many employees of small firms work in the black economy and are thus unlikely to provide information on their movements. Moreover, at the present time, numbers of employees and trends in employment cannot be estimated from the Labour Force Circulation surveys.

In considering the implementation of the supplement to the Labour Force Survey (method 3), which would appear to be the most reasonable statistical method of the three, it should be borne in mind that supplementary surveys can be extended by *ad hoc* surveys like the Labour Force Circulation survey. Another advantage of this method is that there would be no need to collect basic information, data gathering and processing costs would be considerably lower than those for method 1 and the survey questions would only need to be devised once since they would be repeated in succeeding surveys.

Annex Table 1. **Data collection from a separate panel of people with higher education degree**

Advantages	Disadvantages	Expenditure per survey
• The new sample would allow analysis matching most of the requirements. • The sampled people would probably not be identical to those having participated in other surveys; therefore, they would be more willing to answer. • The new sample could be selected on the basis of the census held in 2001. • Sample size (highly educated, according to age groups): 15 000 to 20 000 people.	• Basic information needs to be gathered. This could be avoided if the survey supplemented an existing one. • Survey could not be carried out before the second half of 2002. • Given that the survey would be launched with an entirely new sample that cannot be combined with existing surveys, initial costs would be considerable (especially the first time). • Drop-outs are difficult to predict for the first 5-10 years, the sample may prove to be insufficient.	Sampling Development of statistical methods Questionnaire Methodological assistance Preparation of interviewers Fee of interviewers Statistical control of the responses Material costs Software development Data processing Writing up the survey ***Total expected costs in the first year: EUR 170 000; in the following years: EUR 34 000***

Annex Table 2. **Supplementing the questionnaire of the Labour Force Circulation surveys**

Advantages	Disadvantages	Expenditure per survey
• Adding new questions to the supplementary Labour Force Circulation survey would render the development of a new survey unnecessary.	• The survey would only yield data in the case of people who change jobs in the given year; insufficiency of sample size would preclude more detailed analysis. • Sample size (participants of the supplementary Labour Force Circulation survey in first quarter 2000): 327 people	Preparation of interviewers Supplementary fee to interviewers Modification of software Writing up the survey ***Total expected costs: EUR 14 000***

Annex Table 3. **Supplementary questions in the Labour Force Survey**

Advantages	Disadvantages	Expenditure per survey
• The supplementary survey would not need to collect basic information. • Data gained from the Labour Force Circulation survey could also be used. • The supplementary survey could already be carried out in the first quarter of 2000. • Data gathering and processing costs would be considerably lower than those of version 1. • Questions in the surveys could be repeated in other surveys following the first occasion.	• The number of people, who refuse to answer is expected to increase with the introduction of a further questionnaire. • Costly sample size (people with higher education degree in the core sample): 6 000 people.	Questionnaire Methodological assistance Preparation of interviewers Fee of interviewers Statistical control of responses Material costs Software development Combining data recording, collection, and control Processing Writing up the survey ***Total expected costs: EUR 24 000***

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Chapter 13

CZECH LABOUR MARKET MOBILITY, 1993-2000

by

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Introduction

The role of labour and the role of highly qualified labour in the process of economic transformation and growth based on R&D is a crucial one, in both quantitative and qualitative terms. The optimal allocation of labour is a complex and imperfect process. Production structures are being modernised, while the structural composition of firms and the occupational and educational levels of the labour force are changing as well. Some branches and some groups of workers are more affected by these changes than others. Adjustment and modernisation call for sectoral, spatial and professional mobility on the part of the labour force. The skills of those who are currently employed, but also of new graduates and new entrants in the labour market, have to be constantly upgraded to meet the demands of the knowledge-based economy. Changing individual perspectives with regard to access to jobs has led to imbalances in the allocation process; the Czech Republic's transition to a market-based economy means that deep-seated reforms need to take place at a very fast pace.

This chapter analyses the extent and direction of labour market mobility in the Czech Republic. Using quarterly data from the Labour Force Survey (LFS), we analyse the probability of movement among various labour market states during 1993-2000. We first calculate the gross probabilities of mobility in three basic states, employment, unemployment, and out-of-labour market. We continue with an analysis of sectoral and occupational mobility. We will attempt to answer the key question of whether Czech labour market mobility is the result of a deep-seated, intensive and effective restructuring process, which should not be understood as merely the liquidation of over-employment but rather as an integrated process of adjustment to the new conditions of a market economy. This process should result in a changed economic structure, associated with technological development, the implementation of new production processes and new methods of labour organisation and, hence, intensive labour mobility.

This chapter is linked to the general issue of how employment relates to economic growth or technological change. In Chapter 3 of this volume, Tomlinson demonstrates that there is time-dependent demand for high- and low-skilled labour during economic up- or downturns. The aim of the

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present chapter is to better understand changes in employment patterns and mobility caused by profound economic transition, as experienced by the Czech Republic during the greater part of the 1990s. The transition process has led to new demand for labour in sectors which had been severely underdeveloped prior to the collapse of the Soviet Union.

Data and methods

There are three sources of data on employment patterns in the Czech Republic. First, there are the so-called Labour Office data. The advantages of this data set lie in its accessibility and the fact that it is available from 1991 on a monthly basis. On the downside, the data focus on unemployed people seeking jobs through the Labour Office or making job-to-job changes, and exclude other types of labour mobility. Similarly, the structure of the data is not well suited to flow analysis [or other analyses such as human resources devoted to science and technology (HRST), brain drain or gain]; therefore, the data must be adjusted prior to utilisation. Nevertheless, this data set has been used successfully in a number of studies, for example micro-data studies (Gottvald *et al.*, 1999; Ham *et al.*, 1994, 1996). In addition, Boeri (1995) made use of limited Labour Office data on unemployment.

The second source of data is the retrospective sociological surveys or special sociological or other surveys. In combination, these surveys provide a representative sample of the population (labour force, employed, unemployed). They tend to concentrate on selected districts, although sometimes they extend to the macroeconomic level (*e.g.* the Estonia survey in 1995 covered the years from 1989-95 in order to eliminate data gaps, see Eamets *et al.*, 1997). The *Second International Adult Literacy Survey* (SIALS) has been conducted in the Czech Republic since 1998 and consists of stratified, three-stage probability data based on the Czech Statistical Office type staff selection. The survey asks additional questions relating to changes in employer, changes in occupation, etc., and thus contributes to the information mosaic on labour flows during 1992 and 1997.

The third source uses data from the Labour Force Survey (LFS), conducted regularly by the Czech Statistical Office (CSU) since 1993 in the first quarter of each year.[1] This is the source used in the present study. Few studies have used LFS data to examine Czech labour market flows. Terrell and Šorm (1996) analysed two sets of cohorts of the working age population over the four quarters of the years 1994 and 1995, and compared their flows in and out of three different states (employment, unemployment, out-of-labour force). They calculated gross probabilities and estimated exits out of unemployment in the same years by means of multinomial Logit analysis. A more detailed, yet methodologically similar, comparative analysis of the determinants and extent of labour mobility in the Czech Republic has been undertaken more recently by Šorm and Terrell (2000), using quarterly micro LFS data for the period 1994-98. Huitfeldt (1996) examined flows in the Czech Republic and used individual data from the LFS (in 1994 and 1995). All of these analyses use similar panel data for individuals but are based on different time spans. In addition, Gottvald (2001) investigated Czech labour market flows using gross flow analysis (industries, occupations and gender) using LFS data for the period 1993-98. Finally, Kux and Makalouš (1996, 1997) present a sound exposition of how to measure labour market flows in the Czech Republic by means of the LFS. Their methodological approach is adopted here.

Markov's chain model is used in probabilistic analysis to show how each state in an evolutionary process produces the next state in a finite chain (see Rutherford, 1992, and application in, for example, Terrell and Šorm, 2000). There are three major states: employment (E), unemployment (U) and out-of-labour force or inactive (O), and nine potential transitions are presented in gross transition probabilities. The same methodology is used for sectoral and occupational mobility analyses.

Mobility across labour market states

It is important to calculate the mobility flows across labour market states in order to specify basic proportions and dimensions of total mobility flows on a labour market. The probability that a person who is employed in one quarter will be employed throughout the whole year, given employment in the initial state was relatively high. More specifically, the probability, P_{ee}, that the person would continue to be employed four quarters later was between 92.6% (first quarter 1998 to first quarter 1999) and 95.3% (first quarter 1996 to first quarter 1997). These results are more comparable to those for Western European countries than those for other CEE economies. For example, Gora and Lehman (1995) find that in Poland, P_{ee} = 88.4% (May 1993) and P_{ee} = 89.7% (May 1994), Bellman *et al.* (1995) find in East Germany, that P_{ee} = 83.6% (November 1991). Gora and Lehman (1995) find a similar probability in Britain during the slump of the early 1980s to that of the Czech labour market, P_{ee} = 93.0% (compared also later). Šorm and Terrell (2000) also present similar results for the Czech economy, where P_{ee} was between 95.7% and 96.6% for this status three quarters later.

Table 1. **Czech labour market transition probabilities, 1993-2000**

	Economic status four quarters later								
	P_{ee}	P_{eu}	P_{eo}	P_{ue}	P_{uu}	P_{uo}	P_{oe}	P_{ou}	P_{oo}
1993 – Q2	93.1	1.8	5.1	55.8	32.3	11.9	5.1	1.0	93.9
1994 – Q2	94.7	1.4	3.9	50.0	34.8	15.2	4.0	0.6	95.4
1995 – Q2	93.2	1.2	5.6	46.4	37.5	16.2	3.5	0.6	95.9
1996 – Q2	95.1	1.5	3.4	47.3	43.6	9.1	2.9	0.6	96.6
1997 – Q2	94.2	1.9	3.9	37.9	52.6	9.5	3.9	1.1	95.0
1998 – Q2	93.3	3.0	3.7	31.9	60.2	7.9	3.3	1.4	95.3
1999 – Q2	94.7	2.1	3.2	31.7	61.8	6.5	2.4	0.8	96.8

Source: LFS First quarter 993 – Second quarter 2000.

For a transition economy like the Czech Republic, round-tripping (sometimes several times) could be very important and is indeed to be expected. Job-to-job flows (round-tripping in state P_{ee}) are expected to be significant and the high probability of P_{ee} could be explained by the large proportion of job-to-job shifts. This would indicate a high level of efficiency, flexibility and mobility with no loss of skills or output (GDP).[2] A number of similar studies have been carried out for the Czech Republic and other transition economies; the figures are surprisingly low and reflect only a short period of one year. Flek (1999) presents slightly contrary results based on the SIALS database, with job-to-job moves providing the dominant explanation for employee movements in the Czech labour market between 1992 and 1997. Nearly 40% of the labour force moved voluntarily to another employer and 12.8% to self-employment or private business activity.

Therefore, the probability of job change within employment status E $\rightarrow$ E has been calculated. Respondents to the LFS questionnaire were asked how long their job had continued without interruption. The responses were categorised as follows: less than one month, more than one month but less than three months, more than three months, etc. From these data, we calculated the probability of job change within each quarter of the year. Results indicate (Table 2) that the probability of job-to-job flows are between 0.6% and 3.0%; the data are generally lower that those presented by Terrell, Šorm,[3] Huitfeldt, etc. The expected high job-to-job flows were not evident, although the flows were at least moving in the right direction, as shown in Table 2.

Table 2. **Job-to-job flows, 1993-99**

Percentage of employed

Status in the base period	Status three months later: employed				
	Total duration of the job	Up to 1 month	1-3 months	∑ 0 - 3 months	Other
Employment					
1993 – Q1	100.0	0.2	0.4	0.6	99.4
1993 – Q4	100.0	0.3	0.6	0.9	99.1
1994 – Q4	100.0	1.2	1.8	3.0	97.0
1995 – Q4	100.0	0.8	1.5	2.3	97.7
1996 – Q4	100.0	0.6	1.1	1.7	98.2
1997 – Q4	100.0	0.5	1.1	1.6	98.5
1998 – Q4	100.0	0.3	0.8	1.1	98.9

Source: LFS, Czech Statistical Office.

Looking at the links between the three basic states, it should be borne in mind that they are the result of natural movements, *i.e.* exits from employment and unemployment due to retirement account for roughly 50% of this change. New graduates entering the labour market and new entrants to employment and unemployment also make up about 50% of the total change in each status. Both these categories are very stable over time and are likely to account for only small changes.

Employee mobility is very high in Western Europe. For Sweden, Norway and Finland in 1994/95, it is generally between 20% and 24% (wide definition) (see Chapter 7 of this volume). Comparing these figures to those for the Czech economy points to a rather rigid Czech labour market during the culmination of the privatisation process, as well as in all other periods. These higher flows throughout the economy were to be expected in view of the profound structural changes taking place: privatisation, bankruptcies, etc.

In the 1990-93 period, which has not been monitored by LFS, marked changes took place in total employment and also in the structure of employment. The changes in employment structure occurred most visibly during the first few years of transition. Large state monopolies were privatised and split into many small and medium-sized firms, resulting in a change of industry for many employees without any real change in the type or place of work. Thus, what took place was not a transformation of the economy in the sense of restructuring and modernisation followed by productivity growth or even growth in effective employment. Rather, it was a natural outflow of parts of the labour force from the labour market, with the first wave of exits being the result of over-employment and outflows abroad and to illegal work. On the other hand, previously underdeveloped industries such as the services and the public sector were able to absorb the majority of the dismissed workers. It is difficult to specify the range of these shifts and their impact on resulting changes in industrial structure of employment in 1993. The years 1993-98 are included in the next analysis of LFS data.

Mobility across industries

Transitional probabilities between different states cannot tell the whole story, particularly in cases of a transition to another job in the same firm, or to another firm in the same industrial branch or in a different industry. Many analyses of employment by industries have been carried out, but none have taken a closer look at flows between industries together with unemployment and out-of-labour force over a five-year period. In the following section, we will focus on these processes.

LFS data enable 17 industrial branches to be distinguished using the NACE (sectoral) classification. It is possible to recognise transitions between industrial branches, but job-to-job moves and intra-industry flows are not detected.

Table 4. **Employment by industrial sector, 1989-99**

Percentages

NACE	Dec. 1989	Dec. 1993	1993 Q1	1994 Q1	1995 Q1	1996 Q1	1997 Q1	1998 Q1	1999 Q4
A – Agriculture, hunting[1]	11.5	6.8	6.8	5.9	5.3	5.1	4.6	4.5	4.0
B – Fishing, forestry			1.1	1.0	1.2	1.1	1.0	1.0	1.1
C – Mining and quarrying			2.8	2.0	1.9	1.8	1.8	1.8	1.6
D – Manufacturing[2]	38.9	34.9	30.2	29.9	29.1	28.6	28.1	27.6	27.3
E – Electricity, gas and water supply			2.1	2.0	2.1	1.9	1.8	2.5	1.7
F – Construction	7.8	9.4	8.3	9.0	8.8	9.1	9.2	9.7	9.3
G – Trade, repair of cars & household goods	9.3	12.8	10.4	11.6	12.5	12.9	13.6	13.0	13.4
H – Hotels and restaurants	1.8	2.4	3.0	3.0	3.0	3.0	3.2	3.5	3.3
I – Transport, storage and communication	6.5	7.5	8.1	7.6	7.8	7.7	7.7	7.7	7.8
J – Financial intermediation	0.5	1.4	1.4	1.6	1.8	1.9	2.0	2.0	2.1
K – Real estate, renting and business activities	7.3	6.4	4.5	4.8	4.9	5.0	5.1	5.2	5.5
L – Public administration and defence	1.6	3.0	5.1	5.6	5.7	6.0	6.4	6.4	7.1
M – Education	5.7	6.8	6.7	6.7	6.4	6.4	6.5	6.2	6.2
N – Health and social work	5.2	5.5	6.2	5.9	5.8	5.8	5.7	5.5	6.0
O – Other commun., social & personal services	3.8	3.3	3.3	3.4	3.4	3.4	3.2	3.5	3.6
P – Private households with employed persons	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q – Extra-territorial organisations and bodies	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1. Data for 1989 and 1993, including fishing and forestry.
2. Data for 1989 and 1993 are for the industry sector as a whole.
Source: Enterprise Establishment Data and LFS Data, Czech Statistical Office.

Over the study period, total employment fluctuated at around 4.9 million persons. Changes in employment by industry can be grouped as follows:

- The first group includes agriculture, mining, health and social welfare, electricity, gas, manufacturing and education. These industries have experienced a constant decrease in employment. The greatest decreases were in mining and agriculture and were a natural outcome of the transition process. This also holds true for manufacturing, electricity and gas. The share of manufacturing in total employment declined gradually from roughly 35% in 1990 to 27% in 1999. In contrast, the sizeable decrease of 10.4% for health and social welfare (although during 1998 and 1999 employment bounced back to its 1994 level) and 5.4% in education was unexpected – and the Czech Republic is the only economy in transition to have experienced such a development. In the health sector, the decrease may have been caused by privatisation of general practitioners, specialists and dentists, while in education, the slow, continuous decline in the numbers of students enrolled in primary and secondary schools during the 1990s has had an impact on employment in the sector.

- The second group covers industries in which employment is roughly stagnant. This group is made up of a mixture of industries such as transport, storage, fishing and forestry, other services and private households with employed persons.

- The third group includes industries which have experienced consistent increases in employment. Construction (the only productive industry), hotels, restaurants and real estate can be characterised by moderate increases of up to 15%. Very high increases in public administration employment bear witness to the reform of the public services as well as a burgeoning bureaucracy. The most intensive growth has taken place in the trade, automobile and financial sectors, all of which had been severely underdeveloped before the transition.

We used Relative Employment Growth Index (REGI)[4] indexes to compare industries (Table 5) and investigate flows between industries (Tables 5 to 7).

Table 5. **Flows between industries and status, January 1993 to January 1994**

Thousands

Industries[1] in which employment:	Decreased (outflow)	Remained stable	Grew (inflow)	Net change in employment	Net change in unemployment	Net change in inactivity
Declines[2]	-169.1	2 478.1	+116.6	-52.5	+13.3	+7.3
Is stable[3]	-41.8	528.2	+34.8	-7.0	-9.8	-6.6
Is growing[4]	-127.3	1 368.5	+186.9	+59.6	-9.4	-24.0
∑	-338.2	4 374.8	+338.3			

1. NACE classification. Industries were broken down according to the REGI index: decrease of less than 5% of total change during 1993-97; remained stable at between -5% and +5% of total change; and growth of more than 5% of total change. The REGI index measures the employment growth of an industry in relation to employment growth in the economy as a whole.
2. Agriculture, mining and quarrying, manufacturing, electricity, gas, water supply, education, health and social work.
3. Fishing, forestry, transport, storage and communication, other community, social and personal service activities, private households with employed persons.
4. Construction, trade and repair of cars and household goods, hotels and restaurants, financial intermediation, real estate, renting and business activities, public administration, extra-territorial organisations.
Source: Own calculations from LFS.

Table 6. **Flows between industries and status, January 1995 to January 1996**

Thousands

Industries in which employment:	Decreased	Remained stable	Grew	Net change in employment	Net change in unemployment	Net change in inactivity
Declines	-133.2	2 302.9	+108.6	-24.6	-15.1	+45.8
Is stable	-41.2	547.1	+40.7	-0.5	-6.0	+9.1
Is growing	-139.6	1 608.4	+164.4	+24.8	-30.0	+26.2
∑	-314.0	4 458.4	+313.7			

Source: Own calculations from LFS.

Table 7. **Flows between industries and status, January 1997 to January 1998**

Thousands

Industries in which employment:	Decreased	Remained stable	Grew	Net change in employment	Net change in unemployment	Net change in inactivity
Declines	-90.6	2 157.8	+80.0	-10.6	+2.4	+92.0
Is stable	-26.2	543.5	+29.8	+3.6	+2.3	+16.2
Is growing	-119.7	1 691.6	+127.0	+7.3	-22.9	+15.0
∑	-236.5	4 392.9	+236.8			

Source: Own calculations from LFS.

Tables 5-7 use REGI indices to show flows among aggregate industries according to changes in employment. There is an clear decrease of about one-third of the total flows in employment changes. Outflows from growing industries did not change significantly, although inflows into declining industries changed quite significantly. Nevertheless, the net increase to employment decelerated. Outflows from declining industries decreased by nearly 50%, but inflows fell slowly and the net change in employment also decelerated. The net change in unemployment was negative, although a closer look reveals that this differs according to the industry analysed. In declining industries, unemployment fell only in periods of economic growth (1995-96). The net change in inactivity status was positive in declining industries. For growing industries, net changes vary. For the first year, they decreased, while for the remaining years they grew.

Occupational mobility

Structural changes between occupations were not very significant. However, if we break the changes down between men and women, we obtain a rather different set of results. There are significant shifts away from occupations (namely ISCO 9 and also 6, 7, 8) requiring lower qualifications (education) to occupations requiring higher levels of skills, such as ISCO 4 and 5, but especially ISCO 1, 2 and 3. The highest relative increase was in ISCO 1 (legislators) and ISCO 4 (clerks) occupations; however, from a gender distribution point of view, for men, growth was primarily in ISCO 1, while for women, it was in ISCO 4. The greatest decrease was in ISCO 9 (elementary) for women, and ISCO 7 (craft occupations) for men. The employment structure by occupation for men and women reflects the industrial economic structure, with different dominant spheres of employment for one or other gender as a result of, among other things, wage discrimination against women (who earn only 83% of the average wage). Occupational mobility from “blue-collar” to “white-collar” jobs was supported through increasing wage differentiation. For ISCO 4-9 occupations, wages ranged from 61% to 87% of the average wage, while for ISCO 1-3 categories, they were in the range of 116% to 227% of the average wage.

The highest probability to remain in an occupation is shown by professionals (96.5%), and the lowest for skilled agricultural workers (88.4%); this corresponds to the industrial changes which took place in 1993. At 91% in 1993, the probability to remain in elementary occupations is also very low. There is a 5.5% probability of leaving a skilled agricultural occupation to take up an elementary occupation; this trend can be explained by outflows from agriculture. Probabilities of staying in the same occupation are higher in 1997 for all occupations. Skilled agricultural workers still show the lowest rate, at 91.0%, but the highest probability to remain in an occupation is now demonstrated by clerks, with 96.5%.

Table 8. **Employment by occupations and by gender, 1994 and 1998**

Percentages

Occupation (ISCO classification)		1	2	3	4	5	6	7	8	9
Total										
1994 – Q1	100.0	4.6	10.1	18.9	7.0	10.5	2.3	23.0	13.2	10.2
1998 – Q1	100.0	6.9	9.8	18.1	8.3	11.7	2.2	21.4	12.5	8.2
Men										
1994 – Q1	100.0	6.5	9.4	15.1	2.5	5.7	2.2	34.1	17.9	6.6
1998 – Q1	100.0	9.4	8.1	14.5	2.8	7.0	2.1	32.1	17.0	5.8
Women										
1994 – Q1	100.0	2.4	10.9	23.5	12.4	16.1	2.5	9.9	7.7	14.5
1998 – Q1	100.0	3.7	12.1	22.9	15.6	17.9	2.3	7.2	6.6	11.5

Key: 1 = Legislators; 2 = Professional; 3 = Technicians; 4 = Clerks; 5 = Service workers; 6 = Skilled agricultural workers; 7 = Craft, trade; 8 = Plant and machine; 9 = Elementary.
Source: LFS, Czech Statistical Office.

Mobility according to education and HRST

Occupational and sectoral mobility are often evoked by the need to diffuse knowledge throughout the economy as measured by mobility of highly educated workers.[5] Twelve per cent of all employees, *i.e.* 572 000 workers, have a university education. Table 9 shows that the share of highly educated employees in total is increasing over time, particularly in ICT, S&R, but also in other branches. The share of highly educated employees in ICT seems to be rather low, but is almost twice as high as in other manufacturing branches.

Table 9. **Share and distribution of highly educated employees, 1995, 1998 and 1999**

Percentages

NACE sectors	Share of highly educated employees			Distribution of highly educated employees			Distribution of all employees		
	1995	1998	1999	1995	1998	1999	1995	1998	1999
Primary sectors (A+B+C)	4.6	4.1	4.7	3.5	2.6	2.6	8.3	7.0	6.7
Manufacturing (D 15 – 372) without ICT sectors	5.1	5.0	6.1	13.3	12.1	13.5	28.1	26.9	26.5
ICT sectors (informatics, computer technologies)	12.6	10.1	10.7	0.8	0.7	0.7	0.7	0.8	0.8
Other production sectors (E+F)	6.6	6.7	6.7	6.8	6.8	6.2	11.1	11.2	11.0
Services (G+H+I+J+K without S&R)	10.1	10.6	11.2	27.6	30.0	29.4	29.6	31.5	31.6
Science and research	45.4	51.2	59.6	2.1	2.3	2.2	0.5	0.5	0.4
Education (M)	39.9	40.6	42.4	23.6	21.3	22.0	6.4	5.8	6.2
Public sector (L)	16.2	15.6	16.7	9.0	9.5	9.8	6.0	6.8	7.1
Health services (N)	17.1	19.8	18.8	9.4	9.7	9.4	5.9	5.5	6.0
Other sectors (O,P,Q)	12.6	13.6	13.2	4.0	5.0	4.0	3.4	4.0	3.6
Total	10.8	11.1	12.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Fourth quarter of each year of LFS and own calculations.

The highest overall mobility was 8.2% in 1998, dropping to 6.6% in 1999. Women demonstrate greater mobility than men in all age categories, surprisingly also in the older age categories. Mobility rates of Czech employed HRST were 6.6% and 4.6% for men and 5.2% and 3.7% for women in 1998 and 1999, respectively (Laafia and Stimpson, Chapter 9 of this volume). Taking age into consideration, the share of stable workers increases with age; the share of mobile workers over the age of 30 decreases more than three-fold. The picture is similar for the highly educated (HE), but the range of mobility is significantly lower than total labour force mobility. Mobility of the youngest group decreased dramatically both for the highly educated and for the total labour force in 1995-99.

Table 10. **Mobility rate of labour force, 1995, 1998 and 1999**

Percentages

Age category	Highly educated (ISCED 5+)									Total labour force								
	Men			Women			Total			Men			Women			Total		
	1995	1998	1999	1995	1998	1999	1995	1998	1999	1995	1998	1999	1995	1998	1999	1995	1998	1999
Under 29	16.7	10.4	7.4	20.9	16.0	12.3	18.3	13.1	9.4	15.8	12.5	9.7	16.2	17.2	12.1	16.0	14.5	10.7
30 to 44	3.9	3.5	3.9	4.8	4.6	5.6	4.2	4.0	4.6	4.6	4.6	3.7	5.2	6.7	5.8	5.1	5.5	4.7
Over 45	5.2	5.1	3.8	4.0	4.5	5.4	4.8	4.9	4.4	4.7	5.3	4.8	4.8	7.6	6.3	4.8	6.3	5.5
Total	6.2	5.1	4.3	6.7	6.6	6.6	6.4	5.7	5.2	7.9	7.1	5.8	7.7	9.7	7.6	7.8	8.2	6.6

Note: Mobility is defined as movement observed by means of duration of employment and change of economic status (job-to-job moves are included) between the second and fourth quarters. Employees with a temporary contract are excluded (the share of temporary contracts of up to six months duration in total employment grew from 1.5% to 2.2% in the period 1995–99; the inclusion of temporary contracts would increase total mobility rates).
Source: LFS and own calculations.

When these results are compared to Hungarian data, the overall mobility rate in Hungary was 10% in 1998 while mobility among the highly educated was only 6.1%; the Hungarian mobility rates thus appear to be lower than the Czech ones (which are for a half period).[6] In contrast, in Hungary, mobility of men was higher than that of women, although the differences were not significant. Mobility rates for HE in both countries were, however, significantly lower compared with those of the Nordic countries: Mobility rates for HE in 1994–95 amounted to 23.9% in Finland, 23.4% in Sweden and 18.6% in Norway (Nås *et al.*, 1998).

Not surprisingly, inflows to the ICT sector were the highest for overall employees in 1998 and 1999, even though the Czech economy was experiencing a period of recession. The total share of employment in ICT is small but growing, as is the share of HE in industry. Massive FDI poured into this sector during the second part of the 1990s and the impacts of this development on employment will become more visible over the next decade. In comparison, inflow and outflow mobility rates of highly qualified workers in the United Kingdom are rather high and their *dispersions* from year to year are also high (see Tomlinson, Chapter 14 of this volume). High labour productivity growth in the computer equipment production sector caused a prevalence of outflows (9.8%) over inflows (8.5%), on average. On the other hand, an excessive increase in cellular phone production inflated inflows in the radio, TV communication production sector to 9.7%, while outflows were 1% less on average in 1995–99.

Although the share of HE in S&R is growing dynamically, the overall number of employees in S&R decreased markedly from the beginning of the 1990s. The situation has gradually stabilised and employment reflects the development of expenditures on S&R from GDP.

The developed countries have experienced steady employment increases in the education sector and an increase in the share of HE in employment. This is not the case in the Czech Republic, where

after initial increases in employment at the beginning of the last decade, employment declined from 1993 to the present. This decrease is due to low comparable wage levels and the gap continues to deepen. Although the share of HE employees rose from 40% to 42.4% in 1995-99, their total share in employment is very low. By comparison, in Hungary, the share of HE employees was 58.9% in 1998, and total employment in the education sector was 2% higher than in the Czech Republic.

The public sector and services show the highest inflow and outflow overall mobility rates. In contrast, the primary sectors have the lowest rates. Inflows and outflows of HE clearly point to a lower level of mobility, confirming previous results. In most branches, inflows are higher than outflows for the highly educated, except in the primary sectors, although the results are not conclusive for some branches.

Table 11. **Inflow and outflow mobility rates of highly educated (HE) employees, by sector**

Branches	Inflows (%)				Outflows (%)			
	1998 (Q2-Q4)		1999 (Q2-Q4)		1998 (Q2-Q4)		1999 (Q2-Q4)	
	Total	HE	Total	HE	Total	HE	Total	HE
Primary sectors (A+B+C)	3.3	2.5	3.6	3.5	5.5	5.4	6.8	7.9
Manufacturing (D 15 – 372) without ICT sectors	6.1	5.1	5.8	5.1	6.7	2.7	5.7	4.7
ICT sectors[1] (informatics, computer technology, D 30 + 32)	12.3	3.3	9.4	9.3	10.5	9.5	2.9	0.0
Other production sectors (E+F)	4.6	3.5	4.4	2.2	6.0	5.3	4.6	1.9
Services (G+H+I+J+K without S&R)	7.7	5.6	7.3	5.2	6.2	3.1	6.5	5.2
Science and research	8.8	15.2	4.0	4.6	2.3	2.1	4.4	0.0
Education (M)	5.6	4.7	5.2	5.7	8.6	7.8	5.9	4.9
Public sector (L)	8.6	3.3	8.0	5.5	8.2	3.9	7.7	4.8
Health services (N)	6.2	1.5	5.2	3.6	5.9	1.0	2.7	2.9
Other sectors (O,P,Q)	8.5	7.8	6.3	3.8	8.2	2.1	6.2	4.5

Note: Inflows (outflows) are calculated as people entering (exiting from) employment from unemployment and inactivity plus job-to-job flows where there is a change in NACE status.
1. Interpretation of survey results is associated with so-called selection errors. Selection errors arise when characteristics of the selected data set are applied to the whole basic data set. In general, data are less accurate for small samples and for high levels of disaggregation. Intervals of reliability for partial aggregations (such as that used in this table) are therefore very large. The question is if LFS are suitable to pursue and to analyse stock and mobility of HRST, HE etc. in ICT or S&R sectors. Inaccuracy deepens because the year-to-year comparisons operate only with 20 % of the original sample size.
Source: LFS and own calculations.

Summary and conclusions

In summary, movements among employment, unemployment and out-of-labour force (inactivity) states are rather low. The high probability of staying in employment creates the appropriate conditions to keep unemployment rates low. The small numbers of unemployed are increasingly likely to find new jobs after only a short spell of unemployment. Surprisingly, our results lead us to conclude that even job-to-job flows are not sufficiently high to increase the overall mobility of the labour force. This would suggest that the intensity of the restructuring process on the Czech labour market is lower than would be expected, both compared with other transition countries and with OECD countries.

The structure of employment by industrial sector is changing, with the largest job losses taking place in the mining and agricultural sectors. The sectors with the highest employment growth are

financial services, trade and public administration. Total employment decreased and the mobility process for net change in employment and unemployment *decelerated*. The current employment structure in the Czech Republic is more or less in line with that of other OECD economies.

As expected, the probability of remaining in an occupation is highest for professionals and lowest for agricultural workers and elementary occupations. Occupational structure and mobility are very different according to gender. Employment structures for men and women reflect the industrial structure of the economy, the different dominant spheres of employment of a particular gender and wage discrimination against women. Occupational mobility was supported at increasing wage differentiation. The intensity of flows fell continuously for all groups. There was slow but stable growth of employment in occupations which generally demand a higher level of education (ISCO 1-4) while, conversely, there was a continuing fall in employment in professions that do not require a high level of education (ISCO 5–9), especially university education. The share of highly educated employees is increasing over time, particularly in high-technology branches. Very high mobility for the younger generation contributes to the diffusion of knowledge throughout the economy. Surprisingly, we found higher mobility for women than for men and the picture for highly educated workers is quite similar.

From the above analysis of LFS data and from other data sources, a picture of Czech labour market developments between 1990 and 2000 can be drawn. Labour supply fell sharply as a consequence of the abolition of work duty and the decrease in the number of pensioners who continued to work. In addition, part of the labour force went abroad or joined the grey/hidden economy. During the first and the second waves of privatisation, employees were laid off massively as a result of over-employment. Privatised companies did not immediately feel the need to reduce their workforces because the macroeconomic conditions created relatively soft budget constraints for them. On the other hand, many new jobs were created in service sectors such as finance, retail trade, transport and communication. Large-scale foreign direct investments (FDI) created new jobs in high-technology industries such as the ICT sector. These vacancies and other highly skilled new jobs were not always filled by appropriately educated and qualified workers. Together with a low productivity level, the extensive growth of new firms in services and craft production, created the conditions for a low level of unemployment. Continued economic growth until 1996 only dragged in the spare labour force bolstered by unskilled workers from abroad. The economic recession in 1997 highlighted microeconomic problems and led to the second round of massive lay-offs. Together with a generous social benefit system and a spatially rigid labour force, unemployment increased rapidly to 9.5% in 1999. The favourable labour market and a further increase in high-technology FDI slowly began to change the structure of employment from 1999. There is a small shortage of highly skilled workers in sectors such as ICT services and ICT production, universities, medicine. This structural imbalance is mainly caused by the migration of high-skilled workers from the public sector to foreign private companies or other firms as well as to the lack of flexibility of the education system to adapt to changing conditions.

Finally, we used the LFS to study mobility and show that such surveys can be used for investigations of trends in overall mobility, mobility among industries, gender and among other aggregated samples. However, when we attempt to analyse such samples as highly educated employees at the branch level (at a higher level of disaggregation) over a given time period, we obtain a significant deviation for the estimation for a sub-section. Therefore, the sample of the survey should involve at least 1.5% of the total population in order to permit more detailed analysis without becoming excessively expensive.

NOTES

1. In the LFS, a quarter is shifted one month backwards, *i.e.* the first quarter of 1996 consists of December 1995, January 1996 and February 1996; ordinary regular quarter ranks (first quarter equals January, February, March, etc.) were adopted from 1998 onwards.

2. On the other hand, very high job-to-job flows within a year can hinder the accumulation of firm-specific knowledge and result in increased costs associated with training/socialising new employees, etc. A high mobility rate with significant job-to-job flows represents a reallocation of the labour force. During a transition process, high job-to-job flows can be prejudicial to knowledge accumulation.

3. Differences in figures may be partly due to different methods of calculation; however, only one source of data, question 204, from the LFS questionnaire is used in this study.

4. The same type index was used by Eamets *et al.* (1997, p. 12) and other authors.

5. Highly educated employees means those with university-level education (Bachelor's and Master's degree holders).

6. These comparisons are methodologically inaccurate but do contribute to the basic understanding of the dimension of mobility.

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Chapter 14

THE SUPPLY AND DEMAND OF HIGH-TECHNOLOGY SKILLS IN THE UNITED KINGDOM

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Introduction

From an innovation systems perspective, it has been argued elsewhere (see Chapter 3 in this volume), that the labour market and occupational change should become a focus of innovation systems research. This chapter uses the UK Labour Force Survey to begin to explore some of the issues with respect to human capital and mobility of labour in the United Kingdom. Before this, we present some background information on the current employment situation in Britain.

The *Skilltrends 2000* study (PSI, 2000) is one of the most recent reports on skill trends and occupational change in the United Kingdom. According to that report, the highest employment growth is in regions with high service sector concentration rather than traditional manufacturing industries. There is also an increasing diversity of labour required by the UK economy, *i.e.* different types of contracts, working arrangements, skills, etc.

The study found that skill requirements in the United Kingdom are increasing, with new technologies, changing working practices and increased competition being the main reasons. Recruitment problems are rather severe, with 23% of firms having "hard to fill" vacancies. This is compounded by the fact that skills gaps are also reported by a significant number of employers (15%). Around two-thirds of employers thought that skill needs were increasing. IT and computer technology has had a huge impact on skill requirements in the workplace, especially in large firms (this applies to both manufacturing and service firms). Demand for IT skills is likely to increase in the future.

In terms of labour supply, the labour force is expected to rise in the next decade, although employers are reporting increasing skill shortages. However, educational participation is increasing which will help to offset this trend. There is also an increase in initiatives by employers and government to create a "lifelong learning culture" (for example, the New Deal, Investors in People and other forms of employer best practice).

* Part of this work was done for a report to ESTO (European Science and Technology Observatory). The author would like to thank ESTO, and Odd Bjørn Ure in particular, for helpful comments.

With respect to the demand for skills, the main growth areas are in the service sectors and most prominently in the banking and finance sector. The report also states that the decline in employment in manufacturing is likely to be offset by increases in service sector employment. The authors note that employment flow research is currently a priority, but is not yet completed or advanced in any way.

The overall picture in the United Kingdom, then, is one of a continuous shift from manufacturing to services, with the resultant flow of workers that this entails. Skills are in short supply, but at least the labour force is expected to increase in the next few years. Skill gaps are not associated only with new technology, but also with changing working practices requiring more interpersonal and social skills than previously. Employers appear to be worried that skill shortages are increasing. Much of the report therefore points to the need for the type of research undertaken by the OECD Focus Group on Human Mobility.

Using the UK Labour Force Survey to examine supply and demand for skills

This chapter outlines a preliminary "pilot study" of the under-explored area of labour mobility research and its relation to innovation and competitiveness in the United Kingdom. It is not meant to be a definitive piece of work, but rather the beginnings of a possible future research programme analysing labour mobility and skills in knowledge-based and high-technology sectors.

There are, at present, few studies that link together the generation and movement of human resources within an innovation systems approach. Despite the fact that the mobility of knowledge is mainly facilitated by the movements of people, most studies of occupational mobility are done by sociologists who are, on the whole, interested in other matters. Attention is now beginning to turn to the mobility of people as it affects and is affected by science, technology, innovation and industrial change. For some earlier attempts at this, see Tomlinson (1999), Tomlinson and Miles (1999), Akerblom (1999), and Ekeland (1998).

The importance of diffusion of knowledge through labour mobility was first recognised in the "Canberra Manual" (OECD and Eurostat, 1995). The manual explicitly focused on human resources as they affect the workings of the science and technology system and contribute to national competitiveness. Stocks and flows of personnel were recognised as essential components and crucial objects of study for the analysis of economic systems.

In what follows we attempt to measure stocks and flows in specific sectors of the UK economy throughout the 1990s. The data employed are the Spring waves of the 1992-99 UK Labour Force Survey (LFS). Each wave covers around 60 000 economically active people out of a total of around 140 000 adults (the sampling unit is the household, hence the survey contains information about non-employed people). The databases contain information on mobility, training, education, job search patterns, occupation and sector etc. This allows us to break down data by sector or occupation and explore mobility patterns and training provision. Thus, we can explore aspects of human resources within a stocks and flows framework and link it up to issues of supply and demand within a national innovation system.

The focus here is on certain high-technology manufacturing sectors (aerospace; pharmaceuticals; radio/TV and communications equipment manufacture; office and computer equipment manufacture) and several knowledge-intensive service sectors (telecommunications; computer services; the research and development sector). These producer services are seen as increasingly important in contemporary economies (Tomlinson, 2001).

We explore three areas with respect to these sectors: demand for skilled workers, supply of skilled workers; any mismatches are isolated and assessed. Relevant policy conclusions will then be drawn.

The demand for skilled workers can be measured in two ways: *i)* by the number of highly qualified employees within the sector; and *ii)* by the number of knowledge workers in the sector (knowledge workers are defined by managerial or professional occupations, corresponding to the top three groups of the standard occupational classification). We also look at how high training provision is in each sector to assess the demand for increasing the knowledge and skills of employees. The LFS asks whether any job-related training was received within the last four weeks.

We estimate the supply of skilled workers by looking at mobility rates. Inflow mobility (*i.e.* the proportion of workers flowing into a sector) provides an estimation of the availability and willingness to move from another sector into the sector under consideration. A broader definition can also take into account inflows from non-employment into employment. We can also balance the inflow rates with outflow rates (*i.e.* the proportion of employees leaving a given sector). The LFS collects data on the positions of every employee in the sample as well as information on what they were doing one year previously. Using this timeframe of one year, we estimate the mobility rates (this question is only asked in the Spring wave, hence all the figures refer to Spring of the respective years).

Once we have an idea of the demand and supply in the chosen sectors, we can make some tentative remarks about mismatches and potential problem areas by combining the analyses. Policy conclusions can then be drawn which may help to focus the development of human resource practices for these sectors. We now proceed to the analysis of the LFS data.

The demand for skilled labour

Data are available on the number of highly qualified employees in each sector (defined as those with tertiary level education – ISCED 6 and 7) and on the level of training that was available to different groups of workers. This information is used to estimate demand for qualified employees, on the one hand, and demand for human capital development, on the other, at sectoral level (Tables 1 and 2).

Table 1. **Stocks of highly qualified workers by sector**

	Aerospace	Office/ computer	Radio/TV/ comms	Pharma	Telecoms.	Computer services	Research	All[1]
1992	32.8	40.4	48.7	36.9	27.8	56.1	65.3	22.9
1993	32.5	39.8	38.9	41.9	20.6	52.3	61.0	22.2
1994	24.6	38.0	29.3	34.5	24.6	48.0	62.9	22.2
1995	29.9	39.4	29.2	36.6	23.7	49.7	58.5	19.3
1996	28.6	40.6	27.3	42.9	29.5	49.8	63.8	19.8
1997	29.8	37.5	29.5	42.6	28.2	55.1	70.7	20.3
1998	34.8	39.2	27.0	44.1	32.7	54.9	66.5	24.8
1999	32.8	38.8	29.0	42.5	35.6	54.3	63.5	22.1

Proportion of employees with tertiary education

1. "All" refers to the whole economy, not just to the seven sectors covered in this study.

Table 2. **Training provision by sector**

	Aerospace	Office/ computer	Radio/TV/ comms	Pharma	Telecoms.	Computer services	Research	All
1992	16.4	16.3	15.7	24.0	23.0	16.0	23.8	13.6
1993	20.2	15.8	15.9	23.4	20.5	15.1	22.7	13.6
1994	19.5	17.3	15.0	21.1	15.6	17.1	17.6	14.5
1995	18.3	18.8	15.2	16.7	19.3	12.4	15.6	13.4
1996	17.5	14.4	16.8	18.8	16.8	16.4	12.9	13.8
1997	18.5	15.1	13.6	16.9	15.2	13.9	13.4	14.3
1998	17.8	14.2	14.2	22.1	19.2	16.3	20.0	14.6
1999	15.8	16.5	20.1	19.9	19.4	15.2	19.2	14.9

Proportion of employees who received training in the last four weeks

	Training provision by sector			Knowledge workers (occupational groups 1,2,3)				
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma	Telecoms.	Computer services	Research	All
1992	17.9	16.6	19.6	31.7	24.2	17.4	24.7	19.6
1993	25.0	18.9	16.7	27.3	26.8	14.1	24.7	19.4
1994	19.4	18.5	22.0	25.4	13.6	18.6	17.6	20.2
1995	21.7	23.9	18.8	21.7	19.3	12.6	18.0	18.8
1996	20.7	16.7	21.3	19.5	16.7	15.7	13.5	18.9
1997	22.7	17.2	20.3	21.6	16.7	14.0	14.3	18.7
1998	22.9	17.6	21.7	28.7	18.8	16.4	19.8	19.2
1999	19.0	20.1	28.8	23.1	20.9	15.4	19.7	19.8

Proportion of knowledge workers who received training in the last four weeks

	Training provision by sector			Educated workers (ISCED 6+7)				
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma	Telecoms.	Computer services	Research	All
1992	24.7	20.2	20.8	34.6	25.2	18.8	25.7	24.2
1993	28.8	18.0	12.7	29.4	24.3	13.2	24.8	23.6
1994	21.9	21.6	19.5	32.4	13.9	18.0	17.3	24.2
1995	17.3	23.0	16.0	25.8	21.8	13.4	20.3	22.8
1996	17.5	14.4	16.8	18.8	16.8	16.4	12.9	13.8
1997	19.8	19.7	19.6	20.3	16.2	13.4	13.5	22.2
1998	24.8	15.1	25.5	24.2	23.1	18.4	20.9	22.7
1999	23.3	20.5	36.2	20.3	22.3	16.0	20.0	23.3

Proportion of educated employees who received training in the last four weeks

Some general conclusions from stocks and training data

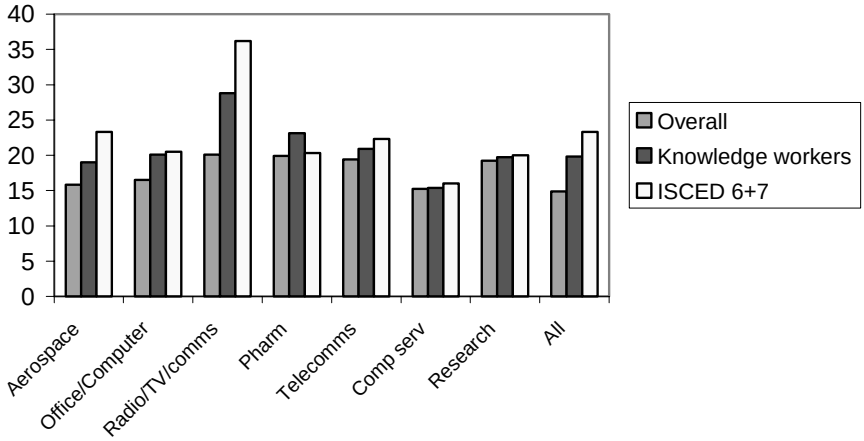
Stocks of qualified personnel are very high in these sectors. The overall average for all sectors is about one-fifth of employees having tertiary education, but the sectors under consideration in this study have substantially larger stocks of qualified personnel. For instance, office and computer equipment manufacture and computer services have around 40%-50%, while the research sector has around two-thirds. Stocks, however, are very unevenly distributed between these sectors (*e.g.* research and computer services are much higher than aerospace and telecommunications).

Although the figures fluctuate due to low numbers in some instances, we can make some general statements about changes in the levels of stocks over the 1990s. In some sectors, stocks are generally falling (*e.g.* in radio/TV/communications equipment, there appears to be a general decline from quite high levels to relatively low levels by 1999), while in most of the sectors stocks remain fairly constant or fluctuate in no particular direction (*e.g.* aerospace has around 30% for the whole period 1992-99; office and computer equipment and pharmaceuticals around 40%). Telecommunications appears to show a rise from a low 20% to around 30% in the later period.

Not only are stocks of qualified personnel high, provision of training is also generally high in these sectors. This implies that sectors that already have a high level of human capital are keen to develop their human capital. This suggests that demand for, and maintenance of, skill levels in high-technology sectors and knowledge-intensive services is of paramount importance.

There is also quite uneven opportunity for training by sector. For example, computer services, which have a high level of stocks, have a relatively low level of training provision compared to, say, telecommunications. This suggests that employees in computer services arrive already trained, while telecommunications workers are more likely to need continual upgrading or re-training. Other points to note are that, in most of the sectors considered here, knowledge workers and highly qualified staff are more likely to get training than other workers. This suggests that a certain polarisation of skills and knowledge may be occurring in certain sectors (Figure 1). For example, based on 1999 figures, computer services and research appear to display a more equitable distribution of training than do radio/TV and communications equipment manufacture or aerospace. In the economy as a whole, there also appears to be a sharp polarisation in human capital formation (14.9% of the whole sample received training in the last four weeks, compared to 23.3% of highly educated workers).

Figure 1. **Provision of training, by sector**



There is thus evidence of polarisation of human capital formation even in some high-technology and knowledge-intensive sectors. This is a cause for concern: in a knowledge-based economy, it may not be wise to exacerbate differentials in this respect. It is generally accepted that an overall upskilling of the population is required in order to reap the benefits of IT and other new technologies. Giving significant advantages to those who are already ahead in the game seems to go counter the prevailing wisdom.

The other cause for concern is that most of the sectors show some decline (*e.g.* research, pharmaceuticals) or little change in overall training provision (*e.g.* computer services), while for the economy as whole, provision of training has remained fairly constant. This must have consequences for national competitive advantage – especially when many employers are experiencing growing skill shortages. It must surely be significant that two key sectors of the UK economy are reducing their training provision, while very few are increasing it.

The supply side via mobility indicators

Mobility indicators can be constructed in several ways. The main differences are whether the non-employed are allowed to enter the equation. For example, a broad definition of inflow mobility (*i.e.* the flow of workers into a sector as a proportion of total employment in that sector) might include entrants from unemployment, the education system or other non-employed positions. Similarly, outflows can include outflows to non-employed positions. A narrow definition might only include employees at both points in time (whether measuring inflow or outflow). There are advantages and disadvantages to both methods. For example, a broad definition will provide more detail about the overall dynamics of an economy, including linkages with the education system or on take-up of unemployed people (for inflows) or on problems of labour scarcity due to retirements (for outflows). A narrow definition, which only includes employees at both points in time, gives a clearer picture of the dynamics of the more economically active population. This helps to understand the dynamics of employee knowledge flows rather than other types of knowledge flow. In what follows, we concentrate on the narrow definitions of inflow and outflow mobility. (The UK LFS can also be used to calculate using broader definitions as it has non-employed and inactive members of the United Kingdom in its sampling frame at household level.)

Inflow and outflow rates provide an indication of the supply available to different sectors and of the levels of labour turnover in specific sectors. In the next section, we attempt to link the supply indicators with the previously reported demand and training figures to form employment profiles of the industries concerned.

Table 3. **Inflow and outflow mobility rates**

	Inflow mobility rates for high-technology sectors: employees at time t and t-1(%)						
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	3.0	8.3	2.2	6.0	2.6	8.4	3.6
1993	1.2	7.9	5.2	5.4	3.1	9.9	4.4
1994	1.6	7.9	9.0	6.0	3.7	11.1	4.9
1995	2.2	13.2	12.1	4.5	5.0	11.4	6.5
1996	5.8	12.4	12.6	4.8	5.8	12.3	7.5
1997	6.8	10.8	9.9	8.2	9.2	13.3	3.8
1998	6.7	13.5	12.1	10.3	10.4	14.5	7.5
1999	4.9	11.8	9.7	8.7	12.5	10.9	12.9

Proportion of employees in year t-1 who moved into sector in year t (narrow definition)

	Outflow mobility rates for high-technology sectors: all employed at time t and t-1 (%)						
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	4.6	11.5	8.7	5.3	1.5	6.2	6.7
1993	4.1	6.9	3.7	4.3	5.8	7.2	5.8
1994	5.5	7.9	7.5	2.2	2.6	6.4	4.9
1995	5.9	8.3	6.4	8.3	6.6	6.7	3.8
1996	4.2	10.0	9.3	8.7	5.2	6.0	7.1
1997	5.3	9.6	8.8	2.8	5.7	5.7	6.0
1998	4.0	11.9	7.9	5.8	7.6	7.5	6.7
1999	3.9	9.8	12.1	5.9	9.4	6.3	8.8

Proportion of employees in year t-1 who moved out of sector but remained employed in year t (narrow definition)

	Inflow mobility rates for high-technology sectors: employed at t-1 and knowledge workers (SOC groups 1-3) at time t (%)						
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	1.2	5.5	0.0	0.9	4.0	4.1	2.2
1993	1.7	4.5	5.9	5.1	2.7	6.9	5.2
1994	2.2	4.9	10.6	5.4	1.8	11.0	4.0
1995	2.6	9.2	6.3	2.5	5.6	8.6	3.7
1996	1.8	9.9	13.8	3.3	5.3	9.1	5.9
1997	6.4	7.7	8.6	7.7	3.0	13.0	2.5
1998	6.7	11.4	3.2	9.2	9.0	12.5	4.7
1999	4.3	7.0	4.9	5.9	6.7	10.1	13.4

Proportion of employees in year t-1 who moved into sector in year t (narrow definition)

	Outflow mobility rates for high-technology sectors: knowledge workers at time t (%)						
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	4.2	9.6	6.9	4.3	2.0	4.9	7.4
1993	5.5	7.0	4.0	5.1	4.7	3.8	4.6
1994	8.7	5.6	6.7	2.8	3.5	4.7	5.9
1995	4.2	6.8	1.7	7.1	8.6	4.0	2.7
1996	6.0	9.3	12.5	7.8	6.5	5.1	4.6
1997	4.1	7.7	3.6	3.2	3.5	4.2	2.5
1998	3.8	12.7	7.6	3.6	5.2	6.5	4.1
1999	4.3	8.3	7.9	3.8	10.8	4.5	8.4

Proportion of employees in year t-1 who moved out of sector and were employed in year t (narrow definition)

	Inflow mobility rates for high-technology sectors: highly qualified workers (ISCED 6+7) at time t (%)						
	High-technology sectors				Knowledge-intensive services		
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	4.4	6.8	1.2	3.0	3.4	3.5	3.7
1993	1.4	2.5	5.6	6.7	3.9	11.0	4.8
1994	2.2	2.9	8.3	7.3	3.6	14.2	6.2
1995	5.2	9.3	8.1	3.3	3.6	10.1	2.8
1996	4.9	8.0	12.8	2.0	7.4	8.5	5.2
1997	6.2	8.8	14.0	9.7	7.4	14.5	1.4
1998	6.2	10.5	9.5	14.0	6.9	13.3	5.3
1999	3.3	5.8	4.4	8.8	10.0	10.6	13.8

Proportion of employees in year t-1 who moved into sector in year t (narrow definition)

	Outflow mobility rates for high-technology sectors: high qualified at time t (%)						
	High-technology sectors				Knowledge-intensive services		
	Aerospace	Office/ computer	Radio/TV/ comms	Pharma.	Telecoms.	Computer services	Research
1992	2.3	11.7	6.6	3.0	1.4	3.5	7.1
1993	4.8	8.4	4.2	6.7	6.7	5.8	5.6
1994	9.0	5.7	5.7	3.3	3.6	4.5	7.0
1995	8.0	10.1	2.5	10.1	7.8	6.2	3.5
1996	2.5	8.0	14.6	6.8	5.0	6.2	3.8
1997	6.2	8.8	6.5	3.8	5.3	6.0	3.4
1998	2.8	13.0	13.6	3.9	9.4	7.0	7.1
1999	2.5	9.3	6.5	6.4	9.4	4.9	9.4

Proportion of employees in year t-1 who moved out of sector but were still employed in year t (narrow definition)

General remarks on the mobility rates[1]

Inflow mobility to the high-technology sectors considered here seems to be generally increasing throughout the 1990s, but is tailing off for radio/TV/communications and for office and computer machinery manufacture. The inflow figures are generally high for office and computer machinery manufacture, radio/TV/communications equipment and pharmaceuticals, relative to aerospace.

Inflow mobility to knowledge-based services is also generally on the increase. Inflow mobility of computer services has ranked highest throughout the 1990s, although research and telecommunications have now caught up.

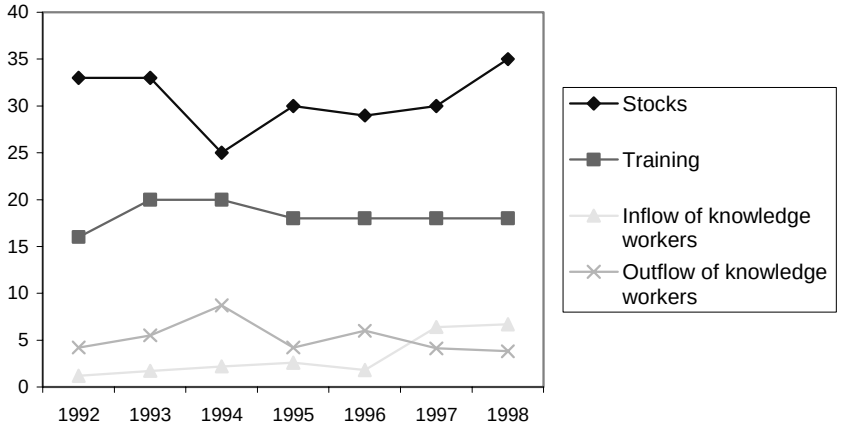
Outflow mobility is far less clear, although it is generally lower in the service sectors considered here. Outflow mobility is generally increasing in these services (except for computer services). It also appears to be increasing in office/computer equipment manufacture and radio/TV and communications equipment manufacture, while in aerospace it has remained fairly constant and it is rather difficult to discern any clear trend in pharmaceuticals.

Synthesis of the results by sector: combining the demand and supply figures

The following graphs plot the results for the various sectors. They show the stocks of educated personnel in each sector, the overall training provision for each sector and the inflow and outflow mobility rates of knowledge workers in each sector. This combination of figures provides a useful "profile" of each industry from a human capital supply and demand perspective which can be used to assess potential problems and highlight differences between sectors at the national level. The results are summarised in Table 4 and discussed in the next section.

Manufacturing sectors

Figure 2. **Aerospace**



1. Sometimes, low cell sizes cause the numbers to vary considerably. The results should be treated with due caution.

Figure 3. **Pharmaceuticals**

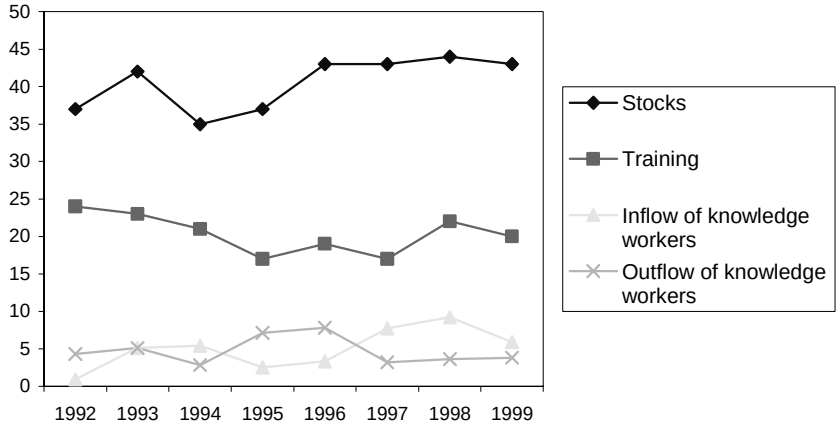


Figure 4. **Office and computer equipment manufacture**

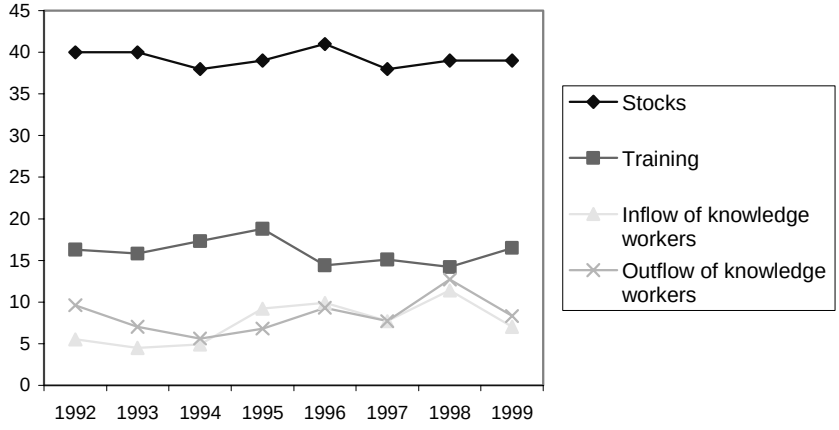
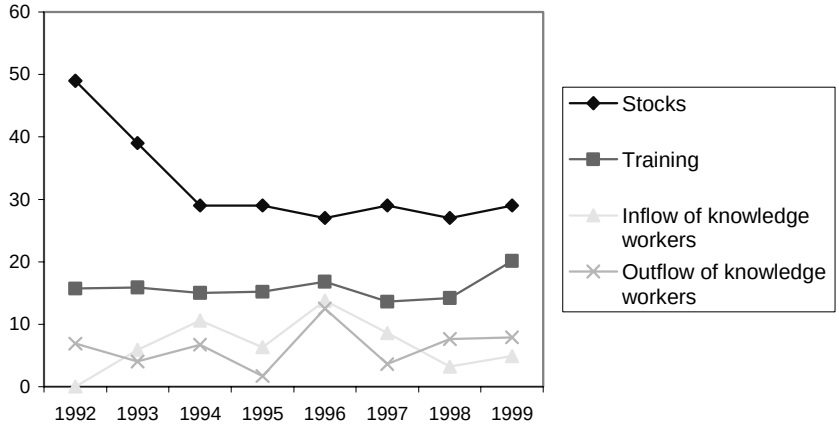


Figure 5. **Radio/TV/communications equipment manufacture**



Knowledge-intensive services

Figure 6. **Telecommunications**

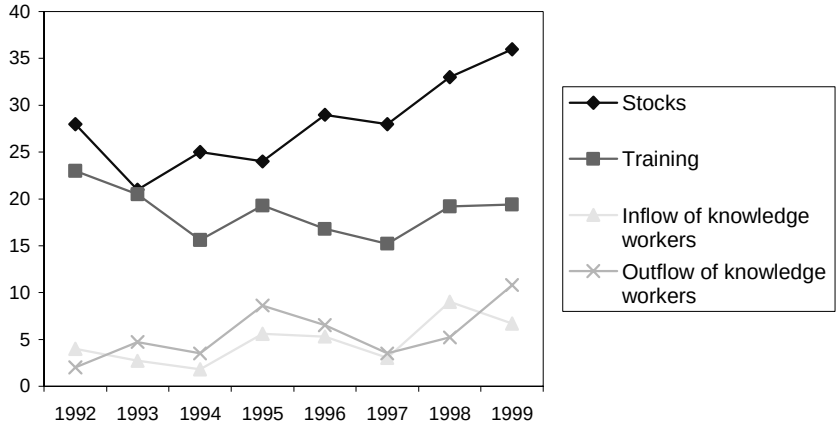


Figure 7. **Computer services**

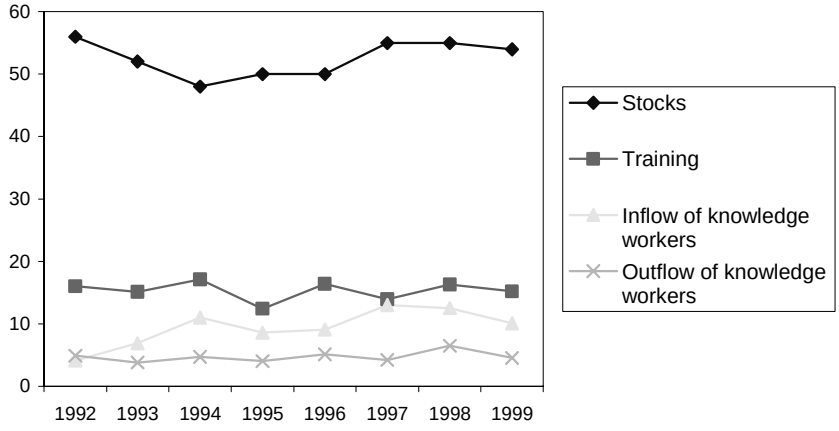


Figure 8. **Research and development**

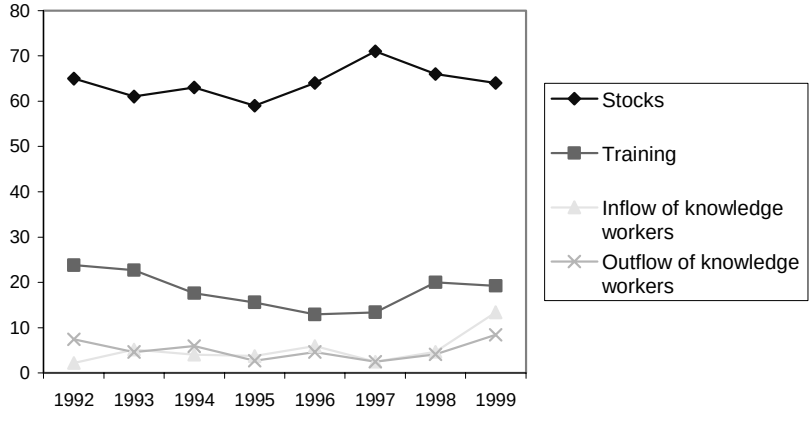


Table 4. **Summary table of supply *vs.* demand, by sector**

	Stocks	Training	Inflow	Outflow
Aerospace	Generally stable at around 30%	Fairly stable around 20%, possibly slow decline	Generally very low	Usually higher than inflow, but converging
Office/ computer equipment	Very high around 40%, stable	Fairly stable at around 17%	Quite high at around 10%	Quite high at around 10%, generally follows inflow
Radio/TV/ communications equipment	Declined from a high of 50% in 1992, now stable at 30%	Fairly stable at 15%	Appears erratic (low number of cases)	Appears erratic (low number of cases)
Pharmaceuticals	High at around 40%	Appears to be slowly declining to around 20%, but with some sign of recovery 1999	Gradually increasing, but low	Erratic. Appears to be lower than inflow 1997-99.
Telecommunication	Increasing rapidly to around 33%	Fluctuates around 16% from a high of 23% in 1992	Increasing trend	Increasing trend
Computer services	Very high at around 55%	Relatively low at around 16%	Increasing trend. Greater than outflow.	Low and stable at around 4%
Research	Highest around 65%, also seems to have an upward trend	Has declined, but shows signs of recovery	Fairly stable, signs of increase towards 1999	Fairly stable, signs of increase towards 1999

Discussion and conclusions

Table 4 summarises the results of the synthesis and shows that the sectors with the highest stocks are office and computer machinery manufacturing, computer services, pharmaceuticals, and research and development. This suggests that demand for graduates and highly qualified personnel will be especially high in these sectors; it indicates that considerable investment should be made in higher education courses oriented towards these sectors. Furthermore, there has been significant growth in demand for skills in telecommunications towards the end of the 1990s. Again, provision of training and education oriented towards this sector should be considered essential (especially as training provision within this sector appears to have declined).

Deficiencies in training provision are apparent in computer services, although this must be offset by the fact that this sector has extremely high stocks of qualified personnel. Pharmaceuticals and research and development also show a decline in provision which is potentially worrying. The other sectors appear to have fairly stable training provision. In any case, it must be borne in mind that provision of training is higher in these sectors than the average for the whole economy.

In terms of mobility, the sectors that appear to have high fluidity in terms of inflow and outflow are telecommunications, and office and computer equipment. Again, steps could be taken to reduce the outflow rates from these sectors if deemed appropriate. Computer services and pharmaceuticals appear not to suffer from this problem, having higher inflows than outflows. This situation looks set to continue.

A "knowledge economy" example: comparing computer services with telecommunications in the United Kingdom

As an example of how this type of analysis might be used within a specific systemic context, consider that in the "knowledge-based" or "new" economy, two sectors which are crucial for progress are telecommunications services (TS) and computer services (CS). These sectors were analysed with respect to their supply and demand of human resources in the United Kingdom. If the government were to implement a strategy to bolster the knowledge-driven economy based upon a focus on these two sectors, then a common strategy for the sectors would be rather inappropriate given the differences in mobility and human resource patterns in the two.

For example, CS has very high stocks of educated workers and high training provision, while TS has low stocks and higher training than CS. The high stocks required by CS are already manifesting themselves in the United Kingdom and immigration controls are being relaxed in order to allow suitably qualified overseas graduates to work in the country. The figures on mobility show that there is no problem in keeping such workers in the industry once they enter (inflow rates are much higher than outflow rates).

In TS, on the other hand, inflow and outflow rates are more or less congruent, although they were on the increase throughout the 1990s. This is the case whether we look at overall mobility or focus on mobility of knowledge workers (*i.e.* professionals and managers). Therefore, relatively speaking, TS have more labour fluidity and experience greater problems than CS in terms of retaining people. The TS training figures may reflect this as well as the fact that stocks are lower. So, from a policy perspective, it would be more useful to introduce training programmes of a different type for telecommunications than for computer services; policy should also attempt to reduce the outflows from TS, perhaps by offering programmes and incentives to telecommunication firms that help to retain staff.

Note that this analysis tells us nothing about mobility *within* the sector which may be of crucial importance for individual enterprises. Whereas the computer services sector seems to be doing relatively well in terms of retaining highly skilled staff and having less fluidity, this tells us nothing about the problems faced by individual firms within sectors. Firms may have extreme difficulties with poaching by other enterprises or training employees who then leave to work for rival firms.

It seems, on balance, that if policy makers wanted to target training programmes or influence competitiveness in the knowledge-based economy, they would be better off devoting more resources to telecommunications than to computer services in terms of labour market policies and training. On the other hand, the high stocks in CS indicate that there is huge demand for qualified staff. This suggests that up-to-date provision of computer-related higher education courses must also be a priority. Recent employee-based evidence supports the need for computer-based skills in general (Green *et al.*, 1999).

There was also evidence of a polarisation of training provision in TS, but not in CS, perhaps indicating another area to be addressed. It may be better to encourage telecommunications firms to train their less-skilled staff as well as their knowledge workers. In CS, there may be a more 'democratic' system in place. This quantitative evidence would need further investigation to be conclusive and some qualitative work would help to shed more light on these findings.

The above analysis is crude, but it does show that some headway can be made with existing data sources such as the LFS, if used carefully. The use of simple indicators such as inflow and outflow mobility may help to shed light on potential problems in national innovation systems in terms of

human mobility and human capital formation. The statistics here show that some simple trends and observations can be made that could help to formulate policy with respect to employment, training and the labour market. The existence of the Community LFS allows comparisons between European countries on certain indicators and may also prove useful providing that due caution is observed.

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PART IV

INTERNATIONAL MOBILITY

Chapter 15

FOREIGN SCIENTIFIC RESEARCHERS IN SELECTED OECD EU COUNTRIES: DATA SOURCES AND ANALYSIS

by

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Introduction

Scientific mobility is a complex phenomenon that is shaped and driven by the identity and objectives of the many and various actors involved: students pursuing skills, higher incomes and better employment opportunities at home and abroad; senior scholars seeking research materials, colleagues and refreshing new experience; governments concerned about competitiveness, human capital and technology transfer; regional organisations bound on creating a regional consciousness; international organisations in search of peaceful international relations; and private foundations that wish to advance human welfare. The various groups of actors influence mobility and take part in it in accordance with their respective objectives. These can be economic, political, cultural, and education-scientific-technological objectives. The more an objective cuts across the various groups, the higher it moves up the policy agenda.

Understanding the underlying dynamics of scientific mobility calls for a better understanding of the complexities of scientists' subjectivity. For instance, some research has shown that scientists might be willing to accept less pay in exchange for the freedom to publish their work. Other studies have shown that scientists are attracted to and favour employers who are known to actively publish the results of their scientific work. This is explained by the peculiarities and specificity of scientific careers. Scientists operate within a meritocratic process that draws on their talent and professional socialisation experiences and rewards them for recognised scholarship. Therefore, scientists ascribe greater value to certain institutions (*e.g.* universities) and rank them relative to others. Because such perceptions can have powerful consequences on the career paths of scientists who become affiliated with these institutions, mobility is an obvious tactic of professional socialisation. Mobility becomes a means for enhancing a scientist's prestige and reputation.

Mobility and national innovation systems

Governments view technology generation and diffusion as primarily a people-oriented phenomenon; the mobility of people with the necessary R&D competencies has become a crucial policy issue. The labour market for scientists and engineers, including those in academia, is becoming increasingly internationalised. A 1995 study found that nearly 10% of scientists in 100 key European

R&D centres came from overseas, with the share rising to 30% in smaller countries like the Netherlands and Switzerland (Pearson, 1995).

Important as it is for policy making in S&T and industrial policy circles, cross-border mobility of highly skilled R&D personnel has even greater importance for the sectors and institutions that make up a country's national innovation system (NIS). For instance, universities play a very important role in the UK innovation system, while the private sector and the large research institutes of the Max Planck, *Fraunhofer* and Blue List institutes play an equally significant role in Germany. Thus, from the perspective of science and innovation policy, country-specificities in national innovation systems should be taken into consideration in investigating issues of international mobility, brain drain and circulation. This is particularly true when efforts are made to collect data for cross-country comparisons. A significant inflow of foreign scientists to British universities will have a greater impact on the UK national innovation system than would, for example, similar inflows to French universities on the French innovation system. This is because, in contrast with the United Kingdom, the French innovation system depends more on large public labs and research institutes (especially those of the CNRS) than on universities. Indeed, generally speaking, French universities are more educational than research-based organisations.

A similar argument could be made in relation to the sector-based mapping of R&D inflows and mobility. To take an example, inflows and outflows of highly skilled personnel in the field of bioinformatics are more significant for the UK and German innovation systems than for the Dutch one. Although it is a vital emerging area in all countries, bioinformatics is far less developed in the Netherlands than in the United Kingdom and Germany. As yet there are no bioinformatics companies in the country, although the drive to establish this field is very high. Therefore, for the purpose of science and technology policy, the search for and collection of data and the making of cross-country comparisons should take into consideration variations in the structures and composition of the national innovation systems of the countries under study.

Measuring scientific mobility

The internationalisation of academic and scientific organisations in western Europe (EU+EFTA) has traditionally been measured by the following indicators: *i)* the proportion of overseas students in the higher education system; *ii)* the intensity of foreign exchange programmes with other countries; and *iii)* the extent of participation in overseas collaborative activities. A better indicator, namely the proportion of overseas members of academic and scientific staff in national research institutions, is often neglected due to the lack of consistent, comprehensive and internationally comparative data. This chapter attempts to explore the availability of data and data sources relating to the latter indicator in a number of OECD European countries. The key questions are: What data are available? What are the sources for these data? What do they tell us? And how can they be improved?

Selected OECD countries

The objective of this chapter is to: *i)* explore existing data and data sources in a number of OECD European countries; *ii)* seek out potential new data sources; and *iii)* provide an overall framework of analysis and interpretation of the data requirements for varying national scientific landscapes. The results of this exploratory study should feed into and complement the ongoing activities of the OECD focus group on mobility. Moreover, it is hoped that this study will lay the groundwork for a larger and more comprehensive project that will engender more concrete results and have a greater input in policy making.

Denmark

The Danish registers do not specify the precise educational level for inflows of people. Alternatives using job level information, firm characteristics, salary, etc., have been attempted. Similarly, there is no information on short-term in/outflows, or for periods of less than a year. The only information available from the Danish National Bureau of Statistics covers the educational level, subject, job level, etc., of Danish citizens leaving Denmark. Other sources of information include the research institutes, which often collect information on their employees. However, this calls for a special data collection exercise which would run the risk of being non-representative, costly and time consuming. Instead, Statistics Denmark has recently launched a project to update the available educational information on all foreigners in Denmark. The questionnaires have been completed and a report was planned for October 2000. As of 1 January 2000, the educational level of immigrants will be kept up to date and published annually.

Germany

Data on inflows of skilled workers are rather sketchy. The only valid source for Germany is the employment statistics of the employment services. These are based on social security records, which have their own limitations. The second source is the European Labour Force Survey, which is based on a representative sample of households. However, the industrial and occupational classification codes of the LFS cannot be broken down to the necessary level which would allow inflows of foreign academics to German universities to be examined. However, and due to the role played by large research and funding organisations in German science, statistics provided by organisations such as the Max Planck Institutes, the *Fraunhofer* Institutes, the *Alexander von Humboldt-Stiftung* and *Deutscher Akademischer Austauschdienst* (DAAD) can be used to provide a valuable picture of inflows/outflows in Germany. For instance, the *Alexander Von Humboldt Stiftung* (AvH) provides a breakdown of the nationalities, disciplines, and host institution of the foreign visiting fellows it supports.

France

The *Observatoire des Sciences et des Techniques* (OST, 2000) produces statistics on the numbers and proportions of foreign students in French universities and at various levels including doctorates and postdocs. These can also be broken down in terms of nationality and field of work. Furthermore, the *Centre d'Études et de Recherches sur les Qualifications* (CÉREQ) produces information on the employment status of PhD and postdoc students in France and includes information on their place of employment. Consequently, information is available on the number of French PhDs and postdocs abroad; this includes length of stay abroad and field of practice.

Further statistics on non-student scientists and academics can be obtained from the CNRS (mainly regarding CNRS institutes), and French embassies outside the EU (France introduced a Scientific Visa in 1998). The latter might become an important source of information on scientific inflows to France. According to Mr. Anthony Mauvias from the Kustler Foundation in France, data on foreign researchers in France will soon be available at a very detailed level, mainly due to the introduction of a visiting card for foreign researchers coming to France. However, given the significant role played by government labs and research centres (such as INSERM, INRA and the CNRS) in the French national innovation system, an attempt should be made to retrieve information on foreign researchers and other R&D personnel directly from these institutions. Finally, the French Ministry of National Education, Research and Technology (MENRT) provides data on the number of foreign recipients of French PhDs, together with their countries of origin and fields of specialisation.

The Netherlands

Arbeidsvoorziening is the only organisation in the Netherlands to provide any information on foreign skilled labour in the country. Data are collected on the basis of work permits provided by the immigration authorities to non-EU/EEA citizens. Data cover those employed in the scientific research sector, with a breakdown by economic activity (education, agriculture, transport, etc.) and nationality. These data only go back to 1997, the year in which the data collection exercise began. Another potential data source is the files kept by the Dutch tax department (based in Herleen). Since all highly qualified foreign individuals (including EU/EEA citizens) are entitled to apply through their employer for a 35% discount on their income tax, there is a large body of data on the educational background and occupational status of applicants; this is one of the most useful data sources on foreign researchers and other highly skilled workers. Obtaining access to these data has proven to be very difficult, but with the right official intervention, it is believed that access would be granted.

Sweden

The Swedish Statistical Central Bureau (SCB) can provide, upon request, tailored data on the educational attainment and professional occupation of foreign citizens in Sweden, and possibly also their distribution across Sweden. This organisation provides data on annual inflows and outflows of persons at the level of educational background (economists, civil engineers, etc.) and their employment status for the period 1987-98. This database provides useful information on inflows/outflows of highly skilled persons, with a quite elaborate educational breakdown. Samples of these data are provided in the analysis section of this report.

United Kingdom

Data from the *Higher Education Statistics Agency* (HESA) in the United Kingdom (known as the HESA Return Data), provide detailed information on academic staff at UK universities, broken down by nationality, position and department. This database is very useful when studying the proportion of foreign or non-national personnel among academic and scientific staff at UK universities.

Data provides information on the turnover of foreign staff in a given period but do not necessarily reflect current number of staff and might capture short-term residencies as well. However, this should not prevent the direction and size of the flows being identified. In other words, the important factor is the direction of the flows and the fact that an institution has managed to attract a significant number of overseas staff in a given period. These data are not classified under any particular reference within HESA, they were put together upon specific request. Furthermore, a detailed investigation of staff nationalities is not possible given the confidentiality governing these data. However, a greater aggregation level of nationalities is possible. For instance, North Americans, *i.e.* US and Canadian citizens; East Asians: citizens of Japan, Korea and Chinese Taipei; Oceanians: Australians and New Zealanders; West Europeans: all EU and European Free Trade Area citizens; and finally, All others, *i.e.* the rest of the world.

Table 1 provides an overview of the data sources available in the selected countries.

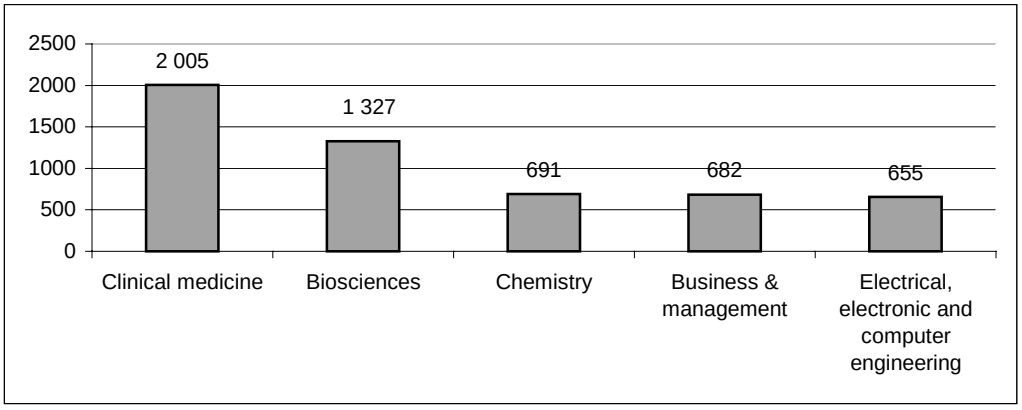
Table 1. **Data sources for international mobility of R&D personnel in selected European OECD countries**

Country	Data source	Type of information
Denmark	Statistics Denmark, MCFA	Educational attainment of foreign pop., students
France	OST, Cereq, MCFA, MENRT, CNRS	PhD students and postdocs
Germany	Alexander Von Humboldt, DAAD, MCFA	Academic personnel, foreign students
Netherlands	Arbeidsvoorziening, NUFFIC, MCFA	Work permits for non-EU/EEA nationals including occupational category, foreign students
Sweden	Statistics Sweden, ,MCFA	Educational attainment and employment status of e/immigrants and foreign population, students
United Kingdom	HESA, MCFA	Foreign academics in universities, foreign students

Data analysis

In 1996, HESA data shows that the United Kingdom received 13 266 professional migrants from abroad. Inflows appear to have been increasing since 1991; inflows of foreign academics thus appear to be part of a general increase in the numbers of foreign professionals arriving in the United Kingdom. The HESA data clearly indicate that the overwhelming bulk of overseas academic inflows to the United Kingdom originate from the countries of the European Union, followed by North America (12%), Oceania (6%), and East Asia. Inflows from western Europe represented around 45% of total inflows. The main "magnet disciplines" in the United Kingdom are clinical medicine and biosciences. These are academic areas of international strength in the United Kingdom. The largest is *clinical medicine*, with a turnover of 2 005 foreign academic staff in 1997. *Biosciences* come second with slightly over 1 300 academic staff received during the same period (excluding those already in the United Kingdom), followed by *chemistry* (691). Those whose nationalities were shown as "unknown" were excluded from the data as these are suspected to concern UK citizens. Figure 1 provides an overview.

Figure 1. **Five largest recipient disciplines, 1994-97**



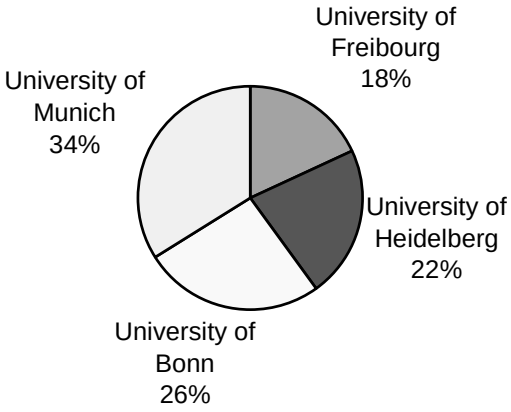
Source: Author.

Virtually all the universities have experienced an increase in the number of overseas academic staff. Indeed, this seems to be a overall trend characterising both the labour market for academics, and the United Kingdom in general. The distribution does not appear to be random, with certain fields and certain universities receiving the bulk of the inflows. The biggest recipient (Cambridge University) received 840 foreign scholars, 210 times more than the lowest recipient (Thames Valley University),

which recruited a mere four foreign scholars over the whole period. The variation across fields and institutions implies that different factors underlie the various inflows. For instance, UK strength in biosciences might explain the attractiveness of the United Kingdom in this field. However, the attractiveness of a particular institution could be related either to its international fame or to the attractions of the place in which it is located.

For Germany, data provided by the largest funds provider (AvH) to foreign researchers indicate that the University of Munich hosted the greatest number of AvH foreign fellows (1 353), followed by the University of Bonn (1 030), University of Heidelberg (858), and the University of Freibourg (717), respectively, in the period 1953-98. Figure 2 provides a graphic overview.

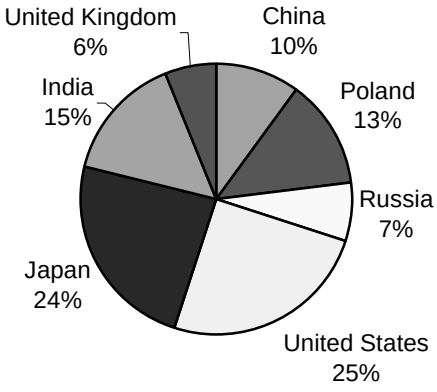
Figure 2. **Distribution of AvH foreign fellows, 1953-98**



Source: AvH (2000).

AvH fellowships are awarded on the basis of merit and are open to all nationalities and disciplines. As shown in Figure 3, between 1953 and 1998, 45% (7 174) of AvH fellowship winners came from within the European continent, with Poland the leading source country (1 025), followed by Russia (576) and the United Kingdom (466). The remaining 55% (8 898) of fellows came from the United States (1 865), Japan (1 835), India (1 146) and China (786).

Figure 3. **Geographical distribution of foreign AvH fellows in Germany, 1953-98**



Source: AvH (2000).

As can be seen, this information, incomplete though it is, provides valuable insights into the attractiveness of various German institutions and the nationalities involved in exchanges of R&D personnel with Germany. This is particularly true when these data are combined with information gleaned from interviews with German administrators of fellowship schemes which indicate that the majority of foreign (non-resident) researchers in Germany come through such channels rather than through regular employment offers.

Statistics Sweden provides some interesting observations. The number of educated Swedes leaving Sweden has been rising steadily, from around 2 167 emigrants in 1989 to 6 128 in 1997. Over the same period, the numbers of Swedish-born holders of research training degrees in science and technology leaving Sweden (593) have exceeded the numbers returning to Sweden (593). However, these numbers remain small for a country in which the population of researchers exceeds 92 000. Furthermore, during the same period, the numbers of foreign-born persons with research degrees in science and technology (S&T) coming into the country exceeded the numbers leaving. In total, Sweden has a population of 15 950 foreign-born persons with research degrees in S&T out of a total 110 274 researcher (or 15%).

According to the *Arbeidsvoorziening* database, 1 534 work permits were awarded to non-EU/EEA nationals in the Dutch scientific research sector (universities, private, public, and non-for-profit organisations) in 1999. This is up on 1997, when only 948 work permits were given to foreign scientific staff. Of the 1 534 people granted work permits, the overwhelming majority (1 104) worked for the educational sector, mainly in universities. This indicates that Dutch universities are the main "gateways" to the Netherlands for foreign non-EU/EEA scientists. Of these, 163 originated from Russia, 111 from India, and 95 from the United States.

According to statistics produced by the Ministry for Education, Research and Technology (MENRT), the largest group of foreign recipients of French PhD awards in 1997 came from North Africa (36.2%), reflecting the composition of the local immigrant community. Sub-Saharan Africa came second (14.2%), followed by the EU countries (13%). Only 1.9% of PhD awards went to persons from the North American region, many of whom probably originate from the French-speaking Canadian province of Quebec. The highest number of foreign PhDs is found in the Humanities and social sciences.

Table 2 provides an overview of the data available in the countries studied.

Table 2. **Data availability for selected OECD European countries**

Available data	Denmark	France	Germany	Netherlands	United Kingdom	Sweden
Annual inflows	Educational level of foreign residents	n.a.	Major fellowship schemes only	Scientific inflows from non-EEA countries	Academics in HESA databases	Educational level of foreign residents
Stocks of immigrant academics	Educational level of foreign residents	n.a.	Educational level of foreign residents	n.a.	n.a., but feasible	Educational level of foreign residents
Stocks of foreign students	UNESCO databases	UNESCO databases, MENRT	UNESCO databases	UNESCO and NUFFIC databases	UNESCO and HESA databases	UNESCO databases
Annual outflows	Nordic countries only	PhDs and postdocs	Major fellowship schemes only	n.a.	Available for students only in HESA statistics	Educational level of residents, including outflows
Duration of stay	Nordic countries only	PhDs	Major fellowship schemes only	n.a.	n.a.	Nordic countries only
Return flows	Nordic countries only	PhDs (see MENRT)	Major fellowship schemes only	n.a.	n.a.	Educational level of residents, including inflows

Conclusions

The availability of data on inflows of foreign R&D personnel to the EU/EEA varies from one country to another. Collection of this data usually takes place as a "by-product" of surveys conducted for different purposes. Recently, growing attention has been given to learning more about the knowledge and skills embedded in human inflows to national states. The main focus is on the possible loss or gains that migration and mobility might have on the migration of knowledge. Therefore, data collection should take into consideration the technological sectors and organisational units that represent push and pull factors for the inflows and outflows of R&D personnel in the countries under study. The various technology foresight exercises that have taken place in the last decade in almost all OECD countries can serve as a guide to prioritising data collection across sectors. The OECD countries have different science and technology agenda and different national strengths and weaknesses. Mobility – both inward and outward – will have to concentrate on those sectors that are perceived as strategic in each country. Furthermore, collection of data on international mobility would have to take into account variations in the structure and composition of national innovation systems. The responsibilities attributed to key organisations in different national innovation systems vary, particularly in terms of the roles played by the private sector, government labs and universities.

DATA SOURCES

Denmark

Statistics Denmark (http://www.dst.dk)

France

OST (www.ost.fr)

CEREQ (http://www.cereq.fr/)

Ministry of National Education, Research & Technology (http://www.education.gouv.fr/default.htm)

Germany

Alexander Von Humboldt (www.avh.de)

DAAD (http://www.daad.de/)

The Netherlands

Arbeidsvoorziening (http://www.arbeidsvoorziening.nl/)

NUFFIC (http://www.nuffic.nl/

Sweden

Statistical Central Bureau (http://www.scb.se/indexeng.htm)

United Kingdom

Higher Educational Statistical Agency (http://www.hesa.ac.uk/)

International sources

Marie Curie Fellowship Organisation (http://www.mariecurie.org/)

UNESCO (http://www.unesco.org/)

National Science Foundation (http://www.nsf.gov/)

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Chapter 16

INTERNATIONAL MOBILITY OF PhDs

by

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Introduction

An interest in the international dimension of education and in international co-operation is a prerequisite for the development and implementation of R&D. Mobility of students and scholars was at the very heart of the university system in the Middle Ages, and today's global research village has a growing international dimension.

Some years ago, the OECD conducted a series of comparative studies on "Education in a New International Setting", covering such areas as cost-benefit analysis of the internationalisation of higher education, financing and the effects of internationalised teaching and learning, as well as the curriculum development aspects (OECD, 1996). Another study compared the development of curricula for the internationalisation of higher education (van der Wende, 1996). Most such studies are based on the premise that providing students with an international experience, whether direct (whenever possible through physical mobility) or indirect (through virtual mobility provided by the inclusion of international elements in the curriculum), has become essential in all disciplines, both at the undergraduate and graduate level. There is widespread recognition of the benefits of acquiring an international perspective, "working in a co-operative context with people from different cultural and national backgrounds". Teaching staff and faculty involved in the process benefit from a constant redefinition of the content of their courses (Kogan *et al.*, 1994). In a recent report, the OECD analysed some of the issues relating to the internationalisation of university research, focusing on the impact of regional groups, the impact of IT and the mobility of students and staff (OECD, 1998). A specific interest in knowledge dissemination and access to knowledge has been reflected by the OECD in a series of studies on the so-called global research village, which specifically emphasise those aspects related to the development of ICT (OECD, 2000).

At the research training level, the internationalisation of study and research activities is of vital importance. According to the OECD, this new internationalised environment is characterised by six main features:

- "Internationalisation is becoming more global and more knowledge-based, especially in linking new knowledge to productivity.

- The rapid economic and population growth in some countries, especially outside the OECD, is creating demand for higher education greater than these countries can provide for themselves.

- The fastest growing area of trade is in exchange of services and this poses questions of acceptability of standards and qualifications across national boundaries.

- New technology will play a role in future internationalisation efforts as software transfers may complement or substitute for student mobility.

- The promotion of lifelong learning will produce both a new clientele for internationalisation and a competing demand for resources in higher education.

- Fiscal problems in many countries may cause the traditional sources of support for internationalisation to stagnate or even decline.

This new environment for higher education, and for its international activities, will require that higher education institutions and systems develop more dynamic and multi-based strategies" (OECD, 1996).

The OECD has analysed the higher education sector (OECD, 1998) and the main factors that in the medium and long term are likely to have the most significant influence on the development of universities have been identified and grouped in three main blocks:

- *Financial problems* due to declining government R&D funding and to its changing nature (increasingly mission-oriented or contract-based) that lead universities to seek new sources of support (mostly private and industrial) and to orient research activities to short-term market-oriented topics, and the related demand for economic relevance of research activities and results.

- *Systemic problems* linked to globalisation and internationalisation, stemming partly from developments and advances in information and communication technologies that contribute to the change in research climate and organisation.

- *Human resource problems* ranging from initial and continuing education activities to concerns for the availability of a highly qualified workforce for R&D, from ageing of the scientific workforce to the declining interest of youth for scientific disciplines and hence for scientific careers.

The pressures placed on the universities are very high, and the diversity of national educational systems that was long considered a serious barrier to mobility is being rapidly harmonised. Trans-national co-operation, at least on a one-to-one basis, can sometimes make it easier to co-operate with a foreign partner than with a national one. International co-operation usually works better when it is based on mutual trust rather than when it is dictated by formal rules (Teichler, 1996). In other words, the invisible college facilitates international exchanges, sometimes even in the absence of written rules.

One of the main points to be borne in mind in any discussion of the internationalisation of education is linked to curriculum content. The International Commission for Education in the 21st Century, set up by J. Delors, analysed the education sector as a whole, from pre-primary to higher education, and strongly recommended the implementation of an international dimension through

changes in education curricula (Delors, 1996). The pressures on curriculum content is made up of different elements coming from government and quality assurance policies, requests for the curriculum content to be manageable and efficient, and of course, the market (Henkel and Kogan, 1999), all of which are strongly linked to the international dimension. On the other hand, in view of the employment effects, mobility of human resources and, particularly, mobility of researchers in the European dimension, was one of the relevant policy implications highlighted by the "Busquin Report" on EU research policy (CEE, 2000).

The above-mentioned study by the OECD presents an in-depth analysis of education policy priorities related to internationalisation. The central propositions derive from five main concepts of the internationalisation process taken from the educational theory:

- "Internationalisation of the curriculum is a process of educational change aimed at improving the quality of education.

- Internationalising the curriculum, together with student mobility and staff mobility, constitute three central and interrelated elements in the implementation phase of the process of internationalisation.

- Effects and outcomes of internationalising the curriculum can be distinguished between short-term effects on students, staff and educational content, and long-term effects on profile of graduates, labour market positions and the quality of education.

- Internationalised curricula can be developed either in a national context or in collaboration with foreign partner institutions (joint curriculum development), and can be aimed at either professional training or social and intercultural integration.

- Content of curricula can be defined on the basis of an analysis of (the international aspects of) the subject area itself, (the international aspects of) the future job, or the learner or target group" (van der Wende, 1996).

International mobility of PhDs: opportunity or illusion?

Analysis of the international dimension of training activities has often focused on science and education policy in an attempt to identify best practices most likely to foster mobility.

A survey on international mobility of PhDs conducted by the Italian National Research Council (CNR) (Avveduto and Cipollone, 1998) took a bottom-up approach, focusing on the opinions and experiences of those who had had the opportunity to spend part of their PhD abroad. The analysis followed the guidelines elaborated by a EU research team on postgraduate education established by Stuart Blume, and focused on specific aspects of international mobility such as its desirability and utility in stimulating, *inter alia*, a sense of belonging to the international scientific community (Blume, 1995). The goal was to highlight the problems and obstacles to international mobility, propose policy recommendations based on the relevant national experience, and draw up a list of requests for submission to the European institutions. CNR participated in this work by carrying out the analysis of the Italian experience.

The CNR survey covered four major aspects of internationalisation:

- The desirability and feasibility of international research training.

- Objectives and benefits of international mobility.
- Barriers to further internationalisation.
- Impact on the labour market.

Structure and methodology of the survey

The CNR carried out a full-scale survey of six Italian universities: Ancona, Chieti, L'Aquila, Genoa, Florence and Rome. These universities were chosen according to location and dimension criteria set out in the European study; the first three are peripheral universities of small size, the others are large metropolitan ones.

The CNR contacted all doctoral students and co-ordinators from the last three course cycles (1995-97). For the survey, 1 935 questionnaires were mailed to doctoral students, and about 600 to professors acting as course co-ordinators. In all, 26.7% of doctoral students replied; there were no variations between men and women, and the response rate was about 26% for each. Only 14.5% of co-ordinators responded, which is indicative of the generally low level of interest in the subject.

In order to produce internationally comparable results, the 40 questions of the semi-structured questionnaire for PhD students, and the 20 questions for lecturers, were built on the basis of the interviews conducted in the participating EU countries. The questions were designed to gradually lead respondents to address the topic of international mobility.

In the case of doctoral students, both those who had had the opportunity to study and conduct research abroad, and those who had not, were asked to express their opinions. Questions tended to focus on problems related to teaching activity during the doctorate course in Italy, and sought, from the outset, to gauge the interest of doctoral students in a possible experience abroad. By exploring the difficulties encountered and the benefits gained from an international experience, we attempted to identify the impact that such an experience could have on future careers.

The first part of the lecturers' questionnaire asked for basic information about the university structure, before going on to address the topic of international exchanges. Semi-structured questions asked whether, in the department for which they were responsible, any international exchanges were in progress at the time of the survey and, if so, at what level.

The second part of the questionnaire was designed to permit a better understanding of the financial or organisational aspects of foreign training activities; lecturers were asked to express their personal views on mobility. The lecturers' suggestions on how to improve this particular aspect of doctoral training are presented at the end of this chapter.

Almost 50% of replies from PhD students came from science side: engineering, mathematics, physics and natural sciences accounted for the majority of replies to the survey. Overcrowded faculties such as law and humanities had a lower response rate. The average age of respondents was 29 (Table 1).

Table 1. **The CNR survey sample**

Professors	600
PhD students	1 935
Average age	29
Male respondents (%)	51.7
Female respondents (%)	48.3
Disciplinary breakdown (%)	
Agriculture	2.8
Architecture	10.8
Economics	2.4
Pharmacy	1.6
Law	5.0
Engineering	22.0
Maths, physics, natural sciences	22.4
Humanities	16.8
Medicine	12.2
Political science	2.9
Statistics	1.0
Veterinary	0.1

Source: Avveduto and Cipollone (1998).

Organisation and structure of exchange: motivations and procedures

The decision to go abroad and the organisation of a study period in a foreign university entails a large number of administrative procedures. There is no simple decision-making process that leads the student to a chosen destination. The case histories recorded vary widely, and are sometimes contradictory.

In some cases, an extremely well-organised process was in place and doctoral students were fully aware from the very beginning of their course of the opportunities available for carrying out part of their research abroad. In other cases, such opportunities only came about through personal initiatives by professors in advising and guiding students, or by students themselves in making applications and independent arrangements.

Overseas experience is rated by the vast majority of students and professors as highly desirable, and is often cited as a value *per se*. In fact, only 26% of students had had the opportunity of spending a study period abroad, although 95,7% of those who were not able to benefit from such an opportunity would have liked to.

Although organisational models differ, analysis revealed that the motivations and procedures for choosing which country to study in, and the best period to do it, tended to converge.

When asked which stage of their training they regarded as the best time to go abroad, 40.9% of respondents opted for the second year of their PhD, although 37.4% thought that the experience should be divided over more than one period (Table 2). Most of the respondents agreed that it was important to spend the first year at the *alma mater* in order to acquire knowledge, gain familiarity with the subject of study and the study environment, prepare the programme of research, draw up a suitable study programme, and begin work on it under the supervision of a tutor. During the first year, many

universities also organise *ad hoc* courses and seminars for doctoral students at which attendance is often compulsory.

During the third and final year of the doctoral course, students conclude their research work, write their theses and should therefore be at their home university. Conversely, the second year of doctoral course is regarded as the time when students, having consolidated their knowledge, can benefit from becoming familiar with an international context. At this stage, students have already laid the bases for their research work at their *alma mater*, but are not yet under pressure to submit their final theses; the new environment can offer new stimuli. Nonetheless, 40.3% of the students who had been abroad went during their first year (Table 2).

The opportunity of visiting a foreign university more than once during PhD has been indicated by 37,4% as the preferable one, but no student due to the present organisation of study leaves, had this possibility under a specific scheme.

Table 2. **Preferred timing for a study visit abroad**

Percentages

	Best timing	Actual timing
First year	6.6	40.3
Second year	40.9	37.3
Third year	12.2	17.9
More than once	37.4	--
n.a.	2.9	4.5

Source: Avveduto and Cipollone (1998).

The choice of overseas destination is made largely on the basis of two fixed parameters: *i)* the type of research being carried out; and *ii)* the web of personal relations established by the student. The two parameters often intersect.

When the decision depends mainly on the type of research being performed, foreign universities are chosen primarily for their prestige and academic reputation. Students pick universities which are recognised for their academic excellence and expertise, and, in many cases, there is no pre-existing relationship with the foreign university. Students do not necessarily go through their professors and often organise contacts and arrangements themselves (Table 3).

In the majority of cases, however, students tend to follow the beaten track in their choice of overseas destination. If they choose a university which has a tradition of joint research with their *alma mater*, this simplifies arrangements and eliminates many difficulties.

Table 3. **Criteria affecting the choice of the foreign destination**

Percentages

Prestige of the university	35.1
Previous relationships of professors	32.8
Previous relationships of students	27.6
Accommodation facilities	4.5
Total	100.0

Source: Avveduto and Cipollone (1998).

The most desirable destination indicated by PhD students is the United States (with 33.5% of students expressing a desire to go there). However, taken together, three EU Member states, France, Germany and the United Kingdom, account for over 50% of replies.

In any subject area, there is always a large body of students who choose to the United States; that country is the preferred destination of engineers, in particular. However, it is noteworthy that some lecturers pointed to a recent fall in the popularity of the United States, due to a decline in the North American influence, particularly in the social sciences, and greater expectations centred on Europe, Although over the last few years, the United States continues to been perceived as the most desirable destination for students wishing to achieve international mobility, Europe is rapidly gaining ground both in terms of reputation and quality of training.

A high concentration of students in architecture opt to go to France and the United Kingdom, while Germany is much sought after for engineers and for students at arts faculties, such as letters or philosophy.

Table 4 shows the difference between the favoured destinations chosen by the sample of students and the final destinations of those who actually went abroad.

Table 4. **Preferred destinations of PhD students *vs.* actual destinations**

Percentages

Countries	Favoured destinations	Actual destinations
United Kingdom	*(22.6)*	24.0
United States	*(33.5)*	18.0
France	*(18.5)*	15.0
Germany	*(11.0)*	13.5
Switzerland	*(1.0)*	5.2
Canada	*(1.0)*	4.4
Belgium	*(0.4)*	3.0
Spain	*(3.0)*	2.2
Japan	*(0.6)*	2.2
Netherlands	*(2.2)*	2.2
Other European countries	*(5.8)*	5.9
Other countries	*(0.6)*	4.4

Source: Avveduto and Cipollone (1998).

In terms of the optimal duration of the study period abroad, opinions differed. In general, respondents agree that a timeframe of six months is ideal, since it allows for an initial period of acclimatisation, while leaving a reasonable amount of time to draw academic benefit from the experience. For the most disparate reasons, however, others suggested a drastically shorter period (no more than three months). Others argued that, if it is to be truly beneficial, the period should be a good deal longer.

The average period of the stay abroad varies from three to six months for scientific and arts subjects. Only medical doctors showed a higher percentage of stays for more than a year. Engineers were the category that most frequently stays abroad for at least three months.

The different points of view regarding the optimal duration of the study period should be seen in a wider context. It appears that in the first case (mainly the opinions of professors in the exact and

natural sciences), the study period abroad is seen as a sort of consolidation (if not a conclusion) of an established piece of research work. This work is at an advanced stage and previous contacts and, in some cases, exchanges, have already played a part. In other words, a stay at a foreign university is considered almost as the climax of an activity which has already been completed, even though it may be only partially relevant to the final preparation of the doctoral thesis.

In the second case, the period abroad is seen more as part of an ongoing study and research activity, arguably more learning-oriented but nonetheless significant for the research *in itinere*. It is felt that an experience abroad may help to further shape or re-orient the activity itself. Professors are more aware of potential problems, albeit mainly from the point of view of optimisation of planning and scheduling. It should be pointed out, however, that the students' decisions to prolong or shorten the period abroad (and often whether to go abroad or not) were often strongly influenced by factors of an entirely different nature. Irrespective of the theoretical possibility of opting for the best solutions possible and of the high degree seriousness and determination shown by the students, practical problems often prove decisive. This is especially true in cases where the universities fail to provide sufficient support and guidance.

Objectives and benefits of international mobility

The value set by students on international mobility depends to a high degree on the value they set on their home research training. The most frequently mentioned objectives are linked to the greater personal cultural and scientific growth that students believe they will obtain from exposure to a different scientific and training milieu. Also important is the chosen research programme that may require a visit to a foreign university in order to collect data or carry out experiments in structures that are not available in the home university.

Most respondents rate a study period abroad as a positive experience. The reasons cited fall into two main categories. The first encompasses exposure to a new scientific and cultural context, leading to broader professional and human experience and, consequently, improved competence; capacity to cope with new work situations, acquisition of greater flexibility and tolerance towards others and willingness to accept mobility.

The second group is concerned with strictly training-related aspects; they highlight the opportunities to learn new research methodologies and gain familiarity with avant-garde techniques and instruments, *i.e.* the chance to acquire specialist training.

Problems and obstacles

The problems involved may be objective (*i.e.* of an economic, bureaucratic or logistic nature) or subjective (*i.e.* knowledge of languages, adapting to the new environment, interaction with different subjects and study methods).

Some 72% of respondents had never left Italy for a study period during their PhD. The reasons that, in their opinion, had prevented them from going abroad included, in 34.4% of cases, lack of sufficient funding, and, in 20.9%, family ties or voluntary work commitments (Table 5).

Lack of time and lack of information are the two most relevant reasons preventing international mobility. Obtaining the appropriate information seems to be a major problem; 16.9% of respondents

complain of a total lack of information, while 12.7% point to a lack of specific information on scientific opportunities abroad.

Table 5. **Obstacles encountered by PhDs who did not travel abroad**

Percentages

Insufficient funds	34.4
Personal commitments (family/work)	20.9
Lack of information	16.9
Lack of time	15.1
Inadequate knowledge of the scientific opportunities abroad	12.7

Source: Avveduto and Cipollone (1998).

In most cases, objective aspects prevail. A good deal of perseverance and problem-solving ability is required on the part of the student, and often of the professor. Where such problems are not so daunting as to actually discourage the student from undertaking the initiative (once, the necessary funds have been gathered), the greatest difficulties centre round practical and bureaucratic problems. Once all the minor, but time-consuming, formalities have been completed, finding accommodation is the prime concern.

Twenty-five per cent of the lecturers surveyed reported no difficulties in arranging a study trip abroad. The rest point to problems in establishing contacts with foreign universities and complain about bureaucratic hitches. Respondents suggest that these difficulties might be ironed out by streamlining bureaucratic procedures through *ad hoc* bureaux, by making stays abroad compulsory and by disseminating more information on the subject.

A large share (37.3%) of students who had spent a study period abroad stated they had not encountered any particular problems. Most students appear to be able to adapt to a new cultural environment and to different teaching methods. Language unfortunately remains a barrier in 25.4% of cases (Table 6).

Table 6. **Main problems encountered abroad**

Percentages

Different teaching methods	9.0
Cultural differences	10.4
Language	25.4
Accommodation	9.0
No problem	37.3
n. a.	9.0
Total	100.0

Source: Avveduto and Cipollone (1998).

Financial support for research doctorates comes exclusively out of public funds, with grants provided mainly by the Ministry of Scientific and Technological Research and Universities. Some research agencies, such as the CNR (National Research Council), which covers all disciplines, the INFN (National Institute of Nuclear Physics), and the ENEA (National Committee for Alternative Energies), fund individual research doctorates. On the whole, however, this tends to be more the exception than the rule, following no fixed pattern from year to year in terms of the number and magnitude of investments made.

To finance his study period abroad, the research student has to rely on his study grant. For a PhD course, the standard study grant at an Italian university amounts to approximately USD 800 per month. According to existing regulations, the doctoral grant increases by 50% during the study period abroad. In most cases, this increase in no way suffices to cover the expenses incurred by the student during his stay abroad. Travel and living expenses may prove prohibitive.

It is not easy to find additional funds through collaborations or scholarships. This means that a considerable part of selection is based on parameters that are not strictly linked to merit and ability but are based solely on economic factors – a socio-economic selection takes place among doctoral students who might potentially benefit from this type of experience.

For 63.4% of the PhD students in our sample, the cost of their stay abroad exceeded the available finances, and the majority (61.2%) relied on their families for financial support (Table 7).

Table 7. **Sources of additional funding**
Percentages

Family	61.2%
Friends	5.9%
Self-financing	21.2%
Other institutions	5.9%
Host institutions	5.9%
Total	100.0

Source: Avveduto and Cipollone (1998).

Impact on employability

One of the questions which obtained most responses (many of which were multiple), asked PhD students whether, in their opinion, those who had spent a training period abroad enjoyed better job opportunities.

Different reasons were put forward to stress the importance of an experience abroad for the development of one's training and professional career.

All lecturers argue that students with overseas experience have better job opportunities than students with no such experience. However, the reactions of the doctoral students themselves, who have to grapple with the precariousness of postgraduate study, are mixed (Table 8). Some 54.8% of PhDs believe that spending part of their training abroad makes it easier for them to find a job by opening up a wider labour market, both in content and geographical terms. The fact of being part of an international framework opens up employment opportunities outside the home country. The negative responses (33.7%) implied a certain level of disillusion concerning the relationship between experience acquired abroad and employers' interest. Students fear that a long absence can be risky as it may mean missing out on opportunities at home that could be seized by those who have remained in daily contact.

The relative wealth of employment opportunities abroad was highlighted in 9.7% of the responses. According to the respondents, this is the result of contacts established with foreign scientific circles and teams of specialists. In terms of the possible professional outlets following the period abroad, some respondents see advantages for students who remain in the academy but not for those who look for a research job in other sectors.

Although they are fewer, the negative replies are backed by telling arguments. The tie with the problems of the professional world is felt very strongly. As many as 39% of replies, albeit many-faceted, reveal disenchantment with the labour market. In Italy, there is a widespread belief that the system fails to provide a link between training and the labour market and that institutional and structural deficiencies prevent training from helping students to find jobs. Some respondents stress that other factors count in achieving this much sought after goal, some of which are political or patronage-related. Some respondents declare that knowledge and qualifications do not guarantee jobs or, at all events, are not sufficiently taken into account by firms seeking candidates.

Another point that was raised by a number of respondents was the fact that moving away from the academic environment in which one has "grown up" may mean missing favourable job opportunities. Those students who stay behind can maintain professional and social relations with the surrounding environment. In other words, those who remain are advantaged, since those who leave have to re-adapt when they return. Underpinning these discordant opinions is the widespread assertion of a certain lack of sensitivity towards international studies.

Table 8. **Job opportunities after an overseas experience**

Percentages

Better job opportunities	54.8
No better job opportunities	33.7
n.a.	11.4
Total	100.0

Source: Avveduto and Cipollone (1998).

Conclusions

The value of an international mobility experience undertaken during PhD studies is rated highly by both students and professors. However, this positive rating needs to be considered in the context of the general aim of the doctoral studies. If the PhD is pursued as part of the student's personal scientific and cultural growth and as the first step in an academic career, the international experience is invaluable. If, on the other hand, PhD students are not considered as being totally integrated into the research activity of the department or are used not to carry out "real" research activities but rather as a sort of "service" for the department, international mobility may be viewed as a negative factor. Many students stressed that some of the difficulties they had encountered abroad, such as those relating to differences in method and approach, became benefits on their return. Most respondents declared that the main advantages of the study period abroad were of a scientific and educational nature.

The organisation of a study period abroad gives rise to a number of difficulties: students need to find solutions to both personal and practical problems, not to mention the need to obtain finance. In the majority of cases, study grants do not cover all the related expenses; very often students are forced to rely on personal savings or on assistance from their families. An unfair selection, based more on affordability than on capability, is therefore applied to students' legitimate desire to spend part of their PhD abroad. Another major barrier concerns information diffusion; many PhD students complain that they are unable to obtain relevant information at the appropriate moment.

Lecturers suggest that to increase the effectiveness of a study experience abroad, it would be necessary to create international doctorates in which courses take place over several co-ordinated venues, to set up international consortia and to set doctoral programmes that follow the lines of the Erasmus or Socrates programmes. A survey question on the impact of internationalisation in research

training envisaged multiple answers. The majority of respondents stressed the need to set up Summer Schools and staff exchange programmes, with common training modules. Many professors called for the EU to introduce supplementary funding, while others demanded the introduction of supranational legislation to allow EU interventions in the field of international training to effectively meet the current demand. Future EU intervention is viewed favourably, provided that it becomes more "lightweight". Respondents feel that this would facilitate the extension of bilateral mobility, not only among students but also among professors. At present, exchanges which take place on a direct bilateral basis tend to involve only a couple of professors or a handful of students – there is no real "liaison" between doctoral courses. Many respondents think it would be a good idea to organise international doctorates with courses at venues throughout Europe. One solution might be to split courses proportionally among, say, three different nations and universities, thus allowing students to follow the same syllabus and achieve the same qualifications.

A supranational intervention would appear to be the most suitable means of simplifying international relations and overcoming differences in local legislation, through a "lightweight" normative role, acting as a catalyst and leaving the universities free to organise the exchange programmes. The financial difficulties that are the real obstacle to the international mobility of doctoral students today, might been overcome if a supranational organisation could provide economic support for the whole process.

There is no direct relationship between better job opportunities and international mobility. Some students and professors believe that acquiring an international experience does give PhD students better job opportunities or at least gives them an advantage in searching for jobs by providing access to a wider labour market outside national boundaries. However, others believe that potential employers are not impressed by international mobility and that taking students away from the day-to-day activities of the department can mean that they miss information on possible job openings.

The universities can play a key role in fostering international mobility. Their primary aim should be to help students cover the expenses incurred during the study period and to ensure that information is disseminated widely throughout the university community. International experience is highly relevant to research training, and universities and research institutions must ensure that the opportunity to partake in such projects is open to all PhDs and will not turn out to be an illusion for the vast majority.

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Chapter 17

RESEARCH AND POLICY ISSUES IN HIGH-SKILLED INTERNATIONAL MIGRATION: A PERSPECTIVE WITH DATA FROM THE UNITED STATES

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Introduction

Migration across national borders provokes many spirited political and policy debates. Although these debates are often most contentious when they deal with lower-skilled migrants, high-skilled migration also raises strong emotions. If nothing else, immigration of any sort changes the status quo. If lower-skilled migrants are sometimes said to take jobs that natives do not want, high-skilled migrants are usually employed in the types of jobs that many would prefer go to natives. At the same time, government in both less-developed and many developed countries worry about losing their more highly educated workers. As high-skilled migration appears to become more important to the world economy, it becomes all the more important to understand its likely effects. Unfortunately, these effects have not been well studied or measured and are likely to be more complex than acknowledged in most policy discussions. This chapter seeks to provide an overview of the major research and policy issues in the international migration of highly skilled individuals and their families. Knowledge and understanding of the effects of this migration are limited not only by available data (as is the case in much immigration research), but also by unanswered questions in labour market theory and economic growth theory: How fungible are skills among those with specialised knowledge? Does the presence in an economy of highly skilled workers affect investment and R&D decisions by firms (increasing demand over time for high-skilled workers)? Do more scientists lead to more knowledge? This chapter does not answer these questions, but deals with how these and other questions affect our understanding of high-skilled migration.

As the world largest economy, as the largest educator of foreign students and as a traditional nation of immigration, the United States is an important nexus for the international movement of high-skilled workers. As such, this chapter uses US data on high-skilled migration to and from the United States to provide some insights into the magnitude and direction of some of the possible effects of high-skilled migration.

While this chapter often focuses on economic and knowledge creation effects for individual countries and the global economy, it is also important to recognise that this should not be the only component of policy making on any form of immigration policy. Freedom of movement is highly valued as a human right, and is recognised as such in the Universal Declaration of Human Rights, albeit in a limited form.[1] Aside from the maximisation of human liberty, it seems likely that migrants

themselves incur the greater economic benefits and costs of high-skilled migration – theory would suggest that at least the expected value of individual net benefits is positive for those who choose to migrate, although these benefits and costs may also include substantial non-economic factors. On the other hand, countries may seek to limit immigration for cultural reasons, or prefer for humanitarian reasons to favour immigration of family members of previous migrants.[2]

National and global consequences of high-skilled migration

Table 1 outlines one attempt to lay out likely or possible economic effects of high-skilled international migration. This needs to include possible positive and negative economic effects for both receiving and sending countries. In additional to country-level effects, there are also global effects on the growth of technology and knowledge that cannot be easily assigned to individual polities.

Table 1. **Possible global and national effects of high-skilled international migration**

SENDING COUNTRIES: POSSIBLE NEGATIVES	**RECEIVING COUNTRIES: POSSIBLE NEGATIVES**
• "Brain drain": lost productive capacity due to at least temporary absence of higher skilled workers and students • Less support for public funds for higher education	• Decreased incentive of natives to seek higher skills • May crowd out native students from best schools • Language and cultural barriers between native and immigrant high-skilled workers • Technology transfers to possibly hostile countries
SENDING COUNTRIES: POSSIBLE POSITIVES	**RECEIVING COUNTRIES: POSSIBLE POSITIVES**
• Increased incentive for natives to seek higher skills • Possibility of exporting skills reduces risk/raises expected return of personal education investments • May increase domestic economic return to skills • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Return of natives with foreign education and human capital • Remittances and other support from diaspora networks	• Increased R&D and economic activity due to availability of additional high-skilled workers • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Increased enrolment in graduate programmes/keeping smaller programmes alive
POSSIBLE GLOBAL EFFECTS	
• Better international flow of knowledge • Better job matches • Greater employment options for workers/researchers • Greater ability of employers to find rare/unique skill sets • Formation of international research/technology clusters (Silicon Valley, CERN) • International competition for scarce human capital may have net positive effect on incentives for individual human capital investments	

The categories, "receiving" and "sending" are not meant be synonymous with "developed" and "less developed". Many developed countries, such as the United Kingdom, have expressed concerns about retaining their researchers, and many less-developed countries do attract foreign talent in areas where they are able to offer opportunities to study or use geological and biological natural resources. Indeed, many countries may be both net receivers and net senders in different skill areas.

Few of the possible effects discussed in this chapter are well established empirically, although some "indicator" data do exist. Thus, this chapter represents an agenda for research.

Negative effects for sending countries

A loss of productive capacity due to the, at least temporary, loss of highly skilled workers and students is the most discussed negative effect of high-skilled migration on sending countries. This "brain drain" has been an issue not just for countries, but for any area whose educated natives migrate – in the United States, rural states often worry about the products of their state universities moving to other parts of the United States where their skills are in greater demand. In addition to the direct effect on the availability of high-skilled labour, another consequence of highly educated workers leaving a country may be a reduction in political support for funding for higher education.

Table 2. **Share of US foreign-born with foreign degrees**

	% with highest degree from foreign school	% with any foreign degree	% with foreign secondary school
Bachelor's degree	49.1	51.1	67.4
Master's degree	24.1	57.2	76.4
Professional degree	60.0	69.3	74.3
PhD	31.2	73.3	86.7
All degree levels	40.2	54.7	71.0

Source: NSF/SRS 1993 National Survey of College Graduates.

College educated migrants to the United States do have a significant proportion of their formal education from outside the United States. As shown in Table 2, about 55% of the college-educated foreign-born in 1993[3] had at least one post-secondary degree from an institution outside the United States, and 40% had their highest degree (or most recent if at the same degree level) from a foreign institution. Even at the highest education level, nearly one-third of the foreign-born with doctorates who were resident in the United States received their doctorates from foreign institutions. Although many immigrants to the United States arrive as children, 71% of the college-educated foreign-born graduated from a foreign secondary school, with their pre-university education funded outside the United States.

Many countries are concerned with the return rates of their nationals who go to other countries for graduate training. Finn (1999) shows that slightly over half (53%) of 1992-93 recipients of science and engineering doctorates from US schools were working in the United States in 1997.

Positive effects for sending countries

Less often discussed are the positive effects that may exist for countries whose highly skilled natives and citizens move across borders. In part, this is because of measurement difficulties. Although data on international migration is often poor,[4] counts of initial migrations of people are easier to obtain than data on return migration or return knowledge flows. Nevertheless, there are several indicators that such benefits might exist. While there is talk of "brain drain", others have talked of "brain gain" or "brain circulation" to describe some of these complex effects.

Incentives for human capital investment

The most difficult to measure – but theoretically likely benefit – may be an increase in the incentive for natives to invest in their own human capital. This can occur in theory through three mechanisms:[5] *i)* through an increase in the domestic return to skills due to the relative scarcity created by the "brain drain"; *ii)* through an increase in the expected value of an individual's human capital investment if they have migration as an option; and *iii)* through a reduction in the risk associated with the return on individual human capital investment if migration serves as a labour market stabiliser.

The first effect is the improvement of labour market conditions for highly skilled workers when their domestic supply is reduced by emigration to other national labour markets. Wages and unemployment for high-skilled workers in less-developed countries (with less developed financial markets and entrepreneurial infrastructure) may be particularly sensitive to "over-supply". Other channels, through which migration leads to increased supply may, of course offset this.

The second effect results from uncertainties that individuals might have about their likely migration behaviour. To show this in a simple algebraic form, the expected value of an individual's human capital can be expressed as:

$$E(H)= P_m\, E_f(H) + (1 - P_m)\, E_d(H)$$

where P_m is the subjective individual probability of migration, E_f is the expected value of human capital H in the best foreign labour market, and E_d is the expected value of the same human capital in the domestic labour market. Where the expected foreign value of human capital is much greater than the domestic value, even a small non-zero expectation of migration may have an important effect on the expected value of a human capital investment decision.[6]

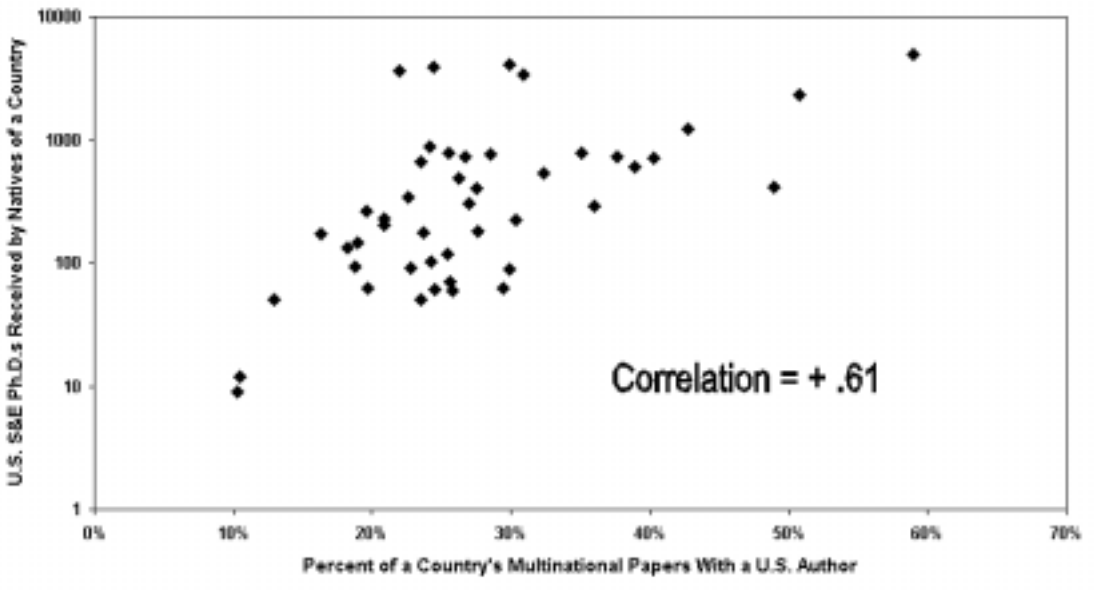
The third effect depends upon whether the amount of emigration of high-skilled labour from a country is related to current labour market conditions. If a downturn in demand for high-skilled labour in a country results in more high-skilled workers leaving, that might tend to reduce fluctuations in employment and salaries, reducing the "risk" associated with the human capital investment. The considerable investments required for an individual to acquire higher skills might seem less worthwhile if the labour market demand for those skills is volatile.[7] To some extent, this role of a labour market stabiliser may be offset by any instability caused by return migration driven by changes in conditions in the receiving countries.[8]

Knowledge flows and collaborations

International migrants (other than refugees) seldom break all ties with their country of origin. There is reason to believe that high-skilled migrants who have extensive education and, often, work experience in their country of origin maintain contacts with former colleague and education institutions. This may provide a benefit for sending nations by facilitating the formation of international networks of contact and knowledge exchange – both with expatriate natives and with contacts nurtured by returning expatriates while abroad. Some evidence for this is seen in Figure 1, which show a positive 0.61 correlation between the log of the number of US doctorates received by natives of a country and percentage of that country's internationally co-authored articles with the United States.[9]

The fact that contact in graduate school may lead to research collaboration across borders is not an unexpected effect. The same effect is likely to be created by the international movements of people employed by industries. Movement of workers between firms has long been recognised as a powerful source of knowledge transfer – both of technology and of more subtle things such as business practices and networks of contacts – and this is likely to occur even when the firms are across national borders.

Figure 1. **Scatter plot of percentage of 1991-95 multinational papers with a US author *vs.* number of 1986-90 US science and engineering PhDs received by natives of a country**



Return of natives with foreign education and human capital

An important, but not necessary, way for a sending country to benefit from knowledge flows is for its natives to return after spending a period of time outside their country of origin. Despite wage differentials and other differences in opportunities, return migrations are common even between developed and less-developed countries.[10] To a great extent, this is unsurprising and reflects the importance of cultural and family ties to migrants. Another factor which encourages return migration is the temporary nature of the work permits that many countries use as their primary method of allowing employers to recruit non-citizens. For example, in the United States, the most common high-skilled work visa (known as a H-1b) is for three years, with a single three-year renewal allowed, and is not formally[11] part of any path to a permanent visa.

Finn (1999) argues that, if half of foreign students with temporary visas who receive US science and engineering doctorates are still working in the United States five years later, this implies that the others leave the United States[12] with training received at a US university and perhaps a postdoc or other post-graduate work experience. As shown in Table 3, Finn found that "stay" rates varied by field of degree, ranging from 32% in the social sciences to 61% in the physical sciences and mathematics.

Table 3. **1992-93 temporary visa US PhD recipients remaining in the United States, 1994-97**

Percentages

	1994	1995	1996	1997
All S&E PhD recipients	48	51	52	53
Physical sciences and mathematics	55	59	60	61
Life sciences	48	51	53	54
Social sciences	29	31	32	32
Engineering	49	53	53	54

Source: Finn (1999).

Also noteworthy is that the stay rates shown in Table 3 hold steady or increase somewhat with time since degree. However, another data source, the NSF's *Survey of Doctorate Recipients* (SDR), suggests that even those who do stay in the United States leave after a period of time. This seeming contradiction may be reconciled through a complex pattern of migration – while some individuals who earned a US doctorate leave each year, others return.[13]

In 1995, a special effort was made in collecting data for the SDR to discover if survey non-respondents resided outside the United States. Since it is quite possible that other non-respondents whose location was never discovered, also resided outside the United States, this should be considered a lower-bound estimate. Table 4 presents these estimates for foreign-born individuals in the SDR (which covers those with doctorates from US schools who were either a US citizen, a US permanent resident, or had plans to stay in the United States at the time of their degree). Thus, the SDR included only those foreign-born PhD recipients with particularly strong ties to the United States. Among this group, about one-fifth of those who graduated in the last three decades were identified as residing abroad; in the case of graduates from the last ten years, over 4% had moved from the United States in the previous two years.

In addition to knowledge transfers, the return of natives to a sending country also brings a gain of human capital that may not have been developed had the migrants stayed in their home countries. There are several reasons for this. Differences in the availability or quality of particular areas of university instruction may have been a reason for the original cross-border movement. Knowledge of unique technologies may also be gained in formal employment. In addition, foreign employers and educational institutions often finance both formal education and job-related training to a considerable extent.

Table 4. **Lower-bound estimates of foreign-born with US science and engineering PhDs working outside the United States in 1995**

US citizens, permanent residents or those who expressed definite plans to stay at time of degree

Decade of PhD	Percentage residing outside the United States in 1995	Percentage in 1995 who had left the United States since 1993
1945-54	6.1	0.6
1955-64	13.7	0.8
1965-74	22.7	1.3
1975-84	22.2	2.3
1985-94	19.4	4.1

Source: NSF/SRS 1993, 1995 Survey of Doctorate Recipients.

Support from diaspora networks

In the general immigration literature, many studies have analysed the effects of having large populations of natives outside of a country's border. These include both the creation of new export opportunities for their home countries and the value of remittances to relatives and institutions in their home countries. It seems plausible that high-skilled migrants create the same type of opportunities, albeit sometimes in different ways.

Less-skilled migrants often form part of the retail and wholesale infrastructure in their new countries. High-skilled migrants may be less likely to become retail or wholesale managers, but more likely to be involved in the purchase or selection of technology products and services. For example, there is significant anecdotal evidence that Indian migrants have played a key role in the business partnerships and relationships between US and Indian technology firms.

Remittances from high-skilled migrants may also be only a variation of the phenomenon discussed in the general immigration literature. High-skilled migrants are smaller in number, but often earn higher incomes. In addition to gifts to relatives, high-skilled migrants may serve a significant financial and other role as alumni of education institutions in their home countries.

Negative effects for receiving countries

Many participants in discussions of immigration policy have been surprised in recent years to find that high-skilled international migration is no less politically controversial within receiving countries than is immigration in general. There is a very large literature in economics seeking to find the effect of lower-skilled immigrants on opportunities for lower-skilled natives.[14] However, little research has been conducted on the effects of higher-skilled migration. Nevertheless, several effects can be hypothesised.

Decreased incentive for natives to seek higher skills

If high-skilled migrants are substitutes for natives in the domestic labour market, then a normal type of static supply and demand analysis would suggest a reduction in the wages associated with higher-skilled occupations.[15] This in turn would lead to a decreased incentive by natives to make human capital investments.

There are a number of theoretical factors that may moderate any such effect on native human capital investment patterns. First, the same analyses that assume lower-skilled migrants to be substitutes for both lower-skilled natives and for capital also assume that high-skilled migrants are complements to both lower-skilled workers and to capital. Thus, high-skilled migrants might do more to create new capital investment and utilisation of a perhaps underused segment of the labour force. This is to say that, to some extent, higher-skilled workers may produce economic changes that increase the demand for their services, and thus mitigate the effect of increased supply upon compensation.

Although there have been no detailed econometric studies, the most basic statistics suggest that high-skilled migration is most prevalent in fields which present relatively good employment opportunities. This may be for many different reasons. Workers may be less willing to undertake the costs of migration unless the opportunities are great. Employers may not want to pay the often-considerable legal costs associated with obtaining work visas unless they face a tight domestic labour

market. In addition, it has been suggested that the influx of diverse human capital brought by migrants may contribute to creating opportunities in a field.

Figures 2 and 3 compare the proportion of US science and engineering PhD holders who are foreign born in a list of major S&E fields of degree to measures of labour market conditions for recent PhD recipients in those fields.[16]

Figure 2. **1988-92 science and engineering PhDs**

Comparison of percentage foreign-born to median native salary for selected fields

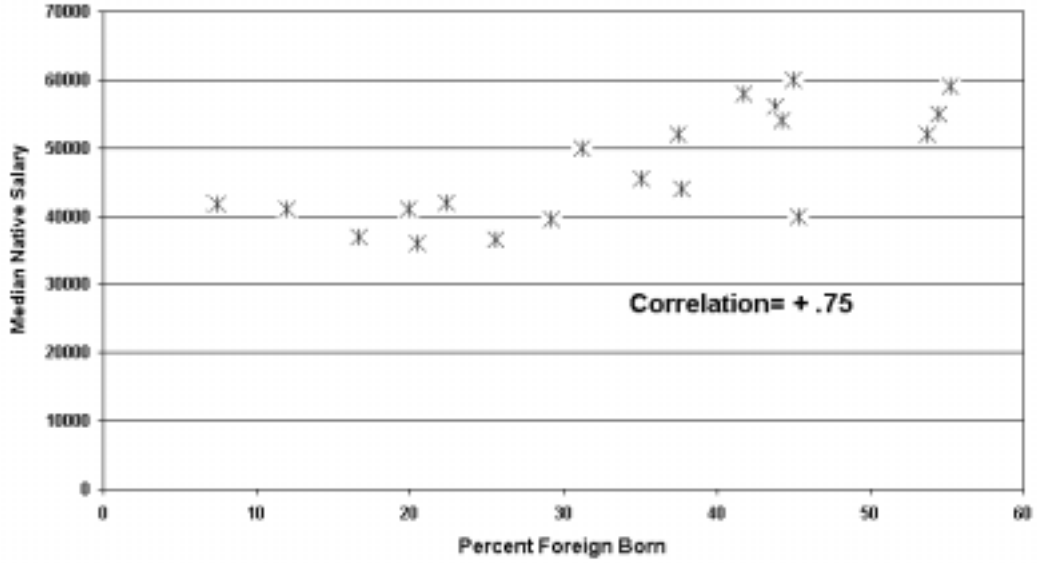
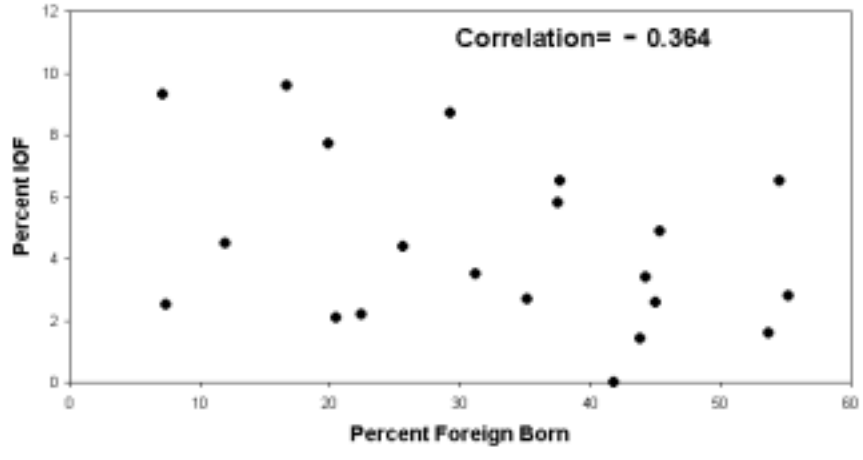


Figure 3. **1988-92 science and engineering PhDs in 1993**

Comparison of percentage foreign-born to percentage involuntarily out-of-field for selected fields of degree



In general, the higher the proportion of foreign-born, the higher the salary. This is not driven just by the high proportion of foreign-born among US PhDs in engineering, since even in many broad fields higher foreign-born representation is associated with higher salaries: In the social sciences, economists are paid more than sociologists. In the life sciences, biological scientists are paid more than agricultural scientists. In the physical sciences, physicists are paid more than geologists. In each case, the lower-paid field had fewer foreign-born PhD holders. In Figure 2, the correlation between median salary and percentage of foreign-born is a strong positive .75.

The same pattern holds when comparing the percentage of a recent PhD cohort that is foreign born with a measure of labour market distress. For high-skilled workers, the unemployment rate can be a poor measure of labour market conditions in a field, since high-skilled workers are usually highly employable in some capacity. A statistic generated from the NSF SESTAT data file, the percentage involuntarily working outside their field of degree, often provides a more sensitive indicator of labour market conditions. Figure 3 shows the involuntary out-of-field rate for recent PhDs to be inversely related (-.364) with the percentage of foreign born.

Crowding out of natives from advanced education

Another, often discussed but little studied, possible effect of high-skilled migration on receiving countries is a "crowding out" of natives from graduate programmes and other sources of advanced training. To some extent, this argument is simple to understand: if a given university has a limited number of openings for graduate students, then a migrant student would prevent a native from taking that slot.

The number of graduate departments that have some flexibility in the number of students they admit may offset this argument, at least in terms of aggregate positions in graduate programmes. Beyond the top tier of institutions, some graduate programmes would prefer to admit more high-quality graduate students to help faculty with both teaching and research. This is particularly true for graduate programmes that may have trouble justifying their existence in terms of total graduate enrolment.

Box 1. **Comparison of change in foreign student enrolment with other enrolment changes at the departmental level**

NSF Graduate Student Survey, 1982-95

A increase in enrolment in a department of one foreign student is associated with a change of:

- 0.02 – Under-represented minority (US citizen or permanent resident).
- 0.33 – US white (US citizen or permanent resident).
- -0.07 – US Asian (US citizen or permanent resident).

Model: Fixed effects (department-level) regression estimates of changes in the enrolment of under-represented minorities controlling for department size in the previous period, dummy variables for year, and the change in the enrolment of US whites and US Asians.

One attempt to look at the issue of displacement can be made using the National Science Foundation's *Survey of Graduate Students and Postdocs* (GSS). This is an annual survey of graduate departments of science and engineering to tabulate their enrolment. Using GSS records from 1982-95,

it is possible to create pooled longitudinal[17] file with academic departments as the unit of observation. From this file, it is possible to make empirical estimates of the observed effect of changes in foreign student enrolment on the enrolment of various ethnic categories of US citizen and permanent resident enrolment. As summarised in Box 1, an increase in enrolment of 1.0 foreign student was associated with a increase enrolment of 1/3 (0.33) of a white US student, of an additional 0.02 US under-represented minority students, and a decrease of 0.07 US Asian students. With the exception of the odd, if small, decrease for US Asians, increases in the enrolment of one group was associated with increases in the enrolment of all groups – a result inconsistent with displacement.

Other negative effects

Two other possible negative effects of high-skilled migration for receiving nations are included here for the sake of thoroughness, although even less analysis has been done on these topics than in other areas.

Some critics of high-skilled migration have raised concerns about cultural differences between natives and migrants as a barrier to native participation in technology. This criticism can range from concerns about the ability of native students to understand the accents of foreign-born teachers, to workplace discrimination against natives who are not part of the same ethnic group as their boss. Although this concern is difficult to evaluate, it would be a mistake to assume that this is not an important part of political response in many countries to high-skilled migration.

Technology transfer to potentially hostile countries is another issue which is difficult to analyse. In terms of a general transfer of knowledge that is useful to both civilian and military industries, this almost certainly occurs. In the more specific sense of espionage to obtain classified information on military technologies, it may be a murkier picture. In the context of the United States, major public espionage cases have sometimes involved ethnic affinity,[18] but in other cases have involved natives apparently motivated by money, power or ideology.

Positive effects for receiving countries

Many of the positive effects of high-skilled migration for receiving countries have been discussed in the discussion of positive effects for sending countries – gains related to increases in international collaboration and technology transfers, with the same implications for increasing domestic productivity and developing global markets.

Increased economic activity and R&D

Even in a model of high-skilled migration where there is no “brain circulation”, receiving nations are the recipients of a brain gain. They experience an exogenous increase in their stock of human capital, often including scarce or unique sets of skills that are needed to overcome bottlenecks in production or research.

In the United States, high-skilled foreign-born workers make up a large part of the total science and engineering labour force (Table 6): one-quarter of S&E doctorate holders; one-fifth of those holding any level of degree in engineering, computer science, chemistry, or physics; around half of PhD holders in computer science, electrical engineering, industrial and civil engineering.

These estimates, and others shown in Table 6 from the NSF SESTAT data file, are underestimates of the total proportion of foreign-born scientists in the United States. Because of the practical difficulties involved in tracking high-skilled migrants, SESTAT data on the US S&E labour force exclude individuals whose science and engineering degrees were obtained from foreign educational institutions unless they were in the United States as of the decennial census of 1990. This would exclude, for example, the majority of individuals entering the United States with the high-skilled H-1b temporary visa. The US Immigration and Naturalization Service reports that 60% of H-1b visa recipients are holders of foreign degrees.

Table 6. **Share of foreign-born S&E-trained US scientists and engineers, by field of highest degree and degree level, 1997**

Field of highest degree	Labour force (total)	Bachelor's degree	Master's degree	Doctorate
All S&E	**12.7**	**9.7**	**19.2**	**26.1**
Engineering	**19.8**	**14.9**	**30.1**	**44.0**
Aerospace engineering	12.4	10.0	14.3	37.2
Chemical engineering	21.4	15.8	35.6	40.1
Civil engineering	21.2	16.5	33.8	52.0
Electrical engineering	22.7	18.0	32.2	46.8
Industrial engineering	16.9	11.2	32.3	50.9
Mechanical engineering	17.8	13.5	32.7	45.4
Other engineering	17.4	10.8	23.1	40.3
Life sciences	**10.7**	**7.8**	**12.8**	**24.7**
Agriculture	6.9	4.3	14.4	21.7
Biological sciences	12.3	9.3	13.0	25.5
Computer/math	**16.5**	**12.7**	**24.6**	**35.6**
Computer sciences	20.4	15.6	30.8	49.5
Mathematical sciences	11.8	9.4	14.8	30.7
Physical sciences	**16.0**	**11.8**	**17.2**	**28.5**
Chemistry	20.0	15.9	23.9	29.1
Geosciences	8.0	5.4	10.2	19.5
Physics/astronomy	18.8	11.8	18.6	30.8
Other physical sciences	10.2	8.8	12.2	30.0
Social sciences	**7.0**	**6.1**	**9.4**	**12.7**
Economics	13.7	11.2	26.3	26.4
Political science	7.0	6.2	10.3	15.7
Psychology	5.4	5.1	5.8	7.2
Sociology/anthropology	4.9	3.9	12.1	13.1
Other social sciences	7.7	6.3	10.7	20.3

Source: National Science Foundation, Division of Science Resources Studies (NSF/SRS), 1997 SESTAT File.

Knowledge flows and collaboration

As shown in Figure 1 and discussed earlier, there are strong reasons to believe that international migration leads to increased international collaboration and transmission of knowledge. With reference to the United States, the increased connection to the rest of the world has always been a benefit of having large numbers of foreign students and large numbers of high-skilled immigrants.

This factor may become even more important as the rest of the world continues to expand it's R&D capacity – as of 1997, the United States' R&D spending was down to 43% of the OECD total.[19]

Increased enrolment in graduate programmes

This is the other side of concerns about displacement of natives in graduate programmes. In the context of the United States, the availability of foreign students may allow many graduate departments to expand or maintain graduate programmes. In other cases, foreign students may allow more elite programmes to maintain very high standards by allowing them to choose among the best of both foreign and native applicants. To the extent that the benefits of a graduate programme accrue to graduate students, this might not be an important benefit, or might even be viewed as a cost if graduate education is partially subsidised. However, graduate programmes are also important sources of new research and knowledge. This may provide a benefit to receiving countries even if foreign students were to leave immediately after graduation and form no part of later knowledge networks.

Global effects

In addition to any benefits or costs that might be viewed as accruing to particular countries sending or receiving high-skilled migrants, there are possible global effects that cannot be assigned to individual countries. These are essentially all the effects that could result in greater efficiency in the production of knowledge, and in the production of goods and services. Even if one rejects the idea that one country benefits from wealth and knowledge creation in another, this greater efficient would result in greater global sum of GDP, however distributed.

A better international flow of knowledge increases the efficiency of new knowledge production everywhere. It leads to better solutions to particular problems and a reduction of duplication in R&D.

An international job market has important implications for the quality of job matches for both workers and employers. In a world where increased specialisation leads to increased employer dependence on scarce or unique skill sets, it becomes clear why employers find it increasingly efficient to search across borders. At the same time, greater employment options resulting from a global labour market may allow workers to find the work most interesting to them.

There may also be a global benefit from the formation of international research and technology centres. Researchers on innovation have long noted the apparent benefits of geographic clustering of particular research activities. To a great extent, this specialised clustering required high-skilled international migration for staffing.

For all of these reasons, high-skilled international migration is likely to have, at the global level, a positive effect on the incentives for human capital investment. It increases the opportunities for high-skilled workers, both by providing the option of job search across borders and by encouraging the growth of new knowledge.

Conclusion

This chapter has outlined major research and policy issues related to high-skilled international migration. Simple models of "brain drain" and "brain gain" do not fully capture either the complex movement of people and knowledge across borders, or the effects of this movement on knowledge creation and investments in both physical and human capital. Both sending and receiving countries have to be concerned with the potential positive and negative effects of high-skilled migration, and much research needs to be done to better understand these effects. Although this chapter does not explore policy options, it seems likely that the magnitude of various positive and negative effects are likely to be significantly affected by aspects of a country's immigration, education and technology policies. As with trade, some countries may find it desirable to compensate domestic "losers" from high-skilled migration as a way of gaining support for more open policies.

Globally, the net effect of high-skilled migration seems likely to be positive for both knowledge creation and economic growth and should result in both more efficient use of high-skilled labour and increased knowledge flows. However, even this assumption needs to be qualified, as little is known about the net global effects of high-skilled migration on human capital investment.

NOTES

1. The UDHR calls for freedom of movement *within* national borders, and freedom of movement to *leave* any country.

2. In the United States, most permanent visas are issued to immigrants on the basis of family ties. Immigration and Naturalization Service records indicate that from 1993 to 1996, slightly more than half of those granted permanent visas ("green cards") used family-based admission categories.

3. The 1993 National Survey of College Graduates, with over 150 000 observations, is a National Science Foundation survey which provides a valid national sample of college graduates up to age 75 who were in the United States at the time of the 1990 Census and in April 1993.

4. The data limitations in the United States are possibly most succinctly illustrated through the title of a National Academy of Sciences study: *Immigration Statistics: A Story of Neglect*. Aspects of the immigrant labour force are picked from different data systems, but many data gaps remain.

5. The domestic demand for skilled labour, and hence the return on human capital, may also increase due to other effects, discussed later in this chapter, which might lead to increased R&D in sending countries. Although many of these hypothesised effects clearly are interrelated, this chapter does not attempt to theorise beyond partial equilibrium effects.

6. In a further straining of the "brain drain" metaphor, an Indian engineer, commenting on the Cable News Network about the disparity between degree production and opportunities in India, said, "Better a brain drain than brains down the drain".

7. To the extent that high-skilled also means specialised skills, additional training may make individuals more, rather than less, sensitive to economic fluctuations. An example from the United States may be aerospace engineers, who have faced greater employment volatility than those in other occupations.

8. A prominent example of labour market instability being caused by return migration involved not high-skilled, but low-skilled labour – the return migration of workers from South-East Asia from the Arabian peninsula at the time of the Gulf War.

9. This is determined by the location of the institution that each co-author is affiliated with. Thus, it could be between natives of the same country, one of whom works in the United States, or any other combinations of nativities.

10. See Abowd and Robinson (1994) for a profile of general emigration rates from the United States.

11. No good estimates of H-1b visa holders remaining in the United States are available.

12. This does not necessarily mean a return to their country of origin.

13. Finn matches Social Security numbers from the *Survey of Earned Doctorates* to individual earnings records. In order to protect confidentiality, the Social Security Administration reports back to Finn the

percentage of a PhD cohort that was found in their records, and does not provide information on any individual. Thus we do not know directly if the same individuals are present each year.

14. For a good summary of this literature, see Friedberg and Hunt (1999).

15. As in many policy debates, there is often a lack of symmetry in the arguments made. For example, economic critics of lower-skilled immigration often worry that lower-skilled immigrants act as substitutes in the labour market for lower-skilled natives, while complementing the labour of higher-skilled natives – thus making the rich richer, and the poor poorer. At the same time, there is concern that if high-skilled immigrants are substitutes for high-skilled natives, this would reduce the incentive for natives to invest in human capital. If you accepted each proposition, it would then be possible to make the dual argument – that lower-skilled migrants would increase the incentive for natives to invest in human capital and that high-skilled migrants reduce income inequality.

16. Both measures were derived from the NSF/SRS 1993 *Survey of Doctorate Recipients.*

17. Econometricians have conducted considerable work on methods to analyse pooled cross-sectional data of this nature. In this case, a "fixed effects" regression was performed that held constant over time department-specific effects, but similar results were found using random effects and simple OLS models.

18. In at least one case, a US native, not a migrant, held the ethnic affinity that may have been a contributory motive for espionage.

19. See *Science and Engineering Indicators 2000.*

Annex

TREND DATA ON HIGH-SKILLED IMMIGRANTS IN THE UNITED STATES

Table A1. **Foreign-born managerial and professional workers in the United States, by occupation**
US Census (1990) and Current Population Survey (1995, 1999)

	1990	1995	1999
Managerial and professional	2 364 000	2 953 000	3 724 000
Professional	1 310 000	1 708 000	2 104 000
Science and engineering	387 000	--	--

Source: 1990 Census; 1995 and 1999 Current Population Survey.

Table A2. **Foreign-born college graduates in the United States**
US Census (1990) and Current Population Survey (1995, 1999)

	1990	1995	1999
Bachelor's degree	1 769 000	2 831 000	3 352 000
Advanced degree	1 350 000	1 581 000	2 042 000
Total	3 199 000	4 412 000	5 394 000

Source: 1990 Census; 1995 and 1999 Current Population Survey.

Table A3. **Foreign-born individuals with higher degrees in science and engineering**

	1993	1995	1997
Total	1 082 000	1 122 000	1 149 000
Bachelor's degree	616 000	657 000	680 000
Master's degree	295 000	300 000	324 000
Doctorate	164 000	159 000	144 000
Field of higher degree			
Engineering	408 000	420 000	428 000
Life sciences	155 000	160 000	162 000
Mathematical and computer sciences	160 000	170 000	184 000
Physical sciences	115 000	116 000	113 000
Social sciences	244 000	256 000	252 000
Occupation			
Engineering	200 000	199 000	212 000
Life sciences	43 000	42 000	41 000
Mathematical and computer sciences	109 000	124 000	157 000
Physical sciences	45 000	44 000	43 000
Social sciences	24 000	24 000	25 000
Non-S&E occupation	480 000	502 000	494 000

Note: Includes those with foreign degrees only if resident in the United States in April 1990.
Source: NSF/SRS 1993, 1995, 1997 SESTAT Data Files.

Table A4. **US Immigration Service permanent visas issued, by S&E occupation**

	Total	Engineers	Natural scientists	Mathematical and computer scientists	Social scientists
1988	11 000	8 100	1 200	1 200	500
1989	11 800	8 700	1 200	1 500	400
1990	12 600	9 300	1 200	1 600	500
1991	14 100	10 500	1 300	1 700	600
1992	22 900	15 600	2 800	3 400	1 100
1993	23 600	14 500	3 900	4 200	1 000
1994	17 200	10 700	3 100	2 800	700
1995	14 100	9 000	2 400	2 100	600
1996	19 400	11 600	3 700	3 300	800
1997	17 000	10 300	3 500	2 600	700
1998	13 500	7 900	2 500	2 500	600

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Chapter 18

MIGRATION BETWEEN THE NORDIC COUNTRIES: WHAT DO REGISTER DATA TELL US ABOUT THE KNOWLEDGE FLOW?

by

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Introduction

Mobility of persons across national borders has long been a high-priority research area. Discussions about the net value of migration have dominated the agenda. Theoretically, there is no clear conclusion as to the optimal level of migration, if any. However, a number of empirical studies have tried to validate or calculate the effects of knowledge mobility and knowledge diffusion. The main conclusions are that circulation of knowledge imbedded in persons increases economic performance, both nationally and within firms. However, very few studies analyse movements of individuals across countries. Obviously, a continuous net outflow of highly educated innovative individuals reduces the long-term ability of a country. Over and above the immediate costs of educating the individual, there is the future social cost of not being able to benefit from that individuals' contribution to GDP. Similarly, flows in the opposite direction may benefit a country in the long run. These situations can be characterised as "loss-win" and "win-loss" situations, where one country gains and another loses.

However, as is the case for national mobility, where individuals move back and forth, increasing the knowledge base in both places, international mobility can also present a "win-win" situation. This is the case, for example, when an individual emigrates and later returns with a higher knowledge stock, experience stock or network contacts that can increase the national innovation ability and economic performance. At the same time, the receiving country may benefit during the period before the individual returns or moves on to a third country, in terms of the knowledge, network contacts, or other kinds of expertise brought by the individual. Hence, the receiving country also gains knowledge.

The difference between win-loss (knowledge gain), loss-win (knowledge drain) and win-win situations seems to lie in the distinction between knowledge flows and knowledge circulation.

* This chapter is a reduced version of a preliminary paper which is a part of a larger Nordic study of human capital job mobility rates in the Nordic countries. Data are missing for Norway, Sweden and Iceland, while the Danish and Finnish figures are not yet fully comparable. The project is partly financed by the Nordic Industrial Fund, partly by the project participants. It aims to investigate the possibilities of developing benchmarks for border crossings and mobility of individuals among the Nordic countries.

Knowledge flow is primarily a one-way movement, in the opposite direction to the circulation. This means that a snapshot of individuals moving across borders provides a static picture that has no real value. Return rates, knowledge increase, job experience, formal education, family restrictions, etc., all contribute to gaining a clearer picture of what the win-win situation actually consists of. Similarly, the share of migrants with national citizenship may influence this conclusion if such individuals have the highest return rates among emigrants and the lowest among immigrants (Figures 1-6).

The aim of this study is to add to the empirical facts concerning the characteristics of migrants between the Nordic countries, *i.e.* to investigate whether the migration that takes place between the Nordic countries represents a win-win situation and to analyse the characteristics of those migrants. Through a comparison of the information collected in national register databases available in the Nordic countries, a more detailed picture can be drawn of migration patterns. Hence, an attempt can be made to measure knowledge drain, knowledge gain and knowledge circulation using descriptions of what the individuals were doing before emigration (using the sending country's register data), and what they are doing after immigration (from the receiving country's register data). Although it is impossible to follow individuals across borders, register data provides a unique possibility to make this linkage through pseudo-individuals.[1]

The national innovation systems of the Nordic countries comprise so many structural similarities that these countries may be characterised as a common NIS area. The Nordic countries have had a common labour market with free mobility of labour for several decades now (Pedersen, 1996). Historically, the countries were ruled by one another, with Denmark the largest conqueror. Today, however, the Nordic Council, working closely with the national governments, co-ordinates co-operation among the Nordic countries. The most recent member, Finland, adopted free labour mobility some decades ago. The countries also have languages that are understandable across borders (except Finnish),[2] similar to the German-speaking area of Germany, Switzerland and Austria.

The similarities and the ease of mobility between the Nordic countries make them an economically integrated region comparable to, for example, the *Bundes Länders* in Germany or the US states. Similarly, economic development has been highly correlated in the Nordic countries, so that differences in the countries' business cycles, although they do exist, are small. Therefore, migration between the Nordic countries may not be generally comparable with migration between developed and less-developed countries, such as the European Union and Africa, for example.

In general, register data provide detailed descriptions of emigrants with national citizenship who leave the country. However, emigrants holding citizenship of a third country are not usually tracked in the registers if, for example, they immigrated only a few years earlier. In such cases, the registers would only contain information on the years of residence and not on items such as, for example, educational levels, skills, and work patterns previous to immigration. In general, the registers do not contain such information for immigrants.[3] Similarly, for national citizens returning to the country, information is only available up until the time they emigrated. Such information might be outdated, *i.e.* downwardly biased, if such individuals raised their educational level while abroad, but this cannot be seen from the register databases. However, the use of information from the register databases in all the Nordic countries can provide an aggregated answer to the information which is lacking.[4]

Bearing these warnings in mind, the registers can provide information on the persons leaving the country and what they do. Combining information from register data in two countries can determine the added knowledge obtained by returning persons, *i.e.* the knowledge gain of return migration and the increase in the knowledge stock obtained through knowledge circulation.

Definition of migration

The Nordic countries apply different rules in terms of registration of migration. Basically, a movement from one country to another is required. However, the period of *intended stay* in another country before a migration is recorded in the statistical registers differs across the countries. In Denmark and Norway, migrants are registered if the length of intended stay is six months or more. In Sweden, Iceland and Finland, the intended stay has to be 12 months before it is registered (Grundström, 1993). The United Nations recommends 12 months of intended stay as a common definition of migration.

These differences in the definition of migration will result in relatively higher numbers of migrations in Denmark and Norway compared to the other Nordic countries. However, Grundström (1993) recommends adjusting the migration figures to cover those individuals who actually stay more than 12 months in the "new" country. Using register data from 1989, he makes the migration figures comparable across the Nordic countries and finds that the Danish figures overestimate the 12-month figures for migration by approximately 40%. The bias is close to 10% for the other Nordic countries. Looking at net migration, the Danish figure is 30% too high, the Norwegian figure 60% too high, the Finnish figure 15% too high and the Swedish figure 7% too high.

To secure comparable statistics, the migration measure needs to be defined as a 12-month *de facto* stay in the country. No matter whether the period of interest covers time before or after 1991, 12 months *de facto* stay is the best statistical measure.[5] The same measure can be used for migration statistics between the Nordic countries and the rest of the world in order to extend the present analysis with comparable studies. The fact that register data in the Nordic countries are annual also supports the use of a 12-month rule. Similarly, most countries report migration figures annually. Hence, all figures based on register data and reported in this chapter are based on year-to-year comparisons. Migration requires that the person leaves or joins the population from one year to the next.

Aggregated migration figures

The total number of persons moving between the Nordic countries is given in the *Nordic Statistical Yearbook*. Table 1 illustrates this for selected years in the 1990s. The majority of migrants move back to the home country a few years later, *i.e.* return migration (Pedersen, 1996).

The difference between the total number of immigrants and emigrants between the Nordic countries in Table 1 shows that some people are missing either from the immigration account or from the emigration account. Theoretically, the total should be equal but, in practice, a difference of up to 1 500 persons per year is found. There also seems to be some correlation between migration numbers and the national business cycle, as measured, for example, by the unemployment rate.

Table 1. **Registered number of migrants between the Nordic countries over time**

Percentage share of total country specific migration in parentheses

Receiving country	Immigration year						
	1990	1992	1993	1995	1996	1997	1998
Denmark	12 182 (30)	10 441 (24)	10 658 (25)	122 45 (19)	12 041 (22)	11 504 (23)	11 351 (22)
Greenland	2 398 (96)	. (.)	2 047 (95)	2 182 (96)	2 378 (96)	2 518 (96)	2 349 (96)
Finland	6 571 (48)	3 723 (26)	3 300 (22)	3 895 (32)	4 286 (32)	4 041 (30)	4 523 (32)
Iceland	1 958 (61)	1 893 (63)	1 680 (62)	1 769 (61)	2 261 (61)	2 396 (60)	2 616 (57)
Norway	8 028 (31)	7 497 (28)	7 713 (24)	7 850 (31)	8 635 (33)	11 774 (37)	. (.)
Sweden	18 094 (30)	7 998 (18)	7 150 (12)	8 760 (19)	8 082 (20)	8 113 (18)	9 854 (20)
All Nordic countries	51 221 (35)	31 552 (24)	34 541 (22)	38 696 (25)	39 679 (28)	42 343 (29)	32 691 (27)
Delivering country	Emigration year						
	1990	1992	1993	1995	1996	1997	1998
Denmark	10 287 (32)	7 900 (25)	7 613 (24)	9 122 (26)	9 735 (26)	9 707 (25)	10 808 (27)
Greenland	3 687 (99)	. (.)	2 585 (99)	2 663 (99)	2 853 (99)	2 943 (99)	2 907 (99)
Finland	4 464 (69)	3 491 (58)	3 424 (54)	4 041 (45)	4 010 (38)	4 575 (47)	5 150 (48)
Iceland	2 688 (70)	1 621 (51)	1 808 (62)	3 185 (74)	3 079 (75)	2 731 (70)	2 637 (72)
Norway	11 221 (47)	5 394 (32)	4 876 (26)	6 362 (33)	6 210 (30)	6 750 32)	. (.)
Sweden	15 255 (61)	11 738 (46)	10 975 (37)	11 020 (32)	12 074 (36)	13 965 (36)	14 242 (37)
All Nordic countries	49 592 (52)	30 144 (36)	33 274 (36)	38 388 (37)	39 957 (37)	42 668 (37)	37 742 (39)

Note: Includes all persons who have moved, independent of age.
Source: Nordic Statistical Yearbook 1999.

The citizenship of these immigrants and emigrants is interesting. The *Nordic Statistical Yearbook 1999* shows that more than 50% of all emigrants have national citizenship. When and whether they return and what they do while abroad are key elements in the present analysis. The *Nordic Statistical Yearbook 1999* illustrates the distribution of the immigrants and emigrants by country for 1998 (Table 2).

Table 2. **Immigration and emigration between the Nordic countries, by country, 1998**
Column percentages in parentheses

Delivering country	Immigration country (measured by receiving country)					
	Denmark	Greenland	Finland	Iceland	Norway	Sweden
Denmark	4 272 (38)	2 183 (93)	342 (8)	1 418 (54)	2 782 (24)	1 927 (20)
Finland	416 (4)	4 (0)	. (.)	58 (2)	1 012 (9)	3 288 (33)
Iceland	1 241 (11)	89 (4)	50 (1)	. (.	782 (7)	346 (4)
Norway	2 852 (25)	45 (2)	613 (14)	554 (21)	. (.)	4 293 (44)
Sweden	2 570 (23)	28 (1)	3 518 (78)	586 (22)	7 198 (61)	. (.)
All Nordic countries	11 351 (100)	2 349 (100)	4 523 (100)	2 616 (100)	11 774 (100)	9 854 (100)
Receiving country	Emigration country (measured by delivering country)					
	Denmark	Greenland	Finland	Iceland	Norway	Sweden
Denmark	3 907 (36)	2 813 (97)	395 (8)	1 301 (49)	2 932 (43)	2 445 (17)
Finland	377 (3)	31 (1)	. (.)	57 (2)	353 (5)	3 472 (24)
Iceland	1 359 (13)	60 (2)	53 (1)	. (.)	408 (6)	560 (4)
Norway	3 117 (29)	18 (1)	1 366 (27)	927 (35)	. (.)	7 765 (55)
Sweden	2 048 (19)	13 (0)	3 336 (65)	352 (13)	3 057 (45)	. (.)
All Nordic countries	10 808 (100)	2 907 (100)	5 150 (100)	2 637 (100)	6 750 (100)	14 242 (100)

Note: Includes all persons who have moved, independent of age. Norway: 1997.
Source: Nordic Statistical Yearbook 1999.

The share of Danes immigrating/emigrating from Denmark to Denmark illustrates the differences in definitions of migration. However, the figures also illustrate that the major patterns of mobility across borders are either historically determined, as in the case of Iceland and Greenland *vs.* Denmark, or caused by short distances, as in the case of a neighbouring country in combination with business-cycle variations, *i.e.* Finland *vs.* Sweden, and Norway *vs.* Sweden.

Information on migrants from national register data

A first item to analyse is whether the stock of migration matches between the countries when the registers are used for the Nordic countries. Such a quality check validates the results presented later in the chapter. First, the stock is persons aged 20 to 70 years old. Second, only year-to-year movements are taken into account, *i.e.* the definition recommended by UN is used. Hence, the figures do not and are not intended to equal the absolute figures found in Tables 1 and 2, although the distributions in percentage terms are expected to be similar.

According to the Danish registers, 182 persons emigrated to Finland in 1995, while 229 immigrated from Finland. The corresponding figures for Finland, which ideally should mirror the Danish figures, are 229 and 259, respectively. Hence, the 229 persons registered as emigrating from Finland are also measured as immigrating to Denmark. Unfortunately, the 182 people registered as emigrating from Denmark do not correspond to the 259 immigrating to Finland. Overall, the figures based on legal registrations do not match exactly and the figures do not reveal whether the persons

summing to the totals are the same persons on each side of the borders. Hence, the actual figures might be larger than the numbers shown, although they must in fact be fairly precise since there only are few people missing, *i.e.* disappearing, from the registers.

As a consequence, it is difficult to determine whether the net migration is positive or negative. However, there is such a high degree of agreement in the figures that it can be pretty accurately ascertained. A more serious problem is the difference between immigration and emigration figures that theoretically should measure the same individuals; hence, using the precise numbers could lead to somewhat misleading results. Looking instead at the broader lines, the migration figures are fairly similar. So, with some caution, the highest number of the two must best describe reality since the probability of recording too few registrations considerably exceeds the probability of recording too many registrations. However, both migration measures are conservative in the sense that they are probably both measuring too few movements compared to reality: some persons move without registering their move, even though it is mandatory according to the national laws. Only in cases where the individuals are employed or in connection with the social and educational systems abroad, do they need affirmative registration.

Table 3. **Nordic immigration by educational level and citizenship in the Nordic countries, 1995**
Column percentages in parentheses

Receiving country and educational level	Citizenship					
	Denmark	Finland	Iceland	Norway	Sweden	Other
Denmark						
PhD	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
MA and BA	393 (20)	3 (1)	40 (4)	20 (2)	5 (0)	3 (4)
ISCED '97 3+4	1 076 (54)	1 (0)	69 (7)	51 (6)	26 (4)	3 (4)
ISCED '97 1+2	333 (17)	2 (1)	9 (1)	10 (1)	19 (3)	2 (3)
No information	204 (10)	211 (97)	879 (88)	804 (91)	675 (93)	68 (88)
Total	2 008 (100)	217 (100)	997 (100)	885 (100)	725 (100)	77 (100)
Finland						
PhD	1 (3)	32 (1)	0 (0)	0 (0)	2 (1)	0 (0)
Master	1 (3)	182 (8)	0 (0)	3 (10)	12 (3)	2 (8)
Bachelor	0 (0)	112 (5)	0 (0)	1 (3)	8 (2)	1 (4)
Other tertiary	1 (3)	260 (12)	0 (0)	2 (6)	13 (3)	3 (12)
ISCED '97 3+4	2 (6)	855 (39)	2 (17)	3 (10)	84 (22)	0 (0)
No information	30 (86)	758 (34)	10 (83)	22 (71)	263 (69)	20 (77)
Total	35 (100)	2 199 (100)	12 (100)	31 (100)	382 (100)	26 (100)

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

Another bias in the register data is on formal education (Tables 3 and 4). Educational information is only collected for the countries' own citizens. The migration authorities do not ask the migrants about their formal education, and the registers only contain information on those migrants who obtain additional educational degrees in the receiving country. Hence, information is missing on the formal educational backgrounds of almost all foreign immigrants. This poses a serious problem when the registers are used to measure knowledge flows and knowledge accumulation among migrants. The quality of the Finnish register is better than that of the Danish one, although it remains low. The reason for the low quality is that migrants registering in another countries are not asked about their educational qualifications. In today's new knowledge economy, registers should be extended with this information. Existing information on formal education usually comes from degrees taken nationally by

registrations at the educational authorities. Since information on educational degrees obtained abroad is not necessarily transferred to the national registers, the educational levels shown in the registers may be severely underestimated. Recent surveys among foreigners in Denmark and Norway reveal a considerably higher educational level among these persons than expected. However, in the registers they are shown as not having any education at all, *i.e.* at best as missing information on the educational level.

Table 4. **Nordic emigration by educational level and citizenship in the Nordic countries, 1995**
Column percentages in parentheses

Delivering country and educational level	Citizenship					
	Denmark	Finland	Iceland	Norway	Sweden	Other
Denmark						
PhD	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MA and BA	402 (22)	2 (1)	23 (6)	27 (5)	6 (2)	0 (0)
ISCED '97 3+4	1 019 (56)	6 (4)	18 (4)	29 (5)	13 (3)	3 (3)
ISCED '97 1+2	285 (16)	1 (1)	4 (1)	7 (1)	6 (2)	3 (3)
No information	116 (6)	147 (94)	399 (90)	496 (89)	373 (94)	93 (94)
Total	1 824 (100)	156 (100)	444 (100)	559 (100)	398 (100)	99 (100)
Finland						
PhD	0 (0)	40 (2)	1 (6)	0 (0)	0 (0)	0 (0)
Master	0 (0)	317 (13)	0 (0)	0 (0)	5 (3)	1 (3)
Bachelor	1 (3)	120 (5)	0 (0)	0 (0)	4 (2)	0 (0)
Other tertiary	1 (3)	457 (19)	0 (0)	1 (4)	5 (3)	1 (3)
ISCED '97 3+4	0 (0)	920 (38)	2 (13)	1 (4)	22 (11)	3 (9)
No information	29 (94)	555 (23)	13 (81)	23 (92)	161 (81)	27 (83)
Total	31 (100)	2 409 (100)	16 (100)	25 (100)	197 (100)	32 (100)

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

If more detailed and trustworthy data on the educational levels of migrants existed, such data could provide a reliable, comparable and useful indicator of the knowledge embedded in individuals moving across borders. For example, a full information set of the knowledge stock of migrants would allow national knowledge accounts for migrants to be calculated, thus providing a more detailed and up-to-date description of the country's status. Similarly, detailed information could be used to describe the type of knowledge, *i.e.* sector or discipline, embedded in migrants. In the current situation, it is impossible to calculate a knowledge account for net migration in order to investigate whether the net knowledge flow is positive or negative.

Figures 5 and 6 indicate considerable migration between the countries although, based on the register data as it stands today, it is not possible to determine whether migration leads to a knowledge drain or a knowledge gain, since information is lacking on a large number of individuals. Augmenting the register data with newly collected survey information, *i.e.* censuses, would increase the information available for future analyses. However, to ensure the high quality of the information, the data set would need to be updated on a continuous basis, which is unlikely. Another way to tackle the problem is to focus on return migration; although no information is given on the activities performed abroad, *i.e.* skills obtained, etc., the return share reveals some information which can enhance the knowledge drain or gain discussion. This will be analysed in more detail below.

Table 5. **Nordic immigration by age and citizenship in the Nordic countries, 1995**
Column percentages in parentheses

Receiving country and age	Citizenship					
	Denmark	Finland	Iceland	Norway	Sweden	Other
Denmark						
20-24	451 (22)	42 (19)	310 (31)	379 (43)	199 (27)	12 (16)
25-29	421 (21)	62 (29)	284 (28)	197 (22)	164 (23)	13 (17)
30-34	367 (18)	46 (21)	161 (16)	110 (12)	118 (16)	25 (32)
35-44	405 (20)	38 (18)	173 (17)	113 (13)	115 (16)	13 (17)
45-54	234 (12)	23 (11)	59 (6)	60 (7)	81 (11)	12 (16)
55-64	93 (5)	4 (2)	7 (1)	15 (2)	31 (4)	2 (3)
65-74	23 (1)	2 (1)	2 (0)	6 (1)	16 (2)	0 (0)
Total	2 005 (100)	217 (100)	997 (100)	885 (100)	725 (100)	77 (100)
Finland						
20-24	8 (22)	425 (23)	5 (24)	3 (11)	63 (17)	2 (8)
25-29	9 (25)	482 (26)	2 (10)	8 (29)	48 (13)	6 (24)
30-34	7 (19)	376 (20)	2 (10)	7 (25)	48 (13)	7 (28)
35-44	7 (19)	508 (27)	1 (5)	8 (29)	79 (21)	6 (24)
45-54	2 (6)	241 (13)	1 (5)	4 (14)	66 (18)	1 (4)
55-64	1 (3)	99 (5)	1 (5)	0 (0)	37 (10)	1 (4)
65-74	1 (3)	68 (4)	0 (0)	1 (4)	41 (11)	3 (12)
Total	35 (100)	2 199 (100)	12 (100)	31 (100)	382 (100)	26 (100)

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

The migration authorities have always requested information on the age of the migrant. Hence, as is shown in Tables 5 and 6, there is no missing information on this aspect and register data provide a detailed description of the age profile of the migrants. Compared with the national education profile by age, an indication of the knowledge flow can be obtained.

The tables show that migration decreases with age, independent of citizenship and of the migration direction, indicating knowledge circulation rather than either a knowledge gain or knowledge drain effect. The figures show that the return migration rates may be of more importance than the migration rates themselves and that the activities performed while abroad or before going abroad may be the information of interest for the knowledge flow study. A study of the activities performed before the (return) migration may reveal whether or not the knowledge account is positive in both directions, *i.e.* a win-win situation.

Table 6. **Nordic emigration by age and citizenship in the Nordic countries, 1995**
Column percentages in parentheses

Delivering country and age	Citizenship					
	Denmark	Finland	Iceland	Norway	Sweden	Other
Denmark						
20-24	447 (25)	32 (21)	129 (29)	162 (29)	98 (25)	14 (14)
25-29	422 (23)	37 (24)	118 (27)	161 (29)	78 (20)	25 (25)
30-34	340 (19)	33 (21)	77 (17)	73 (13)	86 (22)	16 (16)
35-44	336 (18)	40 (26)	74 (10)	89 (16)	65 (16)	22 (22)
45-54	200 (11)	13 (8)	36 (8)	51 (9)	50 (13)	14 (14)
55-64	47 (3)	1 (1)	6 (1)	14 (3)	15 (4)	6 (6)
65-74	24 (1)	0 (0)	3 (1)	8 (1)	5 (1)	2 (2)
Total	1 823 (100)	156 (100)	444 (100)	559 (100)	398 (100)	99 (100)
Finland						
20-24	5 (16)	634 (26)	3 (19)	3 (12)	33 (17)	4 (13)
25-29	9 (29)	628 (26)	5 (31)	5 (20)	41 (21)	7 (22)
30-34	6 (19)	395 (16)	1 (6)	5 (20)	16 (8)	9 (28)
35-44	4 (13)	408 (17)	4 (25)	8 (32)	41 (21)	9 (28)
45-54	4 (13)	240 (10)	3 (19)	3 (12)	27 (14)	2 (6)
55-64	3 (10)	69 (3)	0 (0)	1 (4)	22 (11)	1 (3)
65-74	0 (0)	35 (1)	0 (0)	0 (0)	17 (9)	0 (0)
Total	31 (100)	2 409 (100)	16 (100)	25 (100)	197 (100)	32 (100)

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

Labour market attachment and educational gains for migrants

The previous section analysed the precision of the migration measures when register data is used and compared. The figures validate the quality of these data sources but do not add anything new to our existing knowledge on migrants. However, register data contain new, groundbreaking information regarding migrants. For example, they allow migrants to be fully tracked both before and after the migration. Hence, a clearer picture of the value added of migration can be drawn. Information on both initial and added labour market experience, as well as the stock and amount of additional education, adds to the discussion of knowledge gain, knowledge drain and knowledge circulation from migration. Tables 7 and 8 illustrate the occupational and educational state of the migrants in the year of emigration and in the year after immigration, while Table 9 shows the long-term status five years after immigration (for non-returning immigrants).

Table 7 shows that, in the year they emigrate, approximately half of the emigrants with national citizenship work, while 15%-20% are in education. The remaining one-third of emigrants are neither employed nor studying. If employment status the year previous to emigration is used, the employment rate is approximately five percentage points higher. Looking at the sub-group of migrants with citizenship from other Nordic countries, the percentages are reversed, indicating that a considerable share of these people neither work nor study in the receiving country (or at least not officially). Hence, a significant fraction of the emigrants carry knowledge abroad, supporting the thesis of emigration leading to a knowledge drain. However, as Tables 8 and 9 show, this is only part of the story.

Table 7. **Labour market and/or education attachment of emigrants to the other Nordic countries in the year of emigration**

Percentage share of all emigrants each year,
for national citizens (left column) and other Nordic citizens (right column)

Delivering country	Year																					
	1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998	
Denmark																						
+ job, - education	51	34	46	29	49	28	48	27	50	24	54	24	53	30	53	29	67	31	46	31		
+ job, + education	9	2	10	4	11	2	9	3	11	2	9	4	9	3	9	3	7	4	9	8	-	
- job, + education	4	13	7	15	6	11	8	3	8	13	7	9	7	10	6	11	9	14	8	17		
- job, - education	36	50	37	53	34	59	35	58	32	61	31	63	31	58	33	58	48	52	37	43		
Finland																						
+ job, - education	54	38	52	38	49	37	45	37	39	29	38	30	36	24	39	28	42	27	43	29	49	32
+ job, + education	2	0	2	0	3	0	4	1	4	0	5	1	5	1	4	0	3	1	5	0	5	1
- job, + education	1	0	2	1	2	1	3	1	3	0	4	1	4	1	4	2	4	2	3	2	2	1
- job, - education	43	62	44	61	47	62	49	62	55	71	53	68	56	74	53	71	52	70	48	69	44	66

Note: + means in job or in education, - means no job or not in education. Labour market attachment is measured as being employed or not in the first week of November.
Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70. Emigration country is missing for 50% of the observations in 1996-97.

Table 8. **Labour market and/or education attachment of immigrants from the other Nordic countries in the first year after migration**

Percentage share of all immigrants who are still in the country,
for national citizens (left column) and other Nordic citizens (right column)

Country	Year																					
	1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998	
Denmark																						
+ job; - education			49	35	52	38	45	30	44	29	48	31	50	32	54	36	54	40	58	40		
+ job; + education	-		10	4	8	4	6	4	8	4	7	3	8	5	9	6	9	7	8	8	-	
- job; + education			9	15	8	14	8	15	7	5	7	15	6	16	7	15	7	15	6	16		
- job; - education			33	46	32	45	41	50	42	52	39	51	36	48	30	43	29	38	27	36		
Finland																						
+ job; - education	70	51	70	57	71	52	66	53	51	38	43	28	38	31	42	31	50	43	53	35	56	44
+ job; + education	3	3	3	3	2	2	3	1	3	1	3	1	5	2	6	1	7	2	7	1	6	2
- job; + education	1	0	1	1	1	0	1	1	2	1	2	1	3	3	3	1	3	1	2	1	2	2
- job; - education	27	46	26	39	26	45	31	46	44	60	52	70	55	64	48	67	41	54	38	62	37	52

Note: Labour market attachment is measured as being employed or not in the first week of November. The denominator in the rates is corrected for individuals leaving again before one year's duration. The correction increases the +job rates by approximately 10-15 percentage points in total.
Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

Table 9. **Labour market and/or education attachment of immigrants from the other Nordic countries five years after migration**

Percentage share of all immigrants five years earlier who are still in the country, for national citizens (left column) and other Nordic citizens (right column)

Country	Year													
	1992		1993		1994		1995		1996		1997		1998	
Denmark														
+ job; - education			50	38	52	41	54	42	53	42	55	47		
+ job; + education	-		8	6	7	7	5	5	7	7	7	6	-	
- job; + education			6	7	6	9	5	29	6	7	5	8		
- job; - education			35	49	35	43	36	44	34	44	33	39		
Total			100	100	100	100	100	100	100	100	100	100		
Finland														
+ job; - education	61	50	57	57	54	47	57	44	53	43	58	36	47	26
+ job; + education	3	2	2	2	2	2	3	1	4	2	4	1	4	4
- job; + education	1	1	1	1	1	1	1	1	1	0	1	1	3	0
- job; - education	36	47	40	40	43	50	40	55	42	56	38	62	46	70
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Labour market attachment is measured as being employed or not in the first week of November. The denominator in the rates is corrected for individuals leaving again before five year's duration.
Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

Table 8 shows similarly high proportions of immigrants who work, study or do both the year after immigration. Table 9 indicates that these shares are slightly higher among those immigrants still in the country five years after the immigration year; this is to be expected since these are a selected sample of approximately 50% of the original group. Hence, a considerable amount of the knowledge is carried across borders by migrants, and the flow appears seems to be of equal size in both directions, *i.e.* the net knowledge flow is zero. This supports the knowledge circulation conclusion.

An investigation of the knowledge accumulation among immigrants is difficult to perform using register data. However, a registration of degrees taken allows these to be converted to a measure of additional average formal education in years (although this measure clearly underestimates the true knowledge accumulation from courses, single exams, learning-by-doing in jobs, and other similar tacit knowledge). However, the figures in Table 10 are positive, indicating that immigrants do increase their knowledge levels. If they return to their original country with this increased knowledge stock, this may represent a win-loss situation, *i.e.* the home country gains from return migration, while the host country loses. Figures are only available for Denmark.

Table 10. **Additional education in years for immigrants from the other Nordic countries during the first five years after migration**

Country	Year									
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark										
1 year after	-	0.076	0.007	0.003	0.011	0.009	0.006	0.004	0.026	0.020
3 years after	-	-	-	0.091	0.026	0.023	0.056	0.059	0.029	0.043
5 years after	-	-	-	-	-	0.129	0.073	0.069	0.068	0.063

Note: Number of years of education is measured according to the definitions of the ISCED classification. Individuals who re-migrated during the five years reduce the stock of individuals.
Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

In the knowledge flow discussion, it is also interesting to know the level of education of emigrants with national citizenship. Table 11 shows that the educational level measured in years is slightly higher for women than for men. The Danish figures show that the educational level of emigrants is higher than the national average. Hence, migrants seem to be better educated than the average population. There are a few natural explanations to the observed patterns. First, more skilled men such as carpenters and bricklayers move across borders compared to women, where the share of academicians is higher. This moves the averages apart. Second, a higher proportion of young adults move across borders. They are usually better educated than the older generations, thus giving the higher than average educational level among emigrants from Denmark. Hence, Table 11 does not reveal any new information on the knowledge drain or gain from emigration. Instead, it reveals some of the underlying structural characteristics of the emigrants. However, controlling for other characteristics reveals that both immigrants and emigrants are more highly educated than the average population, which again supports the knowledge circulation argument.

Table 11. **Average education for emigrants with national citizenship to the other Nordic countries in the year of migration**

Years. National population averages in parentheses

Country		Year									
		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	Men	11.50	11.87	12.01	12.09	12.17	11.87	11.74	11.95	11.64	11.49
	Women	11.69	12.24	12.53	12.63	12.51	12.19	11.94	12.12	11.51	11.84
	Total	11.58	12.03	12.25	12.35	12.33	12.0	11.82	12.01	11.58	11.63
		(11.1)	(11.0)	(11.1)	(11.1)	(11.2)	(11.2)	(11.3)	(11.3)	(11.3)	(11.4)
Finland	Men	11.5	11.6	11.7	11.9	12.2	12.4	12.7	12.8	12.5	12.9
	Women	12.0	12.2	12.2	12.3	12.2	12.8	13.1	13.2	13	13.3
	Total	11.7	11.9	11.9	12.0	12.2	12.6	12.9	13.0	12.8	13.1

Note: Years of education is measured according to the definitions of the ISCED code.
Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70. The numbers in parenthesis are the national average years of education, c.f. Statistical Ten-Year book (2000).

Return migration

Part of migration can be more precisely characterised as circulation. In particular, students generally return to their own country after their period of study. Hence, the period spent abroad is part of a planned return instigated by career or educational plans. Figures 1 to 4 show the share of national and other Nordic emigrants who returned to Denmark or Finland in the 1990s. Of national citizens who emigrated to other Nordic countries, 50% had returned after four to five years, a little less in Finland than in Denmark. Around 60% had returned after nine to ten years. Hence, the marginal return rate decreases over time. The return rate appears to be very stable over time since the lines in Figures 1 and 2 for each cohort are superimposed. A large proportion of emigrants with national citizenship return after a short period, thus supporting the knowledge circulation thesis. On the other hand, around 40% of the emigrants have not returned after ten years. Although some may have died or have disappeared for other reasons, this fact support the knowledge drain thesis.

Figure 1. **Return rate to Denmark for Danish citizens emigrating to the other Nordic countries from Denmark, over time**

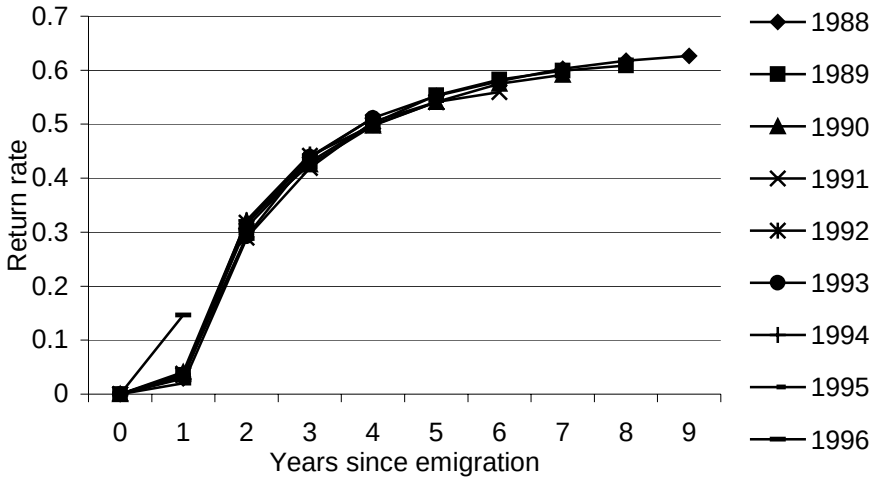
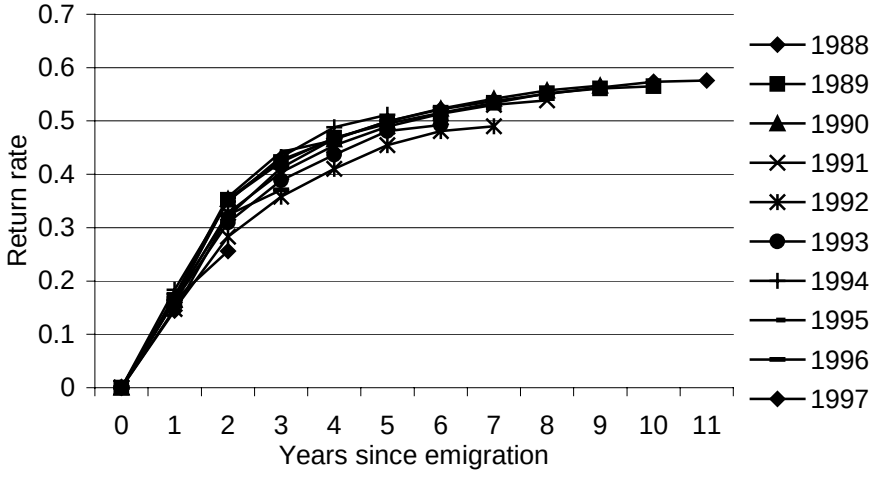


Figure 2. **Return rate to Finland for Finnish citizens emigrating to other Nordic countries from Finland, over time**



Figures 3 and 4 show the same patterns as Figures 1 and 2, although the levels are much lower. This is to be expected, since Figures 3 and 4 illustrate the share of other Nordic citizens leaving the country for some years before returning home. However, it is noteworthy that 10-20% of those holding citizenship of other Nordic countries return to the country after only a few years. This indicates that some people have established permanent connections in the country to which they originally emigrated. Whether such people move regularly, supporting the knowledge circulation thesis, cannot be determined from the present data.

Figure 3. **Return rate to Denmark for other Nordic citizens emigrating to other Nordic countries from Denmark, over time**

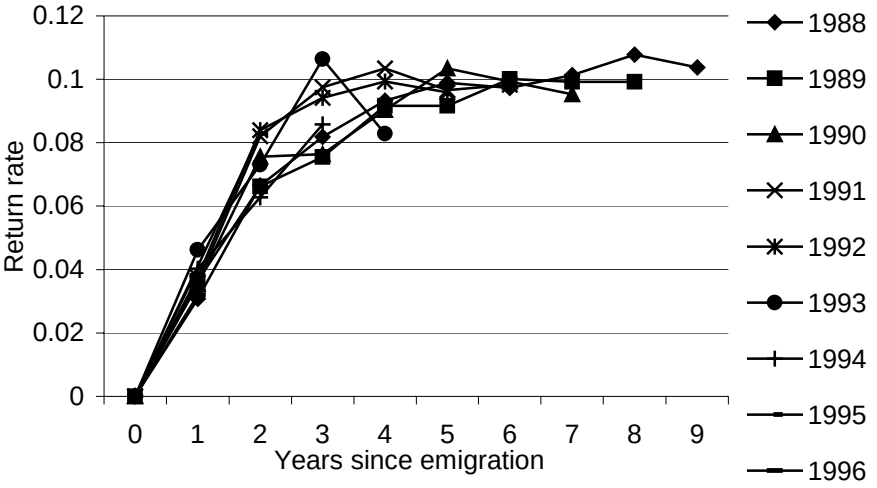


Figure 4. **Return rate to Finland for other Nordic citizens emigrating to other Nordic countries from Finland, over time**

If we turn now to immigrants and calculate their "staying" rate in the receiving country, we see (unsurprisingly) inverse patterns to those found in Figures 1-4.[6] This is shown in Figures 5-8. Ten per cent of national citizens who return home leave again after three years, although this figure is a little lower in Denmark than in Finland in the longer run. Similar findings for other Nordic citizens in Figures 7 and 8 are 50% for Denmark and 35% for Finland in the three years following the immigration year.

Figure 5. **"Staying" rates for Danish citizens immigrating from other Nordic countries to Denmark, over time**

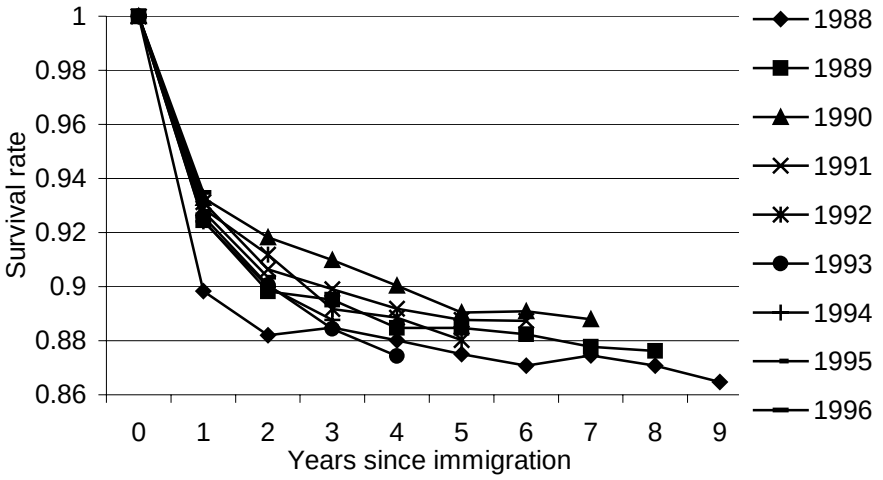


Figure 6. **"Staying" rates for Finnish citizens immigrating from other Nordic countries to Finland, over time**

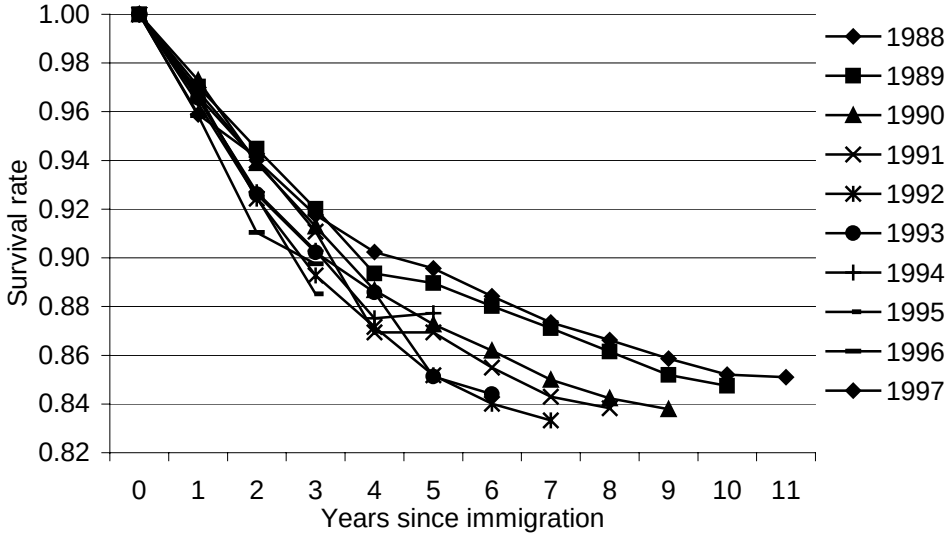


Figure 7. **"Staying" rates for other Nordic citizens immigrating from other Nordic countries to Denmark, over time**

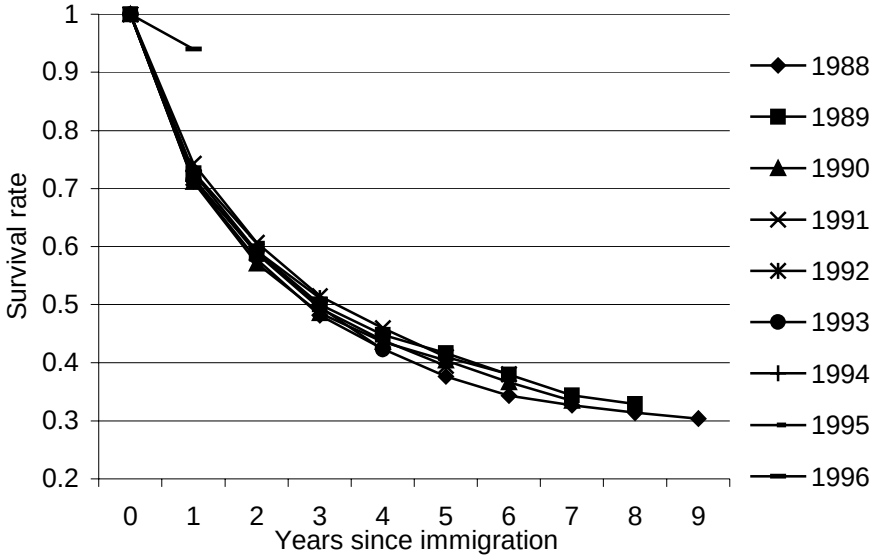
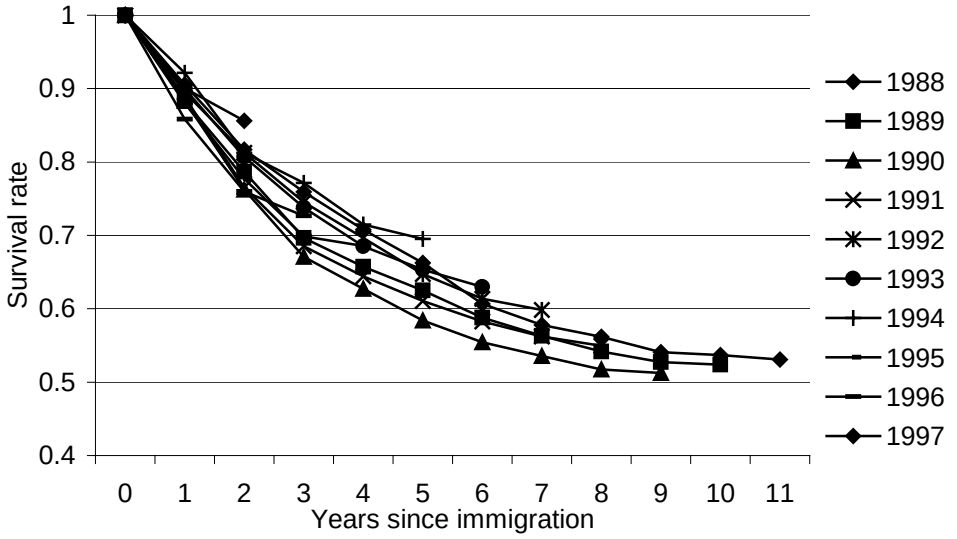


Figure 8. **"Staying" rates for other Nordic citizens immigrating from other Nordic countries to Finland, over time**



Another interesting aspect of return mobility is the differences between national and other Nordic citizens. This is shown in Figures 9-12, where the return mobility and the "staying" rates are broken down by Nordic citizenship for the Danish and Finnish cases, respectively. In addition to the level differences shown in Figures 1-8, the mobility rates indicate another pattern; namely, historical dependency. For example, Norwegians leaving Denmark have the highest return rates among the Nordic countries, as shown in Figure 9. Similarly, as shown in Figure 11, Norwegians immigrating to

Denmark show the lowest return rates (this corresponds to the highest "staying" rate). Iceland and Finland have the lowest rates in Figures 9 and 11.

Figure 9. **Return rate to Denmark for Nordic citizens emigrating to other Nordic countries from Denmark in 1988, over time by citizenship**

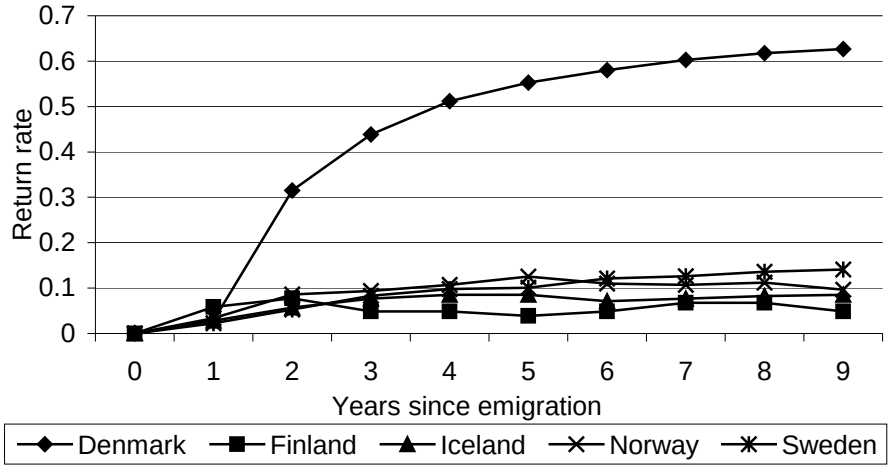


Figure 10. **Return rate to Finland for Nordic citizens emigrating to other Nordic countries from Finland in 1988, over time by citizenship**

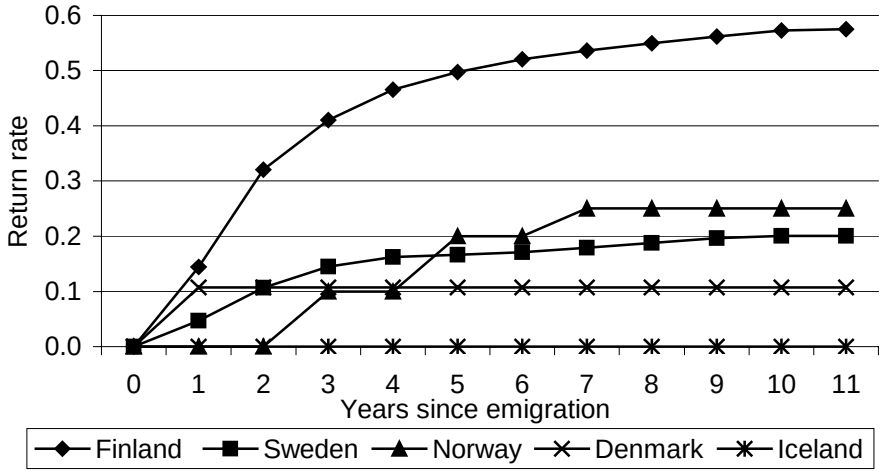


Figure 11. **"Staying" rates for Nordic citizens immigrating from other Nordic countries to Denmark in 1988, over time by citizenship**

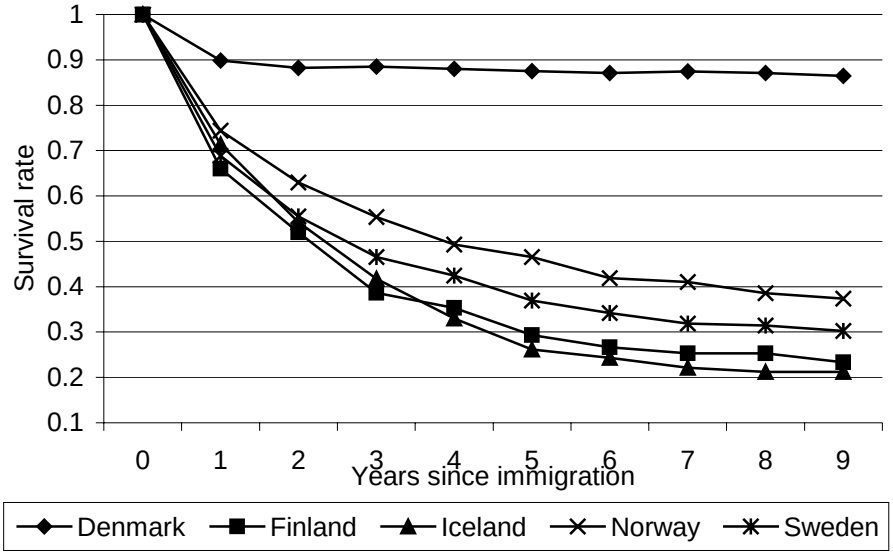
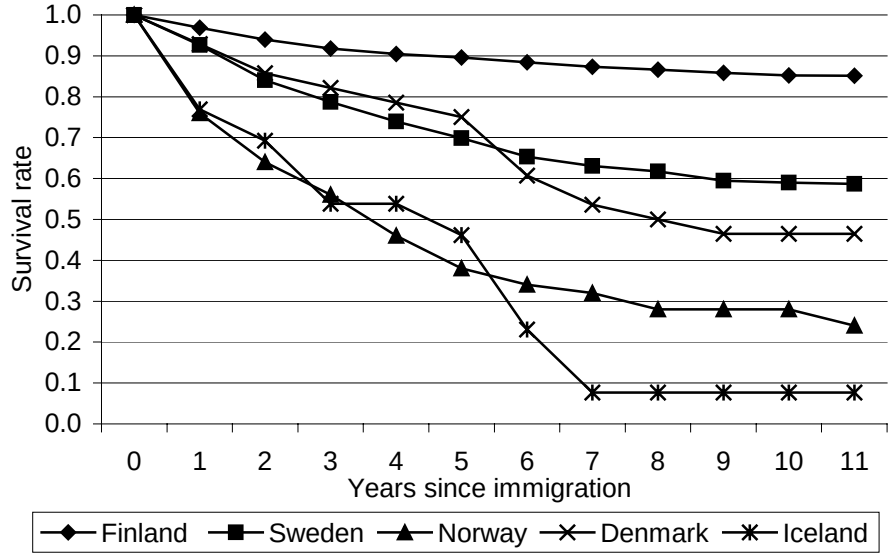


Figure 12. **"Staying" rates for Nordic citizens immigrating from other Nordic countries to Finland in 1988, over time by citizenship**



For Finland, the country-specific differences are even more pronounced. Citizens from the two neighbouring countries, Norway and Sweden, have the highest return rates back to Finland and the highest "staying" rates when they immigrate to Finland.

Hence, cross-border mobility rates are highly influenced by historical and cultural dependencies. It appears to be easier to cross borders and remain in a country if that country is a neighbour or if there are historical linkages such as those that exist between Iceland and Denmark (see Table 1).

Barriers to migration

A more detailed picture of migration can be gleaned by comparing the behaviour of migrants to that of non-migrating persons (Table 12) and by analysing how family status influences migration probability, *i.e.* becomes a barrier to migration (Tables 13 and 14). Table 12 indicates where the dynamics of the migration is changing and where it is becoming a trend. For example, the dynamics of the information and communication technology sector is currently high on the political agenda.

In the Finnish data set, individuals are registered as either students or employees, while in the Danish register, people can do both. This reduces country comparability.

Table 12. **Migration to and from the other Nordic countries, distributed by sector, 1995**

Sectors measured in the emigration year and in the year after immigration; percentages in parentheses

Country and sector	Emigration		Immigration		Population	
Denmark	***In education***	***In job***	***In education***	***In job***	***In education***	***In job***
Higher education institutions and R&D institutes	42 (9)	86 (6)	42 (5)	125 (6)	20 115 (7)	180 142 (9)
Information and communication technology	2 (0)	35 (2)	4 (1)	29 (1)	3 834 (1)	33 059 (2)
Agriculture, mining, manufacturing, utilities and construction	33 (7)	321 (22)	59 (7)	438 (23)	33 74 (12)	603 204 (29)
Trade, hotels, restaurants, transport, financial intermediation and other services	103 (22)	597 (41)	147 (19)	726 (37)	75 141 (12)	652 525 (31)
Other community services	51 (11)	401 (28)	129 (16)	624 (32)	58 542 (21)	610 095 (29)
No sector or missing	248 (52)	0 (0)	413 (52)	0 (0)	86 732 (31)	418 (0)
Total	479 (100)	1 440 (100)	794 (100)	1 941 (100)	278 108 (100)	2 079 443 (100)
Finland	***In education***	***In job***	***In education***	***In job***	***In education***	***In job***
Higher education institutions and R&D institutes	-	124 (12)	-	108 (13)	-	143 512 (8)
Information and communication technology	-	11 (1)	-	13 (2)	-	30 323 (2)
Agriculture, mining, manufacturing, utilities and construction	-	208 (20)	-	188 (23)	-	637 527 (34)
Trade, hotels, restaurants, transport, financial intermediation and other services	-	340 (33)	-	286 (35)	-	583 007 (31)
Other community services	-	249 (25)	-	161 (20)	-	465 544 (24)
No sector or missing	458 (10)	84 (8)	384 (100)	51 (6)	201 485 (100)	42 140 (2)
Total	458100)	1 016 (100)	384 (100)	807 (100)	201 485 (100)	1 902 053 (100)

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

The figures reveal a lower than average population share of migrants in the primary sector in both countries and in the HEI sector in Denmark among workers measured in the year of emigration and the year after immigration,. By contrast, the share of migrants in the HEI sector is higher than the population average in Finland. The share of working migrants is larger than the population average in

the private service sector in both countries. For the remaining sectors, no obvious differences are apparent. Hence, among both working immigrants and emigrants, there is no indication of a higher than average knowledge and ability transfer. On the contrary, the high-level knowledge sectors are under-represented. Instead, the private service sector dominates; this is a sector where unskilled persons can be employed for shorter or longer periods. These tendencies point to circulation of humans, although not necessarily to circulation of knowledge.

When the focus is on persons in education, the Finnish data in Table 12 do not contain any information. However, the Danish figures indicate that only 50% of migrating students work compared to 70% of the student population. A higher than average share can be noted only among emigrating students working in the HEI sector, indicating that students working in the educational sector have a high emigration probability, and are also likely to study abroad as exchange students. Hence, this possibly supports the theory of a win-win situation, in which the returning person increases his/her qualifications during the period spent abroad.

The fact that a large share of migrants is made up of young people (skilled or in education) raises the question of barriers due to family composition. Are single people more mobile than married and cohabiting couples compared to their share in the population? If this is the case, family becomes a barrier to cross-border mobility. Tables 13 and 14 show the distribution of migrants by family status. The distribution is remarkably stable over time, with no significant changes in the composition although the share of single emigrants (but not single immigrants) in Finland increases slightly over the period. However, the tables do not show whether the shares are higher than the population averages, *i.e.* whether, for example, marital status decreases the propensity to migrate. Table 15 reveals that singles have significantly higher than average mobility rate, indicating that family obligations are a barrier to mobility, even when age differences are included, *i.e.* married people tend to be older, and older people have lower migration rates.

Table 13. **Family status for emigrants, by citizenship in Denmark and Finland**

Percentages

		Year											
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark													
National	Single		65	65	69	66	68	65	66	67	71	65	
	Married	-	21	18	16	19	17	18	18	20	16	17	-
	Cohabiting		14	16	15	15	15	17	16	13	13	18	
Nordic	Single		52	56	53	56	65	60	62	61	57	52	
	Married	-	28	25	25	26	18	22	22	18	20	22	-
	Cohabiting		21	19	22	18	17	18	17	20	23	26	
Finland													
National	Single	56	56	58	57	58	59	53	53	56	51	57	58
	Married	33	33	31	32	31	28	32	32	30	35	30	29
	Divorced	9	10	10	11	10	12	13	13	13	13	12	11
	Widowed	1	1	1	1	1	1	2	1	1	1	1	1
Nordic	Single	39	42	43	48	44	42	44	45	51	44	53	53
	Married	44	44	40	37	41	40	37	36	35	40	32	31
	Divorced	14	13	14	11	13	15	17	16	13	14	13	13
	Widowed	3	2	2	3	2	3	2	3	1	2	2	3

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

Table 14. **Family status for immigrants, by citizenship in Denmark and Finland**

Percentages

		Year											
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark													
National	Single		66	65	65	61	59	61	60	62	61	60	
	Married	-	17	17	18	21	25	22	23	23	21	23	-
	Cohabiting		17	18	17	18	16	17	17	16	18	17	
Nordic	Single		54	52	52	50	52	60	56	56	55	57	
	Married	-	23	23	24	27	25	19	20	19	19	20	-
	Cohabiting		24	25	24	23	23	22	24	25	26	24	
Finland													
National	Single	63	63	63	63	60	56	59	58	57	64	63	62
	Married	25	25	26	26	28	31	30	30	31	25	26	25
	Divorced	11	11	11	11	11	12	11	12	11	11	10	11
	Widowed	1	1	1	1	1	1	1	1	1	1	1	1
Nordic	Single	45	45	46	49	50	47	41	42	46	50	46	47
	Married	35	43	37	37	33	37	42	39	38	37	36	38
	Divorced	18	11	15	13	17	14	15	17	14	11	16	14
	Widowed	3	2	3	1	1	3	2	3	3	2	2	1

Source: Register data from the Nordic countries. Finland: Age 20-74. Denmark: Age 20-70.

An empirical model on migration propensities and years before return migration

An empirical model on cross-border mobility of individuals allows a simultaneous treatment of explanatory variables, *i.e.* a quantified determinacy of the differences in mobility propensities. Table 15 gives estimation results from a logistic probability model on a pooled sample of the entire population. The model estimates the probability of migration and determines differences depending on observed characteristics among the individuals. Table 15 also presents the results on a model of the years from migration until return migration on the sample of migrants in 1988. An OLS model is estimated, although it does not permit correct treatment of migrants who remain abroad for ten or more years. Due to the ten-year data period, it is not possible to observe the year in which these individuals' returned. A right-censored model corrects for this, estimating the upper-censored individuals as a point probability. This is the Tobit model in Table 15. Correcting for the unobserved return year considerably affects the estimation results.

The probability model reveals that immigration probability increases when the unemployment rate increases, *i.e.* the business cycle decreases, and that emigration probability increases when the unemployment rate decreases, *i.e.* the business cycle increases. This indicates that there is no push effect in emigration from Denmark and no pull effect in immigration to Denmark. In fact, the opposite effects are significant. These findings are in contrast with the conventional belief that push and pull effects are highly dominant migration motives. However, Pedersen (1996) found only weak evidence of this in a study of economic incentives, *i.e.* wage differentials and unemployment differences, to migrate.

Table 15. **Estimation model on immigration and emigration probability in the period 1988-97 and the years before return migration of the 1988 cohort in Denmark**

Explanatory variable	Immigration			Emigration		
	Probability 1988-97	Years from 1988 before return migration		Probability 1988-97	Years from 1988 before return migration	
	Logit	OLS regression	Tobit regression	Logit	OLS regression	Tobit regression
Unemployment rate	0.069*			-0.021*		
Constant	-3.715*	8.685*	11.690*	-3.445*	7.729*	11.650*
Citizenship						
Danish citizen	-1.684*	1.912*	3.637*	-1.349*	-2.644*	-5.558*
Other	-	-	-		-	-
Gender						
Male	-0.003	-0.552*	-1.218*	0.073*	-0.286*	-0.479*
Female	-	-	-	-	-	-
Civil status						
Single	0.361*	-0.365*	-0.805*	0.886*	-0.231*	-0.397*
Cohabiting	0.018*	0.032	0.015	0.234*	-0.420*	-0.807*
Married	-	-	-	-	-	-
Children						
# Children aged 0-17	-0.516*	-0.180	-0.196	-0.371*	-0.025	-0.023
# Children squared	0.059*	0.058	0.081	0.038*	-0.007	-0.016
Age group						
19 years	0.863*	-0.280	-0.390	0.256*	-2.072*	-2.754*
20-24 years	0.523*	-0.224	-0.312	0.367*	-1.030*	-1.560*
25-29 years	0.151*	-0.187	-0.246	0.238*	-0.249*	-0.381
30-34 years	-	-	-	-	-	-
35-44 years	-0.506*	0.247	0.441	-0.388*	0.003	-0.083
45-54 years	-1.134*	0.321	0.490	-1.026*	-0.145	-0.422
55-64 years	-1.806*	0.762*	0.347	-1.772*	0.431	0.642
65-74 years	-2.881*	-2.536*	-4.122*	-2.517*	2.576*	8.535*
Educational level						
ISCED97 1 + 2	-1.521*	-0.906*	-1.953*	-1.357*	0.348*	0.679*
ISCED97 3 + 4	-0.689*	-0.231	0.372	-0.700*	0.354*	0.667*
Bachelor or Master	-	-	-	-	-	-
PhD	1.133*	-2.691	-6.459*	0.923*	4.7385	30.010
No information	0.647*	-2.588*	-4.390*	0.392*	1.253*	2.673*
Sectoral group						
HEI and R&D	0.040*	-0.285	-0.116	0.242*	-0.023	0.185
ICT	-0.012	-0.817	-1.805	0.588*	-0.168	-0.347
Trade, hotels etc.	0.105*	0.178	0.619	0.243*	0.065	0.053
Community services	0.055*	-0.234	0.016	0.138*	0.174	0.220
No information	1.107*	-0.954*	-1.160*	0.638*	0.044	0.027
Manufacturing etc.	-	-	-	-	-	-
Job						
In job	0.055*	-0.417	-0.114	0.032*	-0.026	-0.025
Not in job	-	-	-	-	-	-
Education						
In education	-0.425*	-0.348*	-0.731*	-0.019*	0.215	0.366
Not in education	-	-	-	-	-	-
Number of observations	37672959	3689	3689	37672959	5090	5090
Share of correct predictions	0.734			0.696		
Normal scale parameter			5.049			4.720
$R^2_{adj.}$		0.331			0.230	

Note: The characteristics of the reference person for the dummy variables are indicated by – in the table. * indicates significance at a 10%-level.

A weakness in the present results is, however, that only the Danish business cycle is included in the regressions. The business cycle in the sending or receiving country could be different, and could dominate the Danish business cycle such that the foreign push or pull effects explain the observed migration rates.

The probability model also reveals that only a minority of the population migrates (negative constant), that Danish citizens have a lower migration probability than other Nordic citizens, that men have a higher emigration probability than women (no gender difference in the immigration probability), that singles and cohabiting couples have a higher migration probability than married couples, that children decrease the migration probability, that the migration probability decreases with age and increases with educational level, that being in education increases the migration rates compared with being in a job (which does not affect the rate). Finally, in general, being employed in the ICT sector increases the emigration probability, while employment in the research sector increases the migration probability. The same is true for employment in the private and public service sectors.

Hence, the findings of the probability model all support the indications found in the single aspect empirical investigations presented above; namely, that migrants are well-educated, single, young adults and that the net flow may be close to zero, *i.e.* knowledge circulation rather than knowledge drain or gain. This supports the win-win outcome of migration. However, the probability models correctly predict only around 70% of the migration incidents using the observed characteristics in Table 15, columns one and four.

An estimation of the years from 1988 before migrants return is also presented in Table 15. The results using the two estimation techniques show the same signs on the effects. Hence, the direction of how the characteristics influence the years is correct in both models and can be generalised. However, using the Tobit methods gives the right size of the estimated coefficients, which is important if not only the direction but also the number of years before return has to be predicted.

The Tobit model reveals that an average person immigrating to Denmark in 1988 leaves again after 11 years; similarly, on average, emigrants from 1988 also return after 11 years. Being a Danish citizen increases or decreases the number of years by four and six years, respectively.

Male immigrants stay one year less than do female immigrants; male emigrants return half a year earlier than do female emigrants. Similarly, the fact of being single reduces the number of years as a migrant, although this is not significant among emigrants. Cohabiting significantly decreases the number of years among emigrants but not among immigrants, compared to married migrants. Having children reduces the number of years of migration, but not significantly.

There is a tendency for migration time to increase with age. However, the effect is only significant among young emigrants. Pensioners emigrate for longer and immigrate for shorter periods. However, this result is due to an unknown, and unidentifiable, share of this age group who die while abroad.[7]

Educational differences among migrants do not significantly influence the length of the migration period before return; in fact, the tendencies are mixed. The sector of employment at the time of migration reveals no significant information on the time of return. Neither does work at all, although the tendency is negative on migration length. However, immigrants in education leave faster than other immigrants. The opposite is true for emigrants, although not significantly.

Hence, the years before return migration reveal the expected patterns – single, well-educated young adults return faster than the average migrant. This supports the knowledge circulation thesis and

indicates that there does not seem to be any noticeable trend in who and why migrants become permanent migrants, at least not among the background characteristics studied here.

Conclusion

Mobility of human capital across national borders is a high-priority policy issue due to the potential knowledge drain or knowledge gain. Debates over the net value of migration have not come up with any clear conclusions, except in the theoretical literature, which predicts both gains and losses depending on the theoretical set-up and the country. As is the case for the national mobility, where individuals move back and forth, thus increasing the knowledge base in both places, the international mobility of individuals may also present a win-win situation. This is the case when individuals emigrate and later return with a higher knowledge stock, experience stock or network contacts to the benefit of national innovation ability and economic performance. At the same time, the receiving country may benefit during the period before the individual returns home. Benefits may include the knowledge, network contacts, or other kinds of expertise possessed by the individual. Hence, the receiving country can also gain knowledge, even if the individual eventually returns home.

The present study reveals that, for the two Nordic countries for which data were available, migration leads to knowledge circulation, *i.e.* knowledge transfer, accumulation and circulation, rather than to knowledge gain or knowledge drain.

The register data could be investigated further to investigate whether, for example, the factors of firm mobility, firm closure, inter- and intra-firm mobility, family members, etc., play a significant role in the decision to migrate. However, such border-crossing registers are not yet available. Today, the Nordic registers are separate although a common Nordic register database for research could be created if the will was present. For the time being, the laws protecting citizens prevent the creation of such a database.

The collection of educational information on immigrants would considerably facilitate estimations of whether net migration results in knowledge loss or gains for a given country. The Nordic register data sets contain a great deal of information, but lack data on the knowledge or education levels of immigrants. This could – and should – be remedied.

The Nordic countries are a special case, with closely related labour markets and economies. The economic incentives for migration among these countries are low. However, between countries with larger differences, economic incentives may be far stronger and show significant pull or push effects. Although, historically, the Nordic countries are an integrated area, register data are not able to point to a particular region which uses labour and knowledge in a flexible manner based on macroeconomic indicators. This is probably because the Nordic countries function as a single region.

NOTES

1. A pseudo individual is a person-type with characteristics (age, gender, education, etc.) that are common to the registers in both the sending and the receiving country.

2. Although many Finns speak and write Swedish.

3. The information collected on immigrants only covers items such as age, gender and family status.

4. It is theoretically possible to merge the register across countries, although this is currently prohibited due to data confidentiality rules. Hence, the story has to be pieced together from information available in the sending and the receiving country.

5. Grundström (1993) refers to the UN definition of immigration: long-term immigrants – more than 12 months; short-term immigrants – less or equal to 12 months.

6. The share of immigrants who remain in the receiving country is called the "staying" rate.

7. The data do not distinguish between disappearance due to death or return among immigrants, and due to death or a decision to remain abroad permanently among emigrants.

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Chapter 19

THE ROLE OF INTERNATIONAL MOBILITY IN THE CZECH LABOUR MARKET

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Introduction

This chapter describes and analyses the role of foreigners in the Czech labour market and that of Czechs working abroad in the period 1993-2000. It presents and evaluates the data sources upon which the analysis is based. Special attention is given to the issue of "brain drain/drain gain", particularly as related to the mobility of highly qualified human resources in science and technology (HRST).

In the wake of the Second World War, political and economic relations developed differently across the European countries, with the Czech Republic becoming a member of the Socialist Bloc. Citizens from the Western market economies had no economic incentives to work in the socialist economies, and those who did faced daunting administrative barriers.

However, in the 1960s and 1970s, extensive economic development led to a shortage of workers. As a last resort, labour was imported. The former Czechoslovakia helped to solve the lack of jobs in some socialist countries and, by the end of the 1980s, the number of foreign workers reached an average of 100 000 (Horalek, 1996).

Some 50% of these were foreigners employed in Czech firms in accordance with international agreements (such agreements were signed with Vietnam, Cuba, Mongolia, Angola, Poland and Hungary). The largest numbers of workers came from Vietnam, Cuba and Poland. Young people from Vietnam, Mongolia, Cuba and some African countries took up vocational education together with on-the-job training. They later went on to work for Czech firms; this was viewed as a way of paying back their education costs. This system remained in existence until 1989.

With the Czech Republic's transition to a market economy, a competitive labour market was rapidly created. The Czech labour market is relatively open and attracts foreigners due to a consistently low rate of unemployment. As a result, the number of foreigners in the Czech labour market has grown steadily. Not all of these are legal immigrants; some are migrants on their way to the West.

Foreigners in the Czech labour market

There are four basic reasons for foreign employment in the Czech Republic:

- *Historical:* for historical reasons, large numbers of citizens from the Slovak Republic and Poland take up jobs in the Czech Republic.

- *Political:* each year 4 000-5 000 people seek political asylum in the Czech Republic; however, refugee status was granted to only 78 persons in 1998 (a mere 1-2% of applicants). Refugees with work permits do not play any significant role in the Czech labour market.

- *Economic:* the Czech Republic offers high wages compared to other central and eastern European countries. Foreigners have usually either been pushed out from their own labour markets by high unemployment or are attracted to the Czech Republic by the relatively higher wages. Such workers are popular with Czech employers because they accept lower wages and are less demanding in terms of working conditions and accommodation.

- *Learning and experience:* motivations for experts and managers entering the Czech labour market include promotion opportunities, their personal interest in the new environment, interesting work; in addition, they are often able to operate within the framework of the activities of their current employers. This is clearly a case of "brain gain" since these people are usually highly qualified experts with university education.

Three groups of foreigners are present on the Czech labour market: *i)* those who come to the Czech Republic with the intention of starting up their own small business; *ii)* those seeking employment; and *iii)* citizens of the Slovak Republic.

Foreigners as entrepreneurs

A sizeable number of foreigners on the Czech labour market run their own small businesses. The applicant obtains a trade licence at the trade office and must prove that he/she is not a convicted felon (not only in the Czech Republic, but also in his/her country of origin or last stay). The applicant must also provide proof of qualifications/certification (in certain cases), and must have a basic working knowledge of the Czech language.

Table 1. **Foreigners obtaining a trade licence**

	Number of foreigners with a trade licence
1994	18 650
1995	36 996
1996	45 499
1997	63 529
1998	44 962
1999	58 386

Source: Horakova (1999).

At the end of 1999, the majority of foreign entrepreneurs had come from the Ukraine (19 521), Vietnam (18 938), Slovakia (6 649), and the countries of former Yugoslavia.

Vietnamese retailers gained a prominent position in stall business in 1992-93, specialising in the sale of alcohol, cigarettes and consumer electronics. The stalls are situated mainly in the border regions and large towns. There are negative and positive aspects associated with this development. On the one hand, these traders have brought a new element of entrepreneurial spirit to Czech business and have thus enriched it; on the other hand, the volume of customs and tax evasion related to their businesses is unacceptably high. In 1998-99, there was a tendency for the stalls to become more permanent shop premises, and the Vietnamese started offering services (mostly fast-food restaurants), and manufacturing some goods (*e.g.* textiles).

Holders of work permits

Responsibility for the co-ordination of foreign workers is defined in the state employment policy. The new policy of the transition economy was formulated in Employment Act No. 1/1991. This act sets out the terms and conditions regarding the employment of foreigners. In compliance with this law, foreigners can be employed in the Czech Republic only if they obtain both a work permit and a resident's permit.

According to Employment Act No. 9/1991, individual labour offices have the power to issue work permits, to prolong and abolish such work permits, and to grant employers permission to hire foreigners to fill vacant positions.

The approach taken by the Czech Republic in employment agreements differs depending on the country involved. The Czech Republic, as a successor state of the Czechoslovak Federation (as of 1 January 1993), observes international agreements concluded during the existence of the Federation (*i.e.* with Germany and Poland). The independent Czech Republic has concluded agreements with the Slovak Republic (1993), Vietnam (1993), the Ukraine (1996), Switzerland (1997), Russia (1998), Hungary (1999), Bulgaria (1999), Luxembourg (1999), and Mongolia (1999). Agreements with Latvia and Austria are currently underway.

According to Czech Statistical Office data, nearly 8 000 valid working permits for foreigners were issued through the end of 1990. By 31 December 2000, the labour offices had registered 40 080 valid work permits (Slovak citizens do not require a work permit and are thus not included in this figure).

Table 2. **Number of work permits issued**

	Total	Jobs for blue-collar workers		Jobs requiring GCE-level qualifications		Jobs requiring a university degree	
		Number of jobs	%	Number of jobs	%	Number of jobs	%
1993	28 281	21 576	76.3	2 023	7.2	4 682	16.5
1994	32 871	24 685	75.1	2 333	7.1	5 853	17.8
1995	52 536	42 475	80.9	3 220	6.1	6 841	13.0
1996	71 002	60 497	85.2	3 364	4.7	7 141	10.1
1997	61 044	50 853	83.3	3 320	5.4	6 871	11.3
1998	49 927	39 550	79.5	3 235	6.5	7 142	14.4
1999	40 312	30 232	75.0	2 972	7.4	7 108	17.6
2000	40 080	29 564	73.8	3 046	7.6	7 470	18.6

Note: Slovak citizens do not require a work permit and are thus not included in this table.
Source: Ministry of Labour and Social Affairs of the Czech Republic.

Foreigners with work permits can be divided into two groups. The first comprises experts with specialised skills that are not available on the domestic labour market, while the second consists mainly of blue-collar workers.

The occupations held by immigrants vary considerably. Foreigners from Eastern Europe are mainly employed in blue-collar occupations (the Ukraine – 96.6% of workers, Poland – 90.4%, Bulgaria – 84.8%). Eastern Europeans hold both qualified and unqualified jobs, although the majority do low-skilled jobs. They are generally taken on as a result of the need to complete the building of infrastructure, repairs and reconstruction and housing development. Such jobs are often seasonal and there is a lack of interest from the local labour force as such jobs are often less well paid, strenuous and require shift work (Selepova, 1998).

Immigrants from the Western Europe and the United States are usually employed in jobs requiring university, or at least secondary, education. They generally work as managers of foreign and international companies, consultants for local companies and government offices, financial experts and in teaching, mainly as teachers of foreign languages. In addition, highly qualified blue-collar workers are sent over from Germany on a short-term basis to help with the introduction of new technologies.

Table 3. **Czech work permits issued at 31 December 2000**

	Total number of work permits issued	Jobs for blue-collar workers (%)	Jobs requiring GCE-level qualifications (%)	Jobs requiring a university degree (%)
Ukraine	15 753	96.6	1.3	2.1
Poland	7 679	90.4	3.0	6.6
Bulgaria	1 523	84.8	5.7	9.5
Germany	1 452	5.4	24.1	70.5
Moldavia	1 446	98.4	1.1	0.5
United States	1 356	0.7	35.3	64.0
Belorus	1 139	88.1	3.1	8.8
United Kingdom	1 112	0.3	32.1	67.6
Russia	1 016	46.9	10.6	42.5
Romania	908	85.0	6.8	8.2
Mongolia	660	93.0	1.1	5.9
France	621	3.6	13.7	82.7
Macedonia	408	88.5	5.9	5.6
Serbia	389	41.4	22.9	35.7
Austria	384	5.7	17.5	76.8
Other countries	4 234	27.7	19.9	54.4
Total	40 080	73.8	7.6	18.6

Source: Ministry of Labour and Social Affairs of the Czech Republic.

In 1993-2000, the largest shift took place in the number of foreigners taking up blue-collar jobs. After significant growth in 1993-96, regulations were issued by the Czech Government, establishing quotas, introducing visas for some countries, and imposing restrictions on the issuance of work permits. These blue-collar jobs are held mainly by citizens from Central and Eastern Europe, with significant numbers coming from the Ukraine, Poland, Moldova, Bulgaria, Belarus, Russia, Romania, Serbia and Mongolia.

The number of foreigners employed in jobs calling for secondary or university education has remained stable since 1995 (with their number and structure being significantly influenced by the introduction of the above-mentioned regulations). These jobs are held mostly by experts from the developed OECD countries, *i.e.* the United States, Germany, the United Kingdom, France and Austria. Among the other countries, only Russia and Serbia have a significant share of both blue-collar workers and highly educated workers (although the numbers are very small, as can be seen from the table in the Annex).

A detailed analysis of the evolution of the employment of foreigners with work permits is made difficult by the lack of flow figures, *i.e.* data are lacking on the number of work permits issued in each year for individual countries and professions, and on the time period for which work permits are valid. The available data provide only the number of valid work permits after three months and only for the three very aggregated educational groups.

Slovaks on the Czech labour market

During the existence of the common state, many Slovaks traditionally commuted to work on Czech territory. However, their numbers had been decreasing and their work activities have changed territorially as well. According to the 1961 census, some 88 000 Slovaks commuted to work in the Czech part; by 1991, this figure had dropped to around 30 000 (Selepova, 1998).

Employment of citizens of the Slovak Republic differs from that of other foreigners. Employment conditions are set out in bilateral agreement No. 227/1993 concluded between the Czech and Slovak Republics in relation to mutual employment. Work permits are not required for Slovak citizens, although employers are required to register them at the labour office.

Table 4. **Citizens of the Slovak Republic employed in the Czech Republic**
Accumulated by end of year

Year	Numbers	%
1993 (March)	21 735	100.0
1993	23 367	107.5
1994	39 209	180.4
1995	59 323	272.9
1997	72 244	332.4
1997	69 723	320.8
1998	61 320	282.1
1999	53 154	244.6
2000	63 567	292.5

Source: Ministry of Labour and Social Affairs of the Czech Republic.

Table 4 shows that employment of Slovak citizens in the Czech Republic grew steadily. There is a certain seasonality to their employment – their numbers have increased each spring since the end of 1993, although their numbers do not significantly decrease in winter. This points to the fact that citizens from the Slovak Republic hold permanent jobs on the Czech labour market and seasonal jobs are not very frequent. According to the statistical data, we can assume that Slovaks have similar job profiles to Czechs. The majority of Slovaks work in Moravia, they commute daily from the nearest districts and have blue-collar jobs. Those coming from further away and working in Prague, Brno and other regions tend to take up lodgings and commute on a weekly or monthly basis.

A detailed breakdown of the qualifications of Slovak workers in the Czech Republic is not available, but it would appear that they work mostly as blue-collar workers, mainly in the building industry. Those who work in the Ostrava region are employed in heavy industry, construction firms and forestry. The increase in employment of Slovaks in the Czech Republic is explained partly by traditional relationship of the labour markets since the Federation and by the more favourable wages offered in the Czech Republic. However, this factor does not seem to be very important. The main reason lies in the different rates of unemployment in the two countries. The unemployment rate is several times higher in Slovak regions than in Czech ones. It is reasonable that people from districts with a high unemployment rate look for the jobs on the nearest labour market in the Czech Republic.

To summarise…

Table 5 presents an overall view of foreigners in the Czech labour market: as of 31 December 1999; 143 440 foreigners (including 53 154 Slovaks) worked or ran their own businesses in the Czech Republic.

Table 5. **Employment of foreigners on the Czech labour market, at 31 December**

Year	Number of work permits issued	Slovak Republic citizens	Foreigners with a trade licence	Total number of foreigners employed	Total labour force of the Czech Republic	Percentage share of labour force
1993	28 281	23 367	n.a.	51 648	5 266 655	0.98
1994	32 871	39 209	18 650	90 730	5 217 329	1.74
1995	52 536	59 323	36 996	148 855	5 220 095	2.85
1996	71 002	72 244	45 499	188 745	5 296 592	3.56
1997	61 044	69 723	63 529	194 296	5 138 708	3.78
1998	49 927	61 320	44 962	156 209	5 170 024	3.02
1999	40 312	53 154	58 386	151 852	5 203 422	2.92

Source: Horakova (1999).

A large group of foreigners (estimated at between 80 000 and 100 000 in 1997) works illegally in the Czech Republic. Foreigners prevail in the construction industry and food services. The struggle against illegal immigration is made extremely difficult due to insufficient sanctions both against illegal workers, and against employers and firms using such workers.

Czechs working abroad

Emigration of workers from the Czech Republic is lower than migration of foreigners to the Czech labour market and it is a less-intensive, gradual process. This is a result of both the restrictive regulations protecting the labour markets of the EU Member states against labour immigrants from outside the EU, and a lesser interest by Czech citizens to work abroad after the improvement of the domestic labour market. This improvement includes some Western companies moving to the Czech Republic and offering employment to Czechs because of the lower labour costs.

Complete statistical data concerning the total numbers of the Czech citizens working abroad are not available. The number of labour contracts for Czech citizens defined in the frame of the inter-government agreement between the previous Czechoslovak Federative Republic and Germany declines every year. Since 1989, the most significant and stable group is the so-called “commuters” who travel daily to work across the border. At the end of 1997, this group comprised some

10 000 persons, according to data from the district offices. Nevertheless, no accurate estimations of the numbers of people involved are available. During 1992-93, German labour offices registered between 13 000-15 000 Czech workers commuting to Germany. However, the Czech labour offices estimated their number at between 18 000-20 000 persons (according to the Ministry of Labour and Social Affairs).

Other types of labour migration of Czech citizens to Germany are marginal. The number of persons employed with the aim of improving their qualifications (maximum stay: 18 months) decreased from 1 292 since the end of 1993 to 530 at the end of 1997. In the first six months of 1998, only 172 Czech citizens signed a contract in the framework of this agreement. The number of seasonal workers employed for a maximum period of three months fell from 11 538 persons at the end of 1993 to 2 266 persons at the end of 1997. In the first half of 1998, 1 383 Czech citizens agreed to seasonal labour contracts. According to the available data, the number of persons working in Czech and German firms outside the context of employment contracts also decreased. During 1991 and 1992, about 5 000 Czech citizens were employed in Germany in the framework of this type of a contract, in 1994, it was 3 000 persons, in 1995, 2 500, in 1996, 2 000 and, in 1997, less than 2 000. Most Czechs are employed in the western parts of Germany where unemployment is lower and where labour market conditions are less severe than in the east. German workers in the Czech Republic (column A of Table 6) are mainly experts working in jobs requiring secondary or university education.

Table 6. **Developments in mutual employment of German and Czech citizens**

Year	A	B	C	D	E	F
1993	660	661	10 964	12 256	5 080	15 000
1994	716	1 030	3 312	4 342	2 988	18 500
1995	1 462	1 096	3 378	4 474	2 417	17 600
1996	1 457	721	3 129	3 850	1 990	10 000
1997	1 536	530	2 266	2 796	1 668	9 787
1998	1 576	172	1 386	1 558	n.a.	n.a.

A. Number of work permits issued to German citizens in the Czech Republic.
B. Number of annual contracts issued to Czech citizens in Germany.
C. Number of seasonal contracts issued to Czech citizens in Germany.
D. Number of annual and seasonal contracts issued to Czech citizens in Germany.
E. Number of agreements for work performed outside the context of employment relationships.
F. Commuters – Czech citizens who commute daily across German border.
Source: Horakova (1999).

The number of the Czech citizens employed in Austria is not registered. The OECD *Review of the Labour Market in the Czech Republic* (OECD, 1994) reported 4 000 persons in 1994; other sources indicate 11 000 persons in 1995 and 1996. The time periods during which Czechs are employed in Austria have not been recorded, nor is there a precise professional structure of the jobs they hold. It can be assumed that these are mostly manual jobs and that people commute daily from the border regions.

It would appear that the interest expressed by Czech citizens in working abroad has generally declined. It is likely that familiarity with the complications involved in seeking a job abroad, higher living expenses and the relative decline in the difference in real wages, have combined to make working abroad appear less attractive. In addition, many Czechs found that it was not easy to find an interesting job upon their return to the home country and those planning their future carefully tend to prefer a career at home (Horakova, 1998). However, the decline might also be explained by the possibility that the accumulated desire to work abroad has levelled off; inflows and outflows to and

from the Czech Republic are now at a level that reflects the differences in wages, work and living conditions.

A relatively small number of Czech citizens are employed in the Slovak Republic, although the number is increasing, from l 439 in 1993 to 1 718 at the end of 1997. The number of Czech business people in the Slovak Republic is not available. Despite the fact that the total number of Czech citizens employed in the Slovak Republic is relatively low, it still represents about 45% of the total foreign labour force in the Slovak Republic. At the end of 1996, 3 294 foreigners were employed in the Slovak Republic on the basis of a work permit. Very little information exists on labour migration to the other countries, and the data that do exist are not comparable.

Based on the available information and estimates, current labour emigrants from the Czech Republic can be divided into several groups. The first group is made up of low- and medium-qualified workers, in terms of educational and professional structure, and they occupy less well-paid jobs. The positions are generally fixed-term, after which the job holders have to return to the Czech Republic. The second group consists of highly qualified experts, some of which go abroad to expand or deepen their knowledge. Most of these come back to work on the domestic labour market, the rest leaves the Czech Republic definitively. Some of the best experts from research institutions or universities leave the country because of poor working and financial conditions. This also applies to young researchers, who face very low starting salaries and poor career prospects. This is a typical brain drain process; it concerns mainly experts from technical and natural science fields and information technology experts.

Conclusion

Foreign workers represent 3% of the Czech labour force. Foreigners hold work permits or else run their own business, although citizens of the Slovak Republic are not required to hold a work permit in order to work in the Czech Republic. Other groups of foreigners work illegally on the Czech labour market.

Foreigners with work permits can be divided into two groups. The first group is comprised of specialists that are in demand because of the lack of such experts in the Czech labour market. The second group of economic importance is mainly blue-collar workers; these are generally Eastern Europeans with jobs in the building industry, retail business, etc. Immigrants from Western Europe and the United States mainly work as language teachers, managers and consultants. The number and share of blue-collar workers is decreasing slowly; nevertheless, 75% of work permits were issued for such positions. Highly qualified experts generally originate from the western OECD countries; some come to the country in the framework of foreign investments, others are managers in joint ventures between Czech and overseas companies or in foreign firms. The numbers of such people has remained stable and their share in the total number of issued work permits is increasing.

Emigration of workers from the Czech Republic abroad is lower than migration of foreigners to the Czech labour market (mainly because of the restrictive regulations protecting the labour markets of EU Member states against labour immigrants from non-member states) and it is a less-intensive, gradual process.

Complete statistical data on the total numbers of Czech citizens working abroad are not available. Only fragmentary information exists on labour migration to the other countries. Some sources report the presence of Czech residents in certain EU countries, without describing their activities in any detail (Hönekop-Werner, 2000).

Even once the Czech Republic joins the EU, no significant movement westwards of Czech workers is expected, although there may be some movements of less-qualified workers in the border regions with Germany and Austria. A strong anti-emigration barrier in the shape of a lack of willingness to move and change professions has recently become apparent in the Czech Republic. A significant change in this behaviour cannot be expected, especially as the Czechs are traditionally strongly attached to the region in which they live and are afraid of the negative impacts a change of job could bring. Another factor arguing against a wave of emigration is the lack of knowledge of foreign languages, especially among the middle and older generation.

It is to be anticipated that there will be some emigration of highly qualified professionals for whom demand exists on the labour markets of the EU, *e.g.* IT experts, physicians, experts in certain fields of natural and technical sciences. In these cases, the level of wages offered and the opportunity to apply their skills in the host country will tip the balance and overcome the traditional reluctance to move. This is a classic case of brain drain/gain and its intensity will depend to a great extent on the differences in income and the general economic level between the Czech Republic and the host countries. The expected migration of some highly qualified experts from the Czech Republic and the role of the Czech Republic as a host country for workers from eastern Europe could lead to a gradual change in the structure of the jobs offered. This structural change would imply a shift away from blue-collar jobs towards more highly skilled positions.

To improve the analysis of the international migration in the Czech Republic, it would be necessary to:

- Improve the quality of the data on work permits issued to immigrants, particularly on annual flows of immigrants.

- Monitor and publish information on the professional level of the immigrants and requirements for the jobs occupied by immigrants, with a focus on highly qualified HRST professions.

- Improve the value of the information on enterprises owned by foreigners in the Czech Republic, for example by publishing their professional structure and the flow in respective years.

- Prepare and implement research to monitor the job placement of graduates and PhDs on the labour market both in the Czech Republic and abroad.

- Develop statistics on labour emigration from the Czech Republic, focusing on highly qualified workers (*e.g.* by adding questions to the Labour Force Survey) and analyse the reasons why emigrants leave and/or eventually return.

In the context of the implementation of further joint OECD projects focusing on the international mobility of human resources, it would be highly desirable to attempt to map the flows of workers between the countries of OECD, with a particular focus on the movement of highly qualified personnel.

Annex

Work permits issued to foreigners in the Czech Republic (excluding Slovaks)

Foreigners from:		1993	1994	1995	1996	1997	1998	1999	1993	1994	1995	1996	1997	1998	1999
Central and Eastern European countries[1]	*a*	20 444	23 682	41 224	59 137	49 354	37 926	28 917	90.1	91.0	93.3	94.9	94.5	93.0	91.2
	b	1 087	1 071	1 094	1 148	995	958	923	4.8	4.1	2.5	1.8	1.9	2.3	2.9
	c	1 151	1 285	1 877	2 061	1 858	1 921	1 869	5.1	4.9	4.2	3.3	3.6	4.7	5.9
	d	22 682	26 008	44 195	62 346	52 207	40 805	31 709	100.0	100.0	100.0	100.0	100.0	100.0	100.0
OECD countries[2]	*a*	212	218	338	340	336	331	328	5.1	4.0	5.0	4.9	4.8	4.7	4.7
	b	733	1 072	1 888	2 017	2 136	2 058	1 832	17.6	19.4	28.0	28.9	30.3	29.0	26.5
	c	3 227	4 221	4 511	4 613	4 580	4 719	4 766	77.3	76,6	67.0	66.2	64.9	66.3	68.8
	d	4 172	5 511	6 737	6 970	7 052	7 108	6 926	100.0	100,0	100.0	100.0	100.0	100.0	100.0
Other countries	*a*	920	815	913	1 020	1 163	1 293	987	64.5	60.3	56.9	60.5	65.1	64.2	58.9
	b	203	190	238	199	189	219	217	14.2	14.1	14.9	11.8	10.6	10.9	12.9
	c	304	347	453	467	433	502	473	21.3	25.7	28.2	27.7	24.3	24.9	28.2
	d	1427	1 352	1 604	1 686	1 785	2 014	1 677	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total	*a*	21 576	24 685	42 475	60 497	50 853	39 550	30 232	76.2	75.1	80.9	85.2	83.3	79.2	75.0
	b	2 023	2 333	3 220	3 364	3 320	3 235	2 972	7.2	7.1	6.1	4.7	5.4	6.5	7.4
	c	4 682	5 853	6 841	7 141	6 871	7 142	7 108	16.6	17.8	13.0	10.1	11.3	14.3	17.6
	d	28 281	32 871	52 536	71 002	61 044	49 927	40 312	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Key: a = jobs for blue-collar workers; b = jobs requiring GCE; c = jobs requiring a university degree; d = total.

1. Poland, Bulgaria, Romania, Hungary, countries of former Yugoslavia, countries of the former USSR.

2. OECD countries (excluding OECD Members from Central and Eastern Europe).

Source: Authors.

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Chapter 20

HUMAN RESOURCES: THE STATE OF KNOWLEDGE AND POLICY CHALLENGES

by

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Policy transitions, capabilities and the systems concept

We are currently going through a period of policy transition, with policy makers seeking to reorient the objectives and instruments of policy to reflect the increasingly sharp awareness of knowledge creation and learning as drivers of innovation, growth, employment and wealth. Many of today's policy considerations stem from new findings coming out of innovation analysis – findings that challenge some of the key elements of past policy thinking. One widely recognised conclusion is that innovation performance depends, at the levels of firms, industries and countries, on the development and organisation of skills and capabilities. Innovation is not simply a process of converting R&D and other inputs into new products. Rather it is a complex process, unfolding through time, in which capabilities are produced and integrated, and through which learning occurs and knowledge is created. Innovation means novelty, and thus implies learning – but learning rests on human capabilities and interactions. Education, training and the acquisition of skills by the workforce are thus central to innovation performance and growth. This, in turn, places the development and mobility of human resources at the very heart of the growth process.

A second important result of recent innovation studies, and one which is strongly reflected in the other themes of this OECD NIS project, is that innovation is a collective phenomenon. The reason for this seems to be that the learning processes and knowledge bases required for innovation are extremely, and will probably become increasingly, complex. The knowledge resources required for innovation often extend beyond the boundaries of the innovating firm, calling for interaction with other agents – suppliers and customers, knowledge institutions, regulatory agencies, and so on. It is this complexity that imparts a systemic character to innovation processes, and that underlies the concepts of "innovation systems" explored in this project. Therefore, the emphasis on capabilities needs to be extended to include how people interact with each other across institutional boundaries and how they flow into and across occupations and sectors. From this perspective, the labour market is not simply a price-setting mechanism to adjust supply and demand, it also distributes skills and capabilities. Its operation is central to how the specific institutional structure of an economy operates, and to any economy's ability to respond either to shocks or to technological opportunities.

These kinds of insights – concerning complexity, collectivity, and so on – into the innovation and growth processes often raise more questions than they answer. They certainly raise problems for

policy makers, if only because they imply that a good understanding of the innovation performance of any sector or economy calls for new forms of knowledge. These tend to be forms of knowledge which we either do not possess, or which we possess in a rather fragmented way. For example, understanding capabilities – and hence understanding where policy intervention might be appropriate – may require a comprehensive understanding of industrial structures, inter-firm linkages and clustering, patterns of technological collaboration, levels and compositions of infrastructure provision, education provision and attainments, and labour force mobility patterns. This is a very demanding agenda, and the empirical study of such phenomena within an integrated systems framework has really only just begun. The goal of the OECD NIS project, in general, and of the present study of human resources and mobility, in particular, is to contribute to this enhanced policy understanding.

A new field of study

The study of the mobility of human resources (HR), particularly from a systemic perspective, is still in its early stage of development. The basic reason for this is not that the importance of the phenomenon of human resource mobility has not been recognised, but rather the lack of availability of data. It is only since the mid-1990s that data enabling the study of HR mobility have become available. From 1992, a significant proportion (although by no means all) of the European countries included the so-called retrospective questions into their Labour Force Survey (LFS). Unfortunately, there is still no detailed harmonisation of these questions. In the Nordic countries, register data became available for researchers in the mid-1990s.[1] It is a reflection of this that the first comparative pilot studies using, respectively, the Community LFS and Nordic register data were both published in 1998 (Åkerblom 1998; Nås *et al.*, 1998). Another indicator of how new this is as a field of study is that in Phase II of the NIS work, only the Nordic countries participated in the focus group on human resources. Only in Phase III – which ran from December 1999 to December 2000 – did other OECD countries join the focus group. Links with related fields of study such as "job creation and destruction" and general labour market issues still remain too weak.

Since data have only recently become available, HR mobility research remains preliminary; we are only in the phase of making data comparable by harmonising definitions and variables. In fact, we are still in an early phase even in terms of establishing the most important stylised facts about mobility. Consequently, there are very few attempts to link mobility rates to other innovation data or even accounting data. Even when this becomes possible, high-quality data and carefully designed studies will be needed to isolate the effect of HR mobility as a mechanism of knowledge diffusion.

As will be discussed in more detail below, the LFS is of limited value as a data source for HR mobility studies. One of the most important conclusions of our work is that the future belongs to register data. In the new digitised "information" society, register data are increasingly becoming a requisite for efficient public and private delivery of services such as social security benefits and Internet banking. There is a growing need for unique and stable identification of individuals and firms over time. The first non-Nordic HR mobility study based on Belgian social security registers is presented in this volume of papers. However, currently, for both historical and political reasons, register data are only available in a few countries. We believe that this situation will change.

Domestic mobility

What do we know about mobility? In the previous phase of the focus group's work, mobility rates were produced for the Nordic countries *between two years* using different breakdowns. The results pointed to *out-of-job mobility* rates in the range of 20%-25%. The rates were highest for

Finland, followed by Sweden, Denmark and, finally, Norway. The high rates in Finland can be explained by the restructuring of the Finnish economy which took place during the severe economic crisis of the early 1990s, partly caused by the implosion of the Russian market. Sweden also experienced more turbulent economic development in the 1990s than did Norway. However, any attempt to rank countries in terms of mobility rates shows how careful one must be. In fact, Denmark had the highest overall out-of-job mobility, at 27%, while Finland had 23%; but if one looks at the educational sub-groups, then the Finnish rates are higher. It is likely that the high overall rate in Denmark is caused by higher mobility of people in the 16-25 age group (which includes many people who have not yet completed their education). When mobility rates were produced for Belgium, the numbers were similar to those obtained for the Nordic countries; however, since the Belgian data cover only a sub-set of the "Canberra" HRST population, the numbers are not strictly comparable.

Comparing mobility rates over countries between *two years only* has its dangers. In Phase III of the NIS project, mobility rates were produced for the Nordic countries covering a whole decade. The results strengthened the hypothesis that Denmark's high overall out-of-job mobility (27%) was caused by higher youth mobility. Further, it showed that the business cycle plays an important role, since mobility rates differ by several percentage points over the cycle. In the Finnish case, the difference was almost ten percentage points from the bottom to the top of the cycle.

In addition, one has to take into consideration the effects of business demography. That is to say, the statistical rules used to count firms, how to treat ownership changes, change of location, major changes in what is produced, etc. From a HR mobility point of view, identification numbers need to be attached to the workplace, *i.e.* to the establishment. Since such has not been the rule, both Denmark and Finland have "corrected" the identification numbers in cases where a major share of the employees was observed at two different numbers in two consecutive years. This lowers the mobility rates. Since this has not been done in the Norwegian and Swedish case, the "real" differences are probably even larger. However, this may not be so – because the routines for managing the firm identification numbers might not have been the same. The importance of the routines for firm identification numbers, *i.e.* business demography, is most visibly demonstrated by the Norwegian case. Between 1986 and 1994, the mobility rates are "well-behaved". In 1995, a new system of firm identification numbers was introduced. At the same time, the routines for checking where people worked were weakened. As a result, the Norwegian rates began to fluctuate wildly – with variations of up to ten percentage points from one year to the next – although there is absolutely no reason to believe that Norwegian employees radically changed their employment habits.

The implication of this is that we are still at a stage of HR research where policy attention needs to be focused on the basic data. Serious data quality and measurement problems persist, to such a degree that when the numbers do not conform to our intuitions, we must check that this is not due to some statistical artefact. In addition, we should be careful not to base conclusions or rankings on differences of a percentage point or two, since variations in registration routines, in the treatment of firms with missing NACE codes, and all the minor deficiencies that are to be found in every data set, might be able to explain the differences.

Mobility rates based on Labour Force Surveys

The Labour Force Survey is the data source for all of the European countries. The LFS has long national traditions, and as a result of co-operation in Eurostat, there has been a greater harmonisation of national Labour Force Surveys. The results from the national LFS are merged into a database – the Community Labour Force Survey (CLFS). Mobility rates calculated on the basis of the CLFS are mostly in the 4%–10% range, *i.e.* they are markedly lower than those from Nordic register data. This

poses the question of whether we are seeing real differences in mobility or statistical artefacts. There are clear indications that the latter is the case. If one compares the CLFS rates for the Nordic countries and Belgium with the rates obtained from register data for the same countries, the Nordic countries are among those countries with the highest rates, often above 10%. Belgium, on the other hand, is in the 6%-9% range. There is thus a 5%-10% difference between the CLFS rates and the register rates. The difference is least for Norway at less than five percentage points. In the Norwegian case, calculations on the Norwegian LFS show mobility rates close to those based on register data (with the LFS rates a percentage or two point higher than the register data).

Turning to the country with the highest mobility according to the CLFS, namely Spain, with rates of around 12% for men and 16%-17% for women, our Spanish colleagues are sceptical of the numbers obtained. Their hypothesis is that the data do not represent real mobility but rather reflect the widespread use of temporary contracts in Spain. They argue that the sharp drop in the Spanish figures between 1998 and 1999 when the mobility rates halved is the result of measures taken by the authorities to reduce the use of temporary contracts. At the other end of the spectrum, Italy has mobility rates in the 2.5%–4.5% range. It is not easy to find another obvious reason why Italy and Spain should be so different in terms of HR mobility.

The fact that significantly different results are obtained from different data sources leads one to conclude that firm policy conclusions cannot be based on these numbers. More detailed research will be needed in order to pinpoint the causes for the differences in level between rates based on register data and rates based on CLFS and national LFS. Work to date has only served to highlight the problems.

Some core results

Keeping in mind the above caveats about data quality and reliability, the following stylised facts emerge:

- *There are marked differences between men and women, with female mobility being higher than male.* This is not the case everywhere: in Poland, the Czech Republic, Hungary and Estonia, HRST mobility rates are higher among males than among females. Why this is so is not an easy question to answer. One has to keep in mind that we are talking about job-to-job mobility, so that maternity leaves, women taking care of small children, and so on, should not influence the rates. One hypothesis might be that men are more likely to be in management positions that by their nature make it more important to be less mobile.

- *Mobility declines with age.* A very clear result is that the mobility is very high for persons under 25 years of age, with rates typically in the range of 30%-40%, and in some cases up to 50%. Mobility declines steadily with age: people aged between 35 and 55 have mobility rates of under 10%. It is very important to keep this in mind when comparing, for example, overall rates for the whole economy with specific educational groups, especially those with higher education; there will be a strong age bias in addition to the pure education effect. From a knowledge accumulation point of view, it is not obvious that the very high mobility rate among 16-25 year olds is necessarily a good thing. Certainly, there is a strong element of searching with the aim to test and validate occupational preferences, as well as creating a broader occupational experience. However, more stable employment might lead to greater knowledge accumulation and consequently reduce training costs for firms.

- *Mobility rates are pro-cyclical.* There is clear evidence from the Nordic countries that mobility rates are influenced by the business cycle (whether measured by the unemployment rate or by GDP growth over the period 1985–97). The LFS results only cover the period 1992-97, but they do point to a generally rising tendency over this period, which corresponds to the economic cycle. The basic reason for this is that people tend to cling to their jobs during a downturn, while an up-turn unleashes a pent-up need in the economy for reallocating human resources to expanding sectors.

- *The highly skilled are more mobile.* Results to date indicate that mobility rates for highly qualified persons whose skills are in high demand, are higher and more stable over the business cycle. The highly skilled are not "disciplined" by unemployment to the same degree as the average employee.

Is there a relationship between mobility rates and growth? Regrettably, we do not have reliable data to answer that question. Isolating the contribution of a specific factor or market mechanism to economic growth is, of course, very difficult, since there are no cases where everything else remains constant with the exception of the mobility rate. On the other hand, since the reallocation of human resources is important for economic restructuring – a prerequisite for economic growth, growth is likely to be incompatible with very low mobility. Looking at growth indicators such as multifactor productivity, one would expect to find a correlation between mobility rates and such indicators.

International mobility

Data from the United States show the special position of that country as the main receiving country for highly educated personnel. Although the United States faces tough competition from other countries for highly skilled human capital, data show that the tendency for PhDs to stay (and thus reduce circulation) is increasing.

It is a well-documented fact that foreigners and foreign-born constitute a non-negligible part of the US HRST workforce in key sectors of the economy, indicating that the United States benefits by employing people who were educated abroad, using their best years. However, in most cases, the rate of return to the home country is unknown, so the question of whether the international mobility of HRST is characterised by brain drain or brain circulation cannot be answered – and, in general, probably depends on the sending country. In any event, the United States is clearly a pole of attraction for people from all walks of life – including the highly skilled. This is not a new phenomenon, and has been going on for over 200 years.

Some economies are more open than others in terms of the stock of foreigners and mobility into and out of these countries. For example, France does not suffer from a brain drain as there is only a small outflow of highly educated personnel. However, the share of foreigners in France is low, at around 3% of professionals, corresponding to a low level of inflows. The United States is at the other end of the continuum, enjoying a high 50% share of foreign-born in the population of the highly skilled. Hence, national innovation systems differ greatly in their openness to new ideas and knowledge from other countries, and thus to the extent that they are able to benefit from the worldwide formation of human capital.

The role of HRST migration between other countries cannot be measured since there is no systematic registration of immigrants' education levels; however, partial evidence indicates that HRST mobility is fairly low. This is as expected since between countries with roughly equal living conditions, the push and pull forces are weaker. However, the large differences in the patterns of

international mobility are linked not only to differences in living conditions, but also to differences in career opportunities for selected groups of personnel.

A related issue in a systemic perspective is that of integration. Human beings are carriers of knowledge, but it is difficult to assess this knowledge on the individual level. Its value is fully realised when it is integrated with complementary components of knowledge, such as colleagues, regions and countries with similar cultures, etc. Hence, the real impact on knowledge transfer cannot be understood only in terms of mobility patterns as such, but rather depend on how and to what extent mobile workers are integrated in their host organisations, their new host countries, etc. English-speaking countries have a clear advantage in this integration process. Small and medium-sized firms may face problems in recruiting highly skilled personnel: the low levels of skills and education existing in the firm make the integration of highly skilled personnel more difficult, and such personnel often become mere "tokens" of their group rather than a knowledge asset. A case in point here is the recruitment of foreign-born scientists to UK universities. This is very unevenly distributed to the benefit of the larger, well-known and internationalised universities such as Cambridge and Oxford. This situation can lead to self-reinforcing mechanisms caused by imperfect knowledge of the scientific qualities of other, less famous, universities in the United Kingdom.

Mobility, labour markets and innovation systems

Mobility matters, and is key to the adjustment processes in any economy. The importance of mobility rates lies in their value as indicators. Mobility rates below 5% might be an indication that labour markets do not function well in terms of knowledge diffusion. Mobility rates of over 30% for highly trained software engineers have as a consequence that teamwork is disrupted, key personnel leave projects before they are finished, and so on. However, we should not automatically assume that high mobility is only for the good. For firms, it is rational to bid up wages to obtain scarce human resources, while for individuals, it is rational to accept substantial wage increases. However, the macroeconomic effect might be wages rising much faster than productivity, software projects being delayed because of too high turnover of key personnel and, of course, increasing transaction costs in general.

If mobility rates are seen as an indicator of economic transition, the high rates of Finland are to be expected. In the case of the Czech Republic and Hungary, the rates are not very high. This might indicate that the needed restructuring of the economy will take longer than many would have anticipated.

In the same vein, one would expect to find very low mobility rates among tenured university personnel. However, this is only the case when all other knowledge diffusion mechanisms function properly. Among those groups of academics with higher mobility (well-known examples are ITC and law), the "drain" away from the university could hamper the creation of new knowledge in the long and medium term. These examples illustrate that mobility rates are just an indicator that should be seen in its proper context – and we argue that the systemic approach is helpful in this respect.

Mobility, as studied in this volume, implies that knowledge flows are defined as the mobility of individuals with certain characteristics. From an innovation point of view, the mobility of groups of people – of knowledge milieus – might be just as important. Anecdotal evidence points to the fact that new technologies are often new combinations of known technologies. This presupposes close co-operation between different fields of applied science and engineering. Large firms often acquire knowledge by buying smaller, knowledge-intensive firms. Processes such as buy-outs, mergers and spin-offs are a natural part of firm demography.

Mobility of human resources – important as it is – must be analysed in relation to the broader patterns of interactions among firms, sectors, institutions and countries. It is no coincidence that the inflow of human capital to, for example, the United States, is associated with very high inflows of financial capital. Networking among firms often covers a broader pattern of interactive mechanisms; this is one of the findings of the focus group on innovative networks (OECD, 2001). Firms in networking relationships, *e.g.* in product development, engage in complementary interactions, such as exchange of personnel, exchange of prototypes and electronic interactions, thus generating a broader basis for knowledge flows in which human mobility, even of a temporary nature, plays an important role.

A crucial issue in the systems approach relates to institutions and institutional structures. Labour market and educational institutions – central as they are to the performance of innovation systems – vary markedly across countries. In the Nordic countries, for example, mobility between the research sectors and other sectors is quite diverse, but is related to the institutional set-up of the knowledge institutions as well as to national industrial structures. Comparative mobility indicators tell only part of the story. Further, the learning capabilities of innovation systems are based on domestic labour markets and the flows within them. Firms may generate and accumulate stocks of knowledge through advanced organisational and managerial practices (although these mechanisms are not explored in this volume). However, high levels of dynamism and interaction *within* organisations may be able to substitute for lower levels of mobility *among* organisations. The main issue for innovation systems is to ensure the continuous growth or expansion of knowledge. In cases where the flows of knowledge stagnate, enhanced mobility may play a "releasing role", enabling innovation systems to avoid lock-ins and stimulating them to generate new combinations of outputs with greater economic value.

Policy challenges

The challenge of enhancing the analysis of mobility and its role in innovation processes is closely linked to improving data and data collection methods. In this section, some important implications for policy are discussed.

The limitations of LFS in mobility studies

The LFS was not designed for studies of mobility and there are very clear limitations to its use. The basic problem is that of sample size – in short, there are too few observations to enable reliable estimates to be obtained for sub-groups. The LFS samples cover only 0.5%-1.5% of the population. This means that it is not possible to obtain mobility rates at the two-digit NACE level – there are too few observations in each sector. The estimate of the number of people working, for example, in the research sector varies considerably according to the LFS – even though we know from other sources that employment in the research sector is stable, and in most countries is growing slowly, but steadily. This problem is compounded when we look at a sub-group in each two-digit NACE sector; for example, the number of highly educated personnel, the number of mobile persons, and combinations of such characteristics. Since the estimates both for the number of mobile persons and the total number of employees are unreliable, the mobility rate of researchers (NACE code 73) cannot be calculated with any degree of reliability on the basis of the LFS.

With the present sample sizes, the LFS allows little more than computing rather general rates for the economy as a whole, such as, male/female, HRST for the economy as a whole, or at best broken down into four or five meta-sectors. Despite the inherent sample-size limitations of the LFS, however, it would be useful to harmonise the definitions used in the questions related to mobility at the OECD

and EU level. This would enable key mobility rates to be compared and would lead towards more harmonised methods of data collection.

From a researcher's standpoint, it is certainly easy to promote the wider use of registry data. The material in this volume strongly points to the value added of using register databases to analyse flows of human resources, in terms of both domestic and international mobility. However, for privacy and data security reasons, many countries place severe restrictions on the use of such data and on the integration of separate data registers. We cannot argue with countries' policies in this area. However, we would suggest that those countries which are part of increasingly integrated economic regions of (such as the EU and NAFTA, in addition to the Nordic region) harmonise their relevant public registers with the aim of enabling flows of human resources in these economic regions to be tracked. Once this has been done, they should facilitate access to the data by the research community for analytical purposes – this is a prerequisite for well-informed policies.

The need for better data

There are few adequate data and data sources allowing reliable analysis of international mobility of HRST. Consequently, the issue of brain drain or brain circulation cannot be fully analysed. The main sources of data for international mobility are surveys and administrative data, in particular immigration data. The problem with the latter is that they are not collected with the purpose of tracking knowledge flows. The number of migrants is registered, too a varying degree and with varying quality, but in the absence of data on education or occupation, the number of migrants in itself is not very useful. Even in the Nordic countries, the education levels of immigrants are not routinely recorded. Recently, both Denmark and Norway have sought to remedy this situation by conducting large-scale surveys of foreigners, in order to register their educational background. However, such large surveys are too costly to carry out on a regular basis. Seen in relation to the sometimes extremely detailed information requested from immigrants, it is paradoxical that very basic and useful information on immigrants' competences is not collected.

The key policy implication from the Focus Group's work on international mobility is that international collaboration is required to develop harmonised data collection routines and data sources in order to enable the analysis of internationally comparable data on mobility of human resources. Harmonisation would also make the data more conducive to showing the ways in which national innovation systems are inter-connected and inter-dependent.

Some implications for policy

In this section, we briefly discuss four aspects of policy related to human resources and mobility. First, there is the need for integration of people into organisations, or more broadly into the national innovation system. Second, there is the question of incentives for mobility. Third, there is the issue of educational investment. Finally, issues relating to the role of clusters and networks in promoting growth in human capital are discussed.

Integration: International mobility of highly skilled human resources may not be vast in terms of the numbers involved, but the relative importance of the knowledge flows is high. In some cases, these flows take place within highly integrated structures like multinational firms, which have their own policies for expatriates. However, the majority, which are not part of these privileged flows, will often require more specific measures to foster integration. Governments should design their immigration policies with this aim; for example, through mandatory language and cultural training in the host

country. The sizeable inflows to knowledge institutions imply that at the level of specific organisations and institutions, measures should be taken to integrate the foreign born in the workforce. Industrial associations could take a leading role to advance private sector practices in this respect.

Incentives: Financial incentives are usually the prime driving force behind the mobility of human resources. However, one could envisage other configurations of mobility and wage differences. In a situation with rather small wage differences, people might – and probably do – change their jobs because they feel they need new intellectual challenges. Relatively large wage differences, on the other hand, may induce people to move to sectors where wages are higher, but can also lock persons into jobs where they do not use their full potential. The fact that highly skilled nurses do not *en masse* decide to become software programmers indicates that wage differences might be more important as signals for young people deciding what they want to do in life, than for more experienced people who have already chosen their occupational orientation. Governments should consider appropriate incentive systems to stimulate a balanced flow of human capital. Some deregulation of employment conditions at knowledge institutions may be relevant to create an optimal flow from these institutions. The design of intellectual property rights and licensing agreements, etc., should take into account the incentives for the employees concerned. However, with a dynamic and ongoing restructuring of the economy, new growth sectors will only expand if the demand for human capital is met. This suggests that governments should leave the reallocation of human resources to the market and limit their role to ensuring sufficient endowments in human capital (see below), and adjusting systemic bottlenecks and disincentives to mobility, such as non-portable pension rights and other welfare schemes.

Human capital investments: It is imperative that mobility of human resources is not seen as a panacea to the necessary knowledge distribution throughout an economy. On the contrary, mobility should be viewed as a complement to the overall formation of human capital through education and training systems. Growth, and hence dynamism, in innovation systems is related to the growth of human capital, and the more this capital formation keeps up with demand, the less will be the disruptive effects caused by extensive mobility. Governments should therefore both ensure sufficient endowments of human capital through public spending in education and training, and make sure that the education system itself is responsive to changing demands for different types of competence.

Dynamic environments: Human resources are not necessarily attracted to countries or sectors, but to regions, specific geographical locations or firms, all of which represent dynamism and opportunities. To avoid the threat of a brain drain, governments should design policies with the aim of creating more dynamic environments in the respective countries, and thereby counteract excessive outflows or stimulate greater inflows. Greater attention needs to be paid to regional clusters, financial and working conditions for knowledge institutions and public-private partnerships. Further, such specialised environments may serve as nodes in worldwide networks for task-sharing and division of labour, and hence provide attractive and competent milieus in the emerging system of task migration which is taking place on a global scale.

NOTE

1. The registers go back to the mid-1908s, but were only available on mainframes in national statistical offices. The PCs of the early 1990s were not capable of handling the amount of data, even for small countries like the Nordic lands. At that time, the machines had roughly as many megabytes as today's systems have gigabytes … and prices per megabyte were an order of magnitude higher per Mb.

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