Flows of Human Capital
in the Nordic Countries

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Mobility from the Research Sector in the Nordic Countries

A project by STEP, The Danish Institute for Studies in Research and Research Policy, Statistics Finland, Statistics Iceland, and Vinnova

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ABSTRACT

The report gives a detailed statistical exposition of flows of personnel between the research-producing sector and other sectors of the economy for the period 1988-1998 in Denmark, Finland, Norway and Sweden. Complete annual matched employee/employer datasets for the four countries make up the bulk of the data. The definition of the research-producing sector is discussed along with potential problems of statistical artefacts and national differences in these register data. The annual flows are then broken down over sub-sectors in research and over the educational background of the personnel, with particular emphasis on science and engineering. Recommendations concerning relevant register data are offered.

These data are interesting from an innovation policy point of view because mobility is an important mechanism for knowledge diffusion in the economy, and outflow of personnel from the research-producing sector to manufacturing and services is expected to be particularly important for the innovative capacity of firms and institutions.

These first comprehensive detailed statistics of researcher mobility in the Nordic countries are the output of a Nordic project which is also dealing with the flow of human capital in job-to-job mobility in general and with the flow of human capital between the Nordic countries through migration. The project is jointly undertaken by STEP, The Danish Institute for Studies in Research and Research Policy, Statistics Finland, Statistics Iceland, and Vinnova.

KEYWORDS	ENGLISH	NORWEGIAN
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Foreword and reader's guide[1]

Competence is a key ingredient for innovation and growth. The prosperity of a nation depends on the knowledge, skills and experience that can be put to work in the operation and development of its economic and social life. Research, education of the young, and lifelong learning are being heralded as crucial mechanisms for supplying businesses and the public sector alike with new and updated competence. A growing body of knowledge about these mechanisms is forming an increasingly strong foundation for public policy and private strategy.

The movement of people involves a mechanism of knowledge transfer that is much less understood. When people move between jobs or between social settings, they carry their skills and experience with them to the new firm or region. When a competence meets with a new situation, innovation can occur, so mobility is not only about moving human capital around but also about creating something new in the process. Competence moves with people in a non-trivial way and mobility may be seriously underestimated as a moving force for social and economic development.

However, research and education take place in purpose-built institutions that are highly visible and relatively easy to study for the purpose of policy improvement. Mobility of human capital, on the other hand, is deeply embedded in social and economic institutions whose primary mission is not the moving of human capital, so it is essentially a by-product of other processes and much less visible to the public eye. Thus the understanding of mobility and its contributions (positive and negative) to a country's competence base is merely in its infancy. Briefly put, the research question is still very open: What is the role of mobility in a National Innovation System?

The project "Flows of human capital in the Nordic countries" ("Kompetansestrømmer i Norden") is a small and exploratory step in the quest for understanding the competence aspect of mobility. The project has set out to illuminate issues of

- human capital flows or circulation through the inter-Nordic labour market
- benchmarks and stylised facts of mobility in the Nordic countries (with a particular emphasis on the significance of the business cycle)
- science – industry mobility

all while identifying and addressing the challenges of opening new, large national register databases to international comparative research.

The project was inspired by the Nordic co-operation in the OECD work on National Innovation Systems in the so-called "Focus Group on Human Mobility" in 1997-1998. Research issues of high policy relevance that were addressed included a better understanding of flows of competence embedded in employees changing jobs. The science-industry relation was a particularly hot topic in this respect. The OECD work was in turn based on the newly available "employment files", i.e. matched employer-employee data produced by combining public register databases. These employment files are constructed in different ways in different countries, but all of them contain a common core of data about all individuals in the population above 16 years, the "active population".

[1] This section is common to the three project reports and the two methodological papers and also appears as the introduction to the summary report.

Until recently it was only the four largest Nordic countries that had such employment files available to researchers and statisticians, but recently Belgium has constructed the first time series of this kind using information from the social security system. In most OECD countries the information exists that would make it possible to construct employment files, but different statistical, legal and political traditions have so far blocked the development of such data sets.

The use of these register data for research purposes is still in an early, explorative phase. Because of this, some caveats are in order for interpreting the results. Firstly, the different mechanisms of knowledge transfer definitely complement each other and they probably also interact. Ideally, mobility rates should be seen in conjunction with measures of research, education and lifelong learning. This has not been possible in the present project.

Secondly, the human capital aspect is not the only aspect of mobility. High mobility increases personnel turnover costs for the firms involved. It disrupts teamwork, makes knowledge accumulation difficult, takes key personnel out of projects that are not finished etc. Low mobility might lead to too little circulation of both experience and new ideas and approaches, incurring high opportunity costs. It is therefore of interest to search for optimal ranges of mobility rates rather than to strive for extreme values. Mobility rates below 5 per cent may indicate stagnation and when they get above 25 per cent, things may seem a bit hectic. Even so, we are not in the position to identify a canonical range.

Our hope is that the results from this project will contribute to the development of research and policy on issues related to stocks and flows of human capital and related labour market issues.

The project has been carried out by a consortium with the following partners:

The STEP Group[2], Oslo (lead partner) (Anders Ekeland, Håkon Finne, Svein Olav Nås, Nils Henrik Solum)

The Danish Institute for Studies in Research and Research Policy (AFSK), Århus (Kenny Friis-Jenssen, Ebbe Graversen, Mette Lemming)

Statistics Finland, Helsinki (Mikael Åkerblom, Markku Virtaharju)

Vinnova[3], Stockholm (Adrian Ratkic, Christian Svanfeldt, Jonny Ullström)

Statistics Iceland, Reykjavik (Ómar Harðarson).

Beyond the partners, Statistics Norway, Statistics Sweden and Statistics Denmark have provided register data. The Nordic Industrial Fund has been the main financial source for the project. Additional funding has been provided by The Finnish National Technology Agency, the Research Council of Norway and the participating consortium members.

The project has resulted in a summary report, three detailed reports and two methodological papers, all of which are published in STEP's report series.

Paper 1, the **Classification paper** (Virtaharju and Åkerblom (2003): Measuring mobility, some methodological issues. Oslo: SINTEF STEP), is a paper that accounts for the methods and classifications used in the project. The paper focuses on dealing with register data. Its target audience is interested non-specialists and fellow researchers.

[2] Since 2003-01-01, SINTEF STEP – Centre for Innovation Research.
[3] Until Vinnova's establishment in 2001, the participating analysts belonged to NUTEK.

Paper 2, the **Data source paper** (Harðarson (2003): Some methodological issues using labour force survey data for mobility research. Oslo: SINTEF STEP), discusses the relationships between register data and Labour Force Survey (LFS) data in detail. This discussion is important because while many countries perform LFSs regularly, only Nordic countries have register data available for detailed mobility studies. Iceland is the fifth of the Nordic countries to be constructing a register database for this purpose.

Project report 1, the **Migration report** (Graversen et al. (2003a): Migration between the Nordic countries: What do register data tell us about the knowledge flows? Oslo: SINTEF STEP), gives a comprehensive picture of flows of migration of Nordic citizens between the Nordic countries for the period 1988-1998. It studies migration rates, rates for returning to the country of emigration and rates for staying in the country of immigration. It breaks these figures down by a number of demographic and economic indicators. This report is aimed at researchers, statistics officials, policy makers and others interested in the flow of human capital between the Nordic countries.

Project report 2, the **Mobility report** (Graversen et al. (2003b): Mobility of human capital – the Nordic countries, 1988-1998. Oslo: SINTEF STEP), compares domestic job-to-job mobility rates in the Nordic countries, broken down over a number of demographic and economic indicators. Particularly important is the verification of procyclical movements in the mobility rates: propensity to change jobs follows the business cycle for most subgroups. The report has produced benchmarks for mobility and stylised facts about influences on mobility rates. This report is aimed at researchers, statistics officials, policy makers and others interested in the flow of human capital between firms.

The present report, Project report 3, the **Researcher report** (Ekeland et al. (2003a): Mobility from the research sector in the Nordic countries. Oslo: SINTEF STEP), is a specialised study of domestic job-to-job mobility rates for personnel in the research sector for the period 1988-1998. This topic is of particular interest for the discussion of the function of specialised research institutions in the innovation system, an expansion of the classical science – industry theme. The report is aimed at researchers, statistics officials, policy makers and other interested parties, including strategy developers of the institutions in the research sector.

The reports and papers are rather detailed. The **Summary report** (Ekeland et al. (2003b): Flows of human capital in the Nordic countries 1988-1998. Oslo: SINTEF STEP) summarises the main findings of the three project reports and the two papers and is recommended as the first intake for all readers. It also contains some material not found in any of the other publications but deemed appropriate for a synthesised formulation.

On behalf of all the partners in the project I would like to thank our sponsors, in particular the Nordic Industrial Fund, for this opportunity to contribute to a literature of growing importance through a stimulating and challenging Nordic co-operative effort.

Oslo, June 2003

Anders Ekeland
Project manager

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1 Introduction

There is an increasing interest in the question of the knowledge flows between universities, research institutes and the business sector, including the labour market mobility[4] between these sectors. Even though we see human mobility as an important mechanism for knowledge diffusion in the economy, we do not think this is the only one. The importance of human mobility for knowledge transfer is clearly dependent on several other factors that can act as substitutes and/or complementary mechanisms for knowledge transfer. One important factor influencing the rate of human mobility is the relationship between tacit and codified knowledge. A recent article by Cowan, David and Foray, "The Explicit Economics of Knowledge Codification and Tacitness" (2000) is an interesting contribution to the discussion of the relation between the process of codification and creation of knowledge and the need for labour mobility. For further discussion of the more theoretical aspects of illustrated by the formal models; see Hauknes and Ekeland (2001) "The mobility of researchers - data, models and policy".

This report is basically a first attempt to create data for comparative analysis between the Nordic countries. As the report shows this is not a straightforward task, even in countries of such cultural, administrative, and economic similarity. There are differences in the structures of the higher education and research sector, and not least there are differences in data available, and even if similar data exist; differences in the available data.

In a comparative study an important task is to try to make figures really comparable. As those who have tried know, this is not a one step procedure, i.e. just agreeing on definitions and then producing the numbers. It is more of an iterative process, where one starts out with some definitions, produces the numbers which often reveal that the common definitions did not produce comparable numbers, because concepts are implemented in different ways, data collection procedures are different, etc. But also data availability is important. The possibility of getting access to data varies considerably in the Nordic countries and determines to a large extent what kind of comparative data that can be used for research purposes. The national statistical system might have much richer data, but these are not available for researchers. From a research point of view this is especially regrettable in the case of the Nordic countries where the existence of a system of register data makes it possible to perform detailed analysis of human mobility. With the exception of Belgium, the rest of Europe and OECD do not have register data in this area and consequently cannot study for example researcher mobility in the way that is done here.

We discuss some of the problems with the register data used in this report that have consequences for the analysis of the results. In the period studied 1988 – 1998 there has been a change of industrial classification in all Nordic countries. There have been changes in the system of firm ID numbers in Norway. Since we still are in an early stage when it comes to using register data a study like this will inevitably reveal some "noise" in the data and, not least, it will point to improvements in the collections of data if the policy questions regarding human mobility in the "triple helix" are going to be answered. The most obvious "problem" is that we are not able to differentiate between scientific and administrative employees in universities and research institutes. But as already mentioned, this is the first attempt to make a comparative study of human mobility from the research producing sector and it had to be of a rather explorative kind. Further studies will hopefully be able to go deeper into aspects of this that have not been covered – or treated somewhat superficially in this report.

[4] We often use the shorter term "human mobility" to separate the flows of knowledge flow from the labour market mobility.

2 Human mobility and the relation between tacit and codified knowledge

In all studies of human mobility the fundamental task is to identify, if possible quantify, the positive and negative aspects of mobility seen from the point of view of each organisation/firm. What is seen as a positive effect for the receiving institution might be a negative effect for the delivering one. There are both win-win and win-lose phenomena and for society it is important to have a holistic, long-term view of human mobility. Briefly stated the "downside" is that too much mobility means that teamwork is disrupted, key personnel leave projects before they are finished, training costs are "too" high, etc. The "upside" is that recruiting new people with new ideas is generally beneficial for your innovative capacity. The problem is to find an optimum between the various negative and positive aspects of mobility. That is not a single number but an optimal range. The golden rule is: avoid mobility rates that are too high or too low.

In the following we shall discuss another aspect of knowledge that influences the mobility rates – the relation between the tacit and codified dimensions of knowledge. One of the reasons why human mobility occurs is certainly that there is a tacit dimension to knowledge. This is of course not an absolute "tacitness", but is clearly given by the context. Some types of knowledge are tacit to some people, but not to others. Knowledge that was not codified can be so if there is sufficient demand for it. Cowan, David and Foray discuss this at length in "The Explicit Economics of Knowledge Codification and Tacitness" (2000). It would be tempting to go deep into this very interesting discussion, but that is beyond the scope of this report. However, the authors touch upon the relation between tacitness and codification and human mobility and its implication for policy and we think their view on this merits some comments.

The authors claim that with the notion of tacit knowledge the traditional Arrowian appropriability argument is less valid, if not outright misleading when an important part of the innovative knowledge is de facto tacit in the given context. Consequently the authors argue that "the traditional economic case for subsidising science and research in general collapses, as there is little or no basis for a presumption of market failure."

Consequently the rationale for subsidies of science as part of a strategic innovation policy in national systems of innovation is raised. A standard argument against public subsidy has been that other nations' researchers could free-ride by using the results of the research of our researchers, given of course that the result of such research has public good characteristics. Cowan, David and Foray write:

> "A corollary of this class of arguments is that the case for granting public subsidies and tax concessions to private companies that invest in R&D would seem to be much weakened, were it not for the difficulties caused these firms by the circulation of their scientific research personnel. Scientific and engineering staff is able to carry critical tacit knowledge off to potential rival firms that offer them better terms of employment, including equity ownership in "start ups" of their own. In the logic of this approach, recognition of the criticality of tacit knowledge argues for further strengthening of trade secrecy protections, to block those "leakages" and altogether eliminate the market failure rationale for governmental support for the performance of R&D by the private sector."

The authors add in a footnote that:

> "Acknowledging the importance of tacit knowledge, and thus at the initial problem [of appropriability] may not be so severe, we face a "new problem" stemming from the fact

> that a firm's *knowledge workers* are easily appropriated by other firms. In both cases the general issue remains however - fluidity of knowledge or information (whether transmitted through codified knowledge or labour mobility) is good for the economy but *bad for the individual firm*." [our emphasis]

This conclusion that mobility is good for the economy but bad for the individual firm cannot be a general conclusion. It is too static in its view of these processes. The individual firm (including research institute) is – as mentioned above – dependent on new people in order to get new ideas, new network connections etc. In short periods you can of course only expand, that is keep "your" knowledge workers and their tacit knowledge – and only hire new people in addition to them, but in the long run you have to have a certain mobility to get rid of people who have become less enthusiastic and replace them with new recruits. In short, one has to find an optimum between getting and losing tacit knowledge. This is also related to the actual capacity of training and socialising those newly recruited and a series of other "constraints".

Later on in the same paper the authors touch upon the more dynamic aspect of these processes. They write:

> "In practice, the extent to which knowledge is codified is determined by incentives: the costs and benefits of doing so. For example, many factors - such as, to take the simplest argument, the high cost of codifying a certain type of knowledge - can decrease the incentives to go further, by lowering the private return on codification. This low rate of return can, in turn induce the maintenance of a large community of people possessing the tacit knowledge. In this case, there will be a labour market that can be used to store and transfer the knowledge from firm to firm. Of course, the presence of a thick labour market as a way of transferring knowledge further reduces incentives to codify.
>
> A self reinforcing process of this kind can generate multiple equilibria. If, for example, there are high returns to codification, more knowledge will be codified. This will decrease the value of a thick labour market as a means of maintaining and distributing (tacit) knowledge. As the labour market shrinks, the relative value of codification increases further. Thus there are two possible equilibria: one with significant resources devoted to codification and a resulting high incentive to codify; and one with few resources so devoted, a thick active market for skilled labour as the mechanism for storing and dissemination of knowledge, and thus low incentives to codify. This argument rests on there being substitutability in the production process between the types of knowledge transferred by these two mechanisms."

It is of course difficult to get data to test such a hypothesis, to say which of the possible equilibria we are in, measure the substitution elasticities etc. But there is reason to believe that the rather costly travels of craftsmen in earlier centuries partly were caused by the low level of codification. One just had to learn the various crafts directly by working with those who mastered the different techniques. This is still a characteristic of the crafts and professions with an important "design" component. We believe one should also take into consideration the ever-expanding universe of knowledge. That means that when techniques become well known, codified and not the least that techniques become more user friendly, more adapted to the average user, then the knowledge frontier will move on. It will not be the same kind of knowledge that is tacit. With an expanding knowledge frontier, with a life cycle of knowledge from new, tacit to codified and trivial one might have a rather stable institutional set-up and not so different mobility rates in the labour markets for researchers since the rate of expansion is more or less the same in all developed countries. An indication that this is the case is those instances where rapid technological change

means that firms cannot wait for knowledge to be codified then studied and mastered by their existing staff. Then firms have to be very active in recruiting, even use professional headhunting. This was the case with people that had some kind of competence in Internet technology in the latter half of the nineties. It was impossible to get enough "codified knowledge" to use existing staff. But one could also observe the negative effect of this scarcity – the same people changed jobs very often, which made it harder to get projects finished as key personnel left when things started to get "tough". It might be very tempting to go elsewhere – and in some cases get a significantly higher wage.

3 The definition of the research sector

3.1 Main definitions

3.1.1 What is research and where is it performed?

A study of the mobility of human resources related to the research sector has to start with a definition of this sector. Earlier work has of course dealt with the question of how to define the research producing sector. An excellent overview of definitions and their statistical consequences is given in Wiig and Mathisen (1994). As Wiig and Mathisen emphasise, the research sector is heterogeneous and there are a lot of borderline cases. Since register data were in practice not available in 1994 and NACE was not yet fully introduced in the statistical systems in the Nordic countries, the discussion does not relate to NACE codes and register data, both of which are essential to the present study.

The definition of research is of course not uncontroversial, but in this report we will not go into that discussion. We will use the conventional, but widely accepted concept of research and experimental development from the Frascati manual. According to this definition research is:

> [..] "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications"[5].

According to the "common sense" concept of research we find research producing entities both in universities, the institute sector and in business. If we leave aside universities, the research sector would be defined by using the current industrial NACE classification.

In NACE "research and experimental development" is defined as NACE code 73. This main sector is again subdivided into two parts:

- 73.1, "Research and experimental development *on natural sciences and engineering*"
- 73.2, "Research and experimental development *on social sciences and humanities*".

This is not a very detailed subdivision. One might have expected further sub-categories like "basic" and "applied" research in each of these fundamental areas of research since the division between basic and applied research is widely used in the public debate and even expert discourse about research. In both cases the debate is not a "philosophical" one, but a debate about resource allocation between basic and applied research. There is no consensus that this division is meaningful.

If one accepts "basic" and "applied" as meaningful and useful concepts, one still has the problem of making it empirically operational. One way to do that would be to say that 'basic' research is done at the universities since they are not contract research institutions. Many would argue that other institutions, often private, often connected to very large firms also do basic research, and maybe in some scientific fields – actually most of the 'basic' research. If not the institutional/financial arrangements can be used as a proxy for "basic" research, one would have

[5] OECD Frascati Manual, 1993.

to evaluate the content, which would be much more controversial – and it would be also be very expensive to collect reliable data.

3.1.2 Detailed division of fields of research

One might ask why there is no further subdivision according to field of research, and to a certain extent there are examples of this in the Nordic countries. The industrial classification (NACE) has five digits, but only four digits are part of the agreed international standard. The fifth digit can be used for national specificities and this is done so far only in Sweden.

One should however keep in mind that even the distinctions between natural science (incl. mathematics and engineering) on the one hand and the social sciences broadly defined is relatively new. The industrial classification used in the seventies and eighties (ISIC rev. 2) did not have this distinction. It was with the introduction of NACE (or ISIC rev. 3) in the early nineties that this division was introduced.

There are probably two reasons for the lack of subdivision of research. The first and most obvious has to do with the system of data collection. In most countries data about the labour market are gathered through the Labour Force Survey (LFS). In any survey there is the problem of "cell size", i.e. that the categories must be broad enough to get a sufficient number of observations so that statistical analysis is possible. Only with register data, i.e. a census, further subdivision becomes possible and useful. The second reason is might be that it is not that easy to find a way to implement such finer subdivisions in a way that would be more informative than misleading. One example could be a possible division between social sciences and humanities. Some would argue that there is no obvious criterion for deciding what are "social sciences" and what are "humanities", besides rather accidental national conventions. Are economic history and ethnography part of humanities as opposed to all the varieties of sociology? There is a lot of cross-disciplinary research that would be difficult to classify. But maybe a further division in scientific fields like economics, law, history and political sciences is feasible. In a national context this might be done using the institutionalised structure of scientific fields at the universities since they generally match disciplinary distinctions. But more often than not, scientific fields are "carved up" differently in different countries, indeed between different universities in a country.

Sometimes one finds economics and law combined, sometimes separate. In the last three decades there is a growing tendency to have new combinations of traditional scientific fields. One hypothesis might be that this "confusion" reflects the fact that society is a complex system of relatively independent subsystems, but basically dependent on each other and with a common denominator in man.

The same goes for research institutions. On a national level they are often are grouped according to scientific field, but this varies considerably from country to country, resulting in different patterns of institutes and scientific fields.

In the same manner one might speculate about the divisions in natural science, NACE 73.1. One could imagine a division into three categories: Firstly the fields related to the study of living organisms (zoology, biology), secondly the disciplines related to dead matter (physics, geology, meteorology, hydrology), thirdly material science and engineering related disciplines. Where to place mathematics, statistics and computer science would of course be a problem. They might be placed in a category of "auxiliary fields". It is not the purpose of this report to try to solve this

issue. The point is that one should not take the existing categories as given, there are various possible ways to classify research.

3.2 The structure of the research-producing sector

In this report the research-producing sector is defined as the educational institutions at university level where research constitutes a major part of their activity and research institutes. One of the reasons why national systems of innovation are different is the specific structure of universities and research institutes, both public, semi-public and for-profit. In Norway for example most of the contract research is done in the institute sector, whereas in Sweden the institute sector is smaller and this type of research is to a great extent done at the universities. Such differences in the size and role of universities and institutes have consequences for the mobility rates. One hypothesis is that applied research is generally more involved with the world outside the university. From this follows that contract researchers might have lower barriers to change jobs. This might "bias" the mobility rates in the Swedish university/industry upwards since they have more contract research at the universities.

3.3 The national implementation of NACE

Closely connected to the question of the structure of the research-producing sector is the question of how this structure is mapped into the industrial classification, into NACE. In order to make the results meaningful and really comparable, one has to take a closer look at how this mapping is done. It is beyond the scope of this report to go deep into this but there are several interesting phenomena that merit some comments.

3.3.1 "University Centres"

The last two decades there has been a growth in "university centres". These are research groups fairly closely connected to the university, but not part of the traditional university structure. One major difference is that they do not have tenured positions, i.e. they do no follow the same formal procedure for permanent employment as do the universities, the positions are not tenured, etc. How do the national statistical systems treat such institutions – as part of the institute sector or as part of the university sector?

3.3.2 The institute sector – the role of private firms

In many countries it is actually the public or semi-public research institutes that are regarded as the "research sector" proper. The definition of the institute sector is often based on those enterprises that get some form of basic, or at least long term strategic funding from the public sector. In this case whether such institutes are formally state owned is not a decisive criterion. They should be non-profit, but could formally be "foundations" or limited companies.

When it comes to the private – in the meaning of receiving no long-term funding from the public sector – enterprises classified under research (i. e. NACE 73) are basically of two types. One archtype is the research departments of great firms and often with a rather clear specialisation, the other archetype is small idealistic institutes that often would not be regarded as scientific by traditional scientific criteria. The latter are few and have few employees and are consequently of

marginal importance, but the statistical treatment of the large commercial research entities is more important. Unfortunately the level of detailed, firm specific data needed to study the private research organisations is not available to researchers. In Norway there also exist some commercial research institutions. In most cases these are the research department of large corporations established as an independent, legal unit.

3.3.3 The problem of "combined" institutes

Another problem when we want to for example compare the mobility patterns between researchers in the social and the natural sciences is the emergence of combined, in most cases regional, research centres. They have departments in both natural sciences and social sciences of considerable size. It might be rather coincidental whether they become classified as natural sciences or social sciences. Even if one of the fields were dominant when the institute first was classified, this may change rather radically over the years; for example by a rapid growth in the ICT part, or by building up milieus for entirely new fields in social sciences. This is one example of the need for a more fine-grained system of entities in the register data if one wants to study such phenomena.

3.3.4 The change from ISIC to NACE

In addition to these problems of using NACE we have the problem that there has been a change in the industrial classification in the early to the mid-nineties. The previous industrial classification (ISIC rev. 2) did not divide research into natural sciences and social sciences. In order to get time series one has to use the NACE code and write it back for all establishments[6] that existed in that year[7]. This has several consequences: changes in classification due to *real* changes in activity (from production to retail etc.) are not reflected – this would be possible but complicated. Generally real changes in activity are not that frequent. For those establishments that did not survive until the year when NACE was introduced we use the most frequent of the NACE codes that have been used to map from ISIC to NACE. Our impression is that with the rather high level of aggregation used in most studies, as is also the case in this report – this method of converting from ISIC to NACE is acceptable. In the case of the research sector where the institutions are more stable this is even more the case, and since the number of institutions is limited it is possible to do a manual check for this.

The change from ISIC to NACE did introduce some noise, it took some time before the system did get used to the new NACE classification[8].

These problems turn up in the case of the research sector as abrupt changes in the number of employees and can be observed in both the Finish and the Norwegian numbers. They might be caused by the reclassification of major institutions. We will discuss some of the possible borderline cases below.

3.4 Other sources that define the research sector

[6] It is only the establishment (production unit, workplace) that has a unique classification code. An enterprise (legal unit) might consist of many establishments belonging to different sectors.
[7] The principles and algorithm used are documented in Nås (1999).
[8] For a detailed discussion of this in the Norwegian case, see Ekeland and Bugge (2002)

There are examples of other sources that define the research sector. The university part of the research sector is generally no problem, since the institutions have a statutory, clearly defined task of conducting research on a high scientific level. As mentioned above this is not the case with the institutions classified in NACE 73. The business register is of course the primary source of information about which institutions and firms that have research as their main activity. There are, however, other sources, one example being the "Catalogue of research institutes"[9] published by the Norwegian institute for studies of research and education (NIFU). Another example is the "Yellow Pages".

The Norwegian Institute Catalogue (IC) contains research institutes that are either public or private-non-profit institutes, many of them have core funding from the public sector[10]. The IC is a very useful publication. It was not made from register data, but is a list developed and maintained as a part of NIFU's work the last thirty years. It is actually not only a list of research institutes defined as institutions where research is their main activity. The list also contains "units with R&D". This is an indication of that even for those that know the sector in detail it is not always easy to draw a line between the institute sector and other institutions and firms that do a lot of R&D.

The "Yellow pages" (YP) is quite different from the Institute Catalogue in that there is no authority deciding who can put themselves in the "Research and development" section of the Yellow Pages. The Yellow Pages is an interesting example of the self-classification of firms. It is beyond the scope of this report to analyse which firms are in the R&D section of the Yellow Pages and which firms are missing, but in general the classification of establishments is often done with rather limited information at hand and the Yellow Pages might give an indication of the firms' own view on their kind of activity and the markets they serve.

3.5 Some borderline cases

Our work with the research sector has revealed a set of issues that we think should be taken into consideration when analysing the available register data – and they are after all the basis for official statistics.

3.5.1 Firms which are research intensive – but whose main product is not research

There are several examples in the registers of firms that are research intensive, but the research is clearly targeted towards developing a product. In the share of employment from such firms are not very important, but in no way negligible. Measured by stock market value some of these private firms can at times be very important, as the incredible rise in stock market value of some research intensive firms that shot up during the dot.com period exemplified.

3.5.2 One man research firms?

These firms are by their nature not important from an employment point of view, but as soon as one starts to make averages "per firm" they may bias averages. In our opinion one-man firms as a

[9] See www.nifu.no for latest online version.
[10] The Catalogue is published every second year as a by-product of the official R&D statistics.

rule should be classified as consultancy and not research[11]. We shall not argue at length for this here, but we think that research fundamentally is an activity of a collective nature; it needs to be institutionalised since close peer interaction is very important. This means that research in an industrial classification sense in almost all cases presupposes a small group, a small research laboratory, institute etc.

3.5.3 Maps and meteorology

Another example of the challenges of industrial classification is the Norwegian state institution that makes maps, Statens Kartverk. In the 1991 edition of the Institute Catalogue it is listed as having 600 employees. These 600 employees are performing between 10 – 24 R&D man years according to the NIFU Catalogue of Institutes. In the register data, Statens Kartverk is classified as research before 1995. In the 1995 IC it is no longer there. The following years Statens Kartverk also disappears from the register data, but not consequently – for some reason the institution making maps for marine purposes is still classified as research.

Meteorology is another borderline case. One could argue that most of the data collection is done to forecast the weather with known models and techniques – that is according to Frascati not R&D because it lacks the element of novelty. On the other hand The Norwegian Meteorological Institute is doing a substantial amount of research. The research department certainly belongs to the research sector, but do all the employees at the measuring stations? If they had been employed there *mainly* for serving research purposes, they would, but there is a lot of routine activities. This is parallel to the collection of register and other statistical data where the main purpose is administrative and political. Such data collection activities should not be classified as research. It is the use of those data by social researchers that should be classified as research, as should non-routine, ad hoc surveys that are developed for specific research purposes.

3.6 Appropriate sectoral breakdown

3.6.1 Towards a more detailed national classification?

We have touched upon this above and we would seriously consider if not all the work and results gathered by NIFU using a more detailed classification of the institutes would be cost efficient. NIFU applies the following categories:

- Culture and society
- Environmental
- Medical
- Primary sector (agricultural, fishing and forestry)
- Technical and industrial

Actually these are only the top-level categories. Wiig and Mathiesen (1994) have an appendix where a more detailed categorisation is presented, thirteen categories all in all. These are the result of the Nordic co-operation around these issues. Maybe thirteen is too detailed, there are too few units in each sector. But clearly a common and more detailed definition would be very useful for

[11] There is an increasing tendency that some people are not traditional employees, but have their own firm, selling their services to research institutions or others.

many policy contexts – and as part of the industrial classification in the business register – not only as a specialised statistical survey.

3.6.2 The university sector

Thirty years ago this was a clear cut concept in Norway, but the development of the regional university-level colleges made it difficult to tell how big the university sector actually was since a lot of the of university level education capacity was provided by the regional colleges. And it is not certain that the quality of these colleges was markedly lower. Since there was stagnation in the number of jobs at traditional universities after a rapid expansion in the sixties many of the young and promising academics ended up in the "province". Given modern transport, and not least e-mail/ Internet, the province is not so provincial any more. Anyhow the tendency was that the "provincial" colleges that were not intended to give higher university degrees and not at all PhDs ended up doing just that, so by now even the formal difference based on the levels of degree they could issue has vanished to a large extent. Consequently we argue in this more general analysis of the diffusion of knowledge via human mobility that the regional university-level colleges should be treated as the traditional universities.

3.6.3 The institute sector – and consultancy

The division between research and consultancy is of course not always straightforward. One might say that consultancy is to apply already accumulated knowledge to give advice to those who do not master this body of accumulated knowledge, while research is to generate knew knowledge by solving applied problems[12] – and generating new knowledge in that process. In reality it is not always that black and white. There is in Norway an increasing tendency that research institutes and consultancy firms compete directly about the same public and (to a lesser extent) private research projects. This is a clear indication that at least the public authorities do not see any fundamental difference between the consultancy firms and "their" (semi-) public research institutes. In addition there has been a rather rapid growth in the consultancy sector. Again one could look at the educational background and career of the employees in the institute sector and the consultancy sector to see if there is any marked difference. These questions will not be pursued in this report.

3.6.4 The overall sectoral breakdown

The tentative conclusion of the discussion of the challenges we face when we want to define a research producing sector that there is a need for more detail for many policy purposes, that there are some difficult borderline cases, that the difference between research and consultancy might need a new discussion, etc. But the overall conclusion is that taken together the University sector (NACE 80.3) and those institutes with public support and the few big industrial research enterprises classified as belonging to NACE 73 constitute the main part of the research producing sector.

[12] "Applied problems" must be understood as being on many levels and include "basic" research, that is research where the problem is stated in rather general terms, like "understand the structure of materials better" is regarded as applied, problem oriented research.

There are several factors that have determined our industrial breakdown for the rest of the economy. Generally one like as much detail as possible since that gives a richer picture of the knowledge flows. However one has to take into consideration the need to have a manageable number of sectors. Even on a two-digit level the NACE classification has 60 sectors. In addition there must not be too few mobile persons in each sector. If the breakdown is as detailed as a strict two-digit NACE the mobility rates will be very "jumpy" since there are very few researchers mobile in each sector. Even the two-digit inspired classification scheme used in R&D statistics and in the Community Innovation Survey (CIS) has 30 sectors. This is still rather detailed, so we have chosen a 20-sector version, which in its turn can be aggregated further into a 5 sector economy. This latter very aggregated sectoral breakdown is easier to read when looking at mobility between two years.

When it comes to this more detailed breakdown we have chosen a breakdown where the research producing sector is divided in three: universities, and two types of R&D establishments – most of them public or semi-public research institutes. The R&D establishments are divided into Natural and Social Sciences. The rest of the economy is divided very roughly into some "meta" sectors (goods, services) and some more specialised sectors, ICT and "Other education".

Since there is a lot of political and research interest, and other studies point in the direction that there is a particularly high mobility from the other sectors to the ICT related sectors, we have constructed a separate ICT sector. There are obvious arguments for looking at the ICT sectors separately given their central role in the development and diffusion of today's new and highly dynamic generic technology. "Other education" is also singled out since there is a special relation between the research producing sectors and education in terms of labour market.

Our resulting sectoral decomposition at the coarsest level is shown in Table 1.

Table 1: Main definition of sectors for this study

Sector name	Definition
Goods producing	Manufacturing, Construction, Energy, Mining, Agriculture, Fishing, Forestry
ICT sectors	Computer hardware (30, 32), Computer services (72), Telecom (64.2)
Services (products)	Wholesale and Retail trade, Transport, Post
R&D, Natural Science	NACE 73.100
R&D, Social Science	NACE 73.200
Services (humans)	Administration, Health, Social services (public and private)
Other Education	NACE 80.309-80.399
Universities	NACE 80.301-80.308

4 Earlier studies on researcher mobility

There are a few earlier studies of researcher mobility in Norway. There are the pioneering works of Baklien, Maus and Skoie (1975) and Berge (1981). Both studies used the Norwegian register of employees of university and research institutes and then by "manual" means found out where those that had quit had moved. With the very rapid expansion of the research-producing sector it became clear that only the use of databases could make it possible to have such mobility studies without cost being prohibitive. The next round of studies came more than ten years later, see Tvede (1992) and Kyvik and Tvede (1994), when the development of databases and computers made it much more feasible to do such studies. These studies also took as their starting point the register of research personnel. But their main focus was on the relationship between the institute sector and the universities. The mobility to other sectors was not studied in much detail. That of course was to a large extent a result of the fact that the data for making such studies possible were not available – or more correctly – not easily accessible. At the same time a series of ad hoc surveys on researcher mobility was done, which focussed on the mobility to the private business sector (Wiig and Riiser, 1992, Wiig and Ekeland 1994). These studies were not done using the Research Personnel Register (RPR) but by sending surveys by fax to the institutes.

This changed when Statistics Norway started producing a set of matched employee – employer files in the mid-nineties. Then there came some of studies that looked at the mobility of researchers between the research producing sectors and the rest of the economy, either as their main focus as in Tvede and Sarpebakken (1998) or as a part of broader studies, Nås et al. (1998).

Of the two studies Tvede and Sarpebakken (1998) is of most relevance to this report. Their starting point is the RPR to which they join data from the matched employer – employee files. The period of study is generally from 1989 to 1995 but differs between outflow and inflow, and between universities and institutes. A discussion of the results is outside the scope of this report, but not surprisingly there is a great deal of stability. This is of course as expected for tenured persons from the universities to other sectors. There is more mobility from the institute sector. This is as expected, but is also an effect of the fact that since there is no tenure system in the institute sector it is not a formal characteristic of the researcher that he or she is tenured. That means that the mobility to a large extent is made up by young people, and they are always more mobile. The population also includes people working on special projects on a temporary basis. It would have been interesting to delineate a group of "senior, experienced" researchers and compare their mobility with the tenured persons at the university. This could be done using age, wages, number of years in the institute sector etc. Another alternative would be to use the classifications of researchers used by the institutes themselves – which often parallel the "lecturer, associate-professor, professor" categorisation. But all institutes do not use this system so there would be some tedious manual work to classify all researchers in the institute sector this way.

Tvede and Sarpebakkken use a four-year period as a consequence of the sampling period of the RPS in order to get a "thicker" stream of mobile persons. This is maybe easier to understand as a "survival rate" than a mobility rate, which often is calculated on a 12-month basis. In this paper we use a yearly rate. But the rates are not comparable since we do not use the RPS as the "population", but all employees in the research sector, and all employees at the universities. That means that we include more young persons early in their career. These people are much more mobile than the more senior person is. The rates in this paper are then generally higher than in Tvede and Sarpebakkken.

The original intention was to use the RPR with its detailed information about occupation/position of university personnel, but due to various institutional and time constraints that was not possible. Consequently we decided to focus on the major patterns of the flows in a longer period 1987-2000 in order to observe the variations from year to year. In coming studies one should use the RPR and the matched employer – employee files to the maximum, both the details about position, type of institute etc. and the full time span of the matched employer-employee files.

5 Data on the mobility of researchers in the Nordic countries

5.1 Overall mobility for the research producing sector

In this part of the report we are going to look at the mobility of researchers in the Nordic countries in increasing detail. There is a set of four tables, the Nordic countries in alphabetical order, for each type of mobility we study. The comments to the tables follow each set of tables, i.e. they come after the Swedish numbers. Sometimes there are comments to individual tables if there is some particular phenomenon that needs to be commented upon.

The structure of the sets of tables is that they look at the research-producing sector, that is the universities and research institutes. The acronym used for this sector is HEI&RD, *H*igher *E*ducation *I*nstitutions and *R*esearch and *D*evelopment (institute) sector.

We look at job-to-job mobility, i.e. the person must have been employed both years. One should first of all keep in mind that the definition of being employed is only that one has been registered as having an employer. Most persons are in full-time positions, but there are also a lot of persons in part time positions, seasonal work etc. One should also not forget that the definition used in the Labour Force Survey is one hour of paid work in the reference week, and in most cases, short and temporary employment do not get registered.

All the tables are based on the higher educated, i.e. persons with all kind of education after the first 12 years, that is all kinds of "university level" education. Later we will look in more detail at the highly educated, i.e. those with five or more years of university level education and the PhD level.

Table 2: Overall inflow and outflow mobility, HEI&RD sector, Nordic countries 1988-1998. Per cent.

	Inflow (HEI&RD is receiving sector)				Outflow (HEI&RD is delivering sector)			
Year	Denmark	Finland	Norway	Sweden	Denmark	Finland	Norway	Sweden
1988		21,2	12,3	26,3		25,4	13,3	26,2
1989	17,4	31,1	14,1	24,3	18,6	25,0	13,4	28,1
1990	13,8	27,1	19,3	22,6	15,9	25,3	16,0	25,7
1991	19,4	24,2	15,8	29,2	19,1	26,0	17,5	29,4
1992	16,7	20,7	15,4	19,6	14,8	20,9	14,9	17,0
1993	16,7	15,7	20,8	20,6	16,5	15,4	20,0	19,2
1994	14,0	15,7	19,4	21,1	15,7	13,5	19,4	22,2
1995	27,4	22,8	22,7	21,3	24,4	23,8	16,5	21,4
1996	20,9	22,7	12,8	21,4	22,0	21,3	13,2	20,8
1997	20,9	21,4	21,4	26,2	20,8	18,0	15,0	26,3
1998		20,1	13,4	19,0		17,7	14,4	20,6
Average	18,6	22,1	17,0	22,9	18,6	21,1	15,8	23,4

The table shows that there are marked differences in the overall inflow and outflow rates. Finland and Sweden are in the area of 22 per cent, Denmark around 19 per cent and Norway around 16 per cent. That Norway has a lower mobility seems to be a general phenomenon. For all countries there is considerable variation in the rates. We know that these fluctuations in some cases are caused by statistical phenomena like changing number systems, changing classifications and definitions, change in data collection routines etc. in each country. Again and again the analytical task will be first of all to try to separate statistical artefacts from real world phenomena, and then try to explain the variations in level and profile of the mobility rates by various factors.

What makes the Danish inflow rate go from 14 per cent in 1994 to 27 per cent in 1995 is difficult to say. There are variations in all countries although not quite as dramatic. And some changes are more explicable than others. That Finland goes from high level of mobility in the late eighties to low rates in the mid-nineties is, we believe, to a large degree explained by the abrupt change in the business climate, in the level of unemployment caused by the near total collapse of the Soviet and East-European markets. These markets were more important for Finland than the other Nordic countries.

In the Norwegian case the great variation in the rates is probably explained by a combination of real and statistical phenomena. There is probably an underlying rising trend in the mobility, but there is considerable noise due to three statistical phenomena. Until 1995 Norway did not have a system of enterprise and establishment identification numbers that were fully adequate for measuring mobility between establishments (workplaces), only for enterprises (legal units). In most cases this weakness of the system should bias the rates slightly upwards. When a new system was introduced in 1995 this created some turbulence that propagated into the following years. The third statistical event was introducing a new industrial classification, NACE. This influenced the sectoral classification. On top of that there was a reorganisation of the research sector and a certain inconsistency from 1993 to 1999 in the classification of enterprises belonging to the research sector.

It is also important always to keep in mind that mobility rates are just an indicator. That implies that they should not be studied in isolation. As discussed in the first part of this report a high level of formalisation of knowledge and/or well-functioning knowledge diffusion interfaces between the research producing sector (RPS) and other sectors might – all other things equal – result in a lower need for human mobility than a system with academic "ivory towers". But one also has to be aware of the differences between countries, differences maybe not so much in the formal definition of who is employed, but in the system of employment. Students in their later stages are employed by universities and research institutes to *different* degrees, and they are also *registered* as such to different degrees. Such differences will influence the mobility rates since persons between 20 and 35 years old are markedly more mobile than older persons. Such temporary employees will be much more mobile than ordinary staff.

When Table 2 above shows clear differences one should not jump to conclusions about differences in the diffusion of knowledge. There are needed more "iterations" between results, interpretation and statistical refinements before the final verdict can be told.

5.2 Inflow mobility to research 1988 – 1998 by sector

Below follows the first set of four tables showing the share of the movers *into* the HEI&RD sector (higher education institutions and research institutes) from other economic sectors, including of course the HEI&RD sector itself. Included in the tables is the actual number of persons with job-to-job mobility. For brevity they are called "Movers". Also included is the total numbers of persons in the population analysed. All averages are average of the yearly rates.

The focus here is to compare the relative contributions to the mobility by different economic sectors in the different countries, not so much the distribution of the movers in each national economy.

Table 3: Inflow mobility to HEI&RD by sector of origin, Denmark 1989-1997. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	10,6	0,7	14,8	48,2	24,6	98,9	4.967	28.609
1990	5,7	0,9	16,7	40,3	35,5	99,1	3.723	27.000
1991	4,3	0,7	13,0	49,6	31,4	99,0	5.123	26.344
1992	12,0	0,8	17,4	31,6	34,8	96,6	4.650	27.797
1993	9,2	2,7	19,7	41,1	26,2	98,9	4.621	27.654
1994	8,6	0,6	23,0	30,4	36,5	99,1	3.852	27.448
1995	6,4	0,5	13,8	50,1	28,9	99,7	8.084	29.503
1996	5,1	2,1	18,7	46,8	26,9	99,6	6.200	29.632
1997	8,0	0,5	14,5	45,7	29,6	98,3	6.496	31.030
Average	7,8	1,1	16,8	42,6	30,5			

Table 4: Inflow mobility to HEI&RD by sector of origin, Finland 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	7,7	2,7	4,3	52,1	33,3	100,1	4.104	16.151
1989	8,8	5,2	3,0	54,3	28,8	100,1	3.916	15.638
1990	7,0	1,6	4,0	55,4	32,0	100,0	4.234	16.753
1991	5,6	4,0	3,5	53,9	32,9	99,9	4.647	17.851
1992	5,8	4,0	2,7	57,9	29,6	100,0	3.937	18.827
1993	4,7	7,0	3,8	55,3	29,2	100,0	3.106	20.196
1994	5,0	6,5	2,6	56,4	29,5	100,0	2.725	20.249
1995	6,0	3,6	3,0	53,7	33,6	99,9	5.061	21.284
1996	5,0	8,1	2,8	55,9	28,2	100,0	4.864	22.864
1997	4,8	3,9	3,2	56,0	32,1	100,0	4.389	24.401
1998	6,0	5,6	3,9	49,8	34,7	100,0	4.569	25.814
Average	6,0	4,7	3,3	54,6	31,3			

Table 5: Inflow mobility to HEI&RD by sector of origin, Norway 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	6,1	1,7	6,9	39,7	38,1	92,5	2.085	18.795
1989	7,9	2,1	6,0	41,9	33,1	91,0	2.397	18.611
1990	5,6	1,5	4,8	50,1	30,1	92,1	3.265	19.262
1991	5,8	1,2	4,4	55,7	25,3	92,4	2.920	20.244
1992	6,5	2,1	6,3	48,4	29,4	92,7	2.637	20.445
1993	3,7	1,0	5,2	66,2	18,6	94,7	3.844	21.304
1994	3,4	0,7	5,2	61,3	22,9	93,5	3.621	20.801
1995	4,0	1,4	6,7	33,2	46,5	91,8	3.936	20.662
1996	5,0	1,2	7,3	39,5	39,5	92,5	3.145	27.468
1997	7,8	12,8	5,5	26,6	41,9	94,6	5.208	27.076
1998	4,4	1,8	7,9	39,8	37,7	91,6	3.728	29.404
Average	5,5	2,5	6,0	45,7	33,0			

The very high inflow from the ICT sector in 1997 12,8 per cent is difficult to explain. If we only had the table for Norway we would have been inclined to treat it as a statistical artefact, probably created by some reclassification of a former HEI&RD institution to ICT. But also Sweden and Finland have a peak here – not in 1997, but in 1996; however, this difference could be caused by the fact that these countries sample the employment in the autumn and Norway in the spring.

Anyhow these years were the peak of the "dot.com" period, and as we shall see, outflow mobility was generally higher than inflow and that the overall trend of inflow. This hectic mobility might have caused this peak value in Sweden and Finland, and in the Norwegian case it may be combined with some error of classification/registration. Without this outlier the Norwegian average of the yearly shares would have been around 1,5 per cent - more in line with the Danish average.

Table 6: Inflow mobility to HEI&RD by sector of origin, Sweden 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	7,8	4,5	4,5	33,5	49,7	100,0	11.563	48.164
1989	6,8	2,6	5,2	37,9	47,5	100,0	11.254	49.549
1990	8,7	2,6	6,1	35,6	47,1	100,1	10.385	48.404
1991	5,3	1,7	5,2	55,8	32,0	100,0	12.938	48.017
1992	12,6	2,7	5,9	37,7	41,2	100,1	8.729	48.731
1993	7,1	1,5	4,6	50,9	35,8	99,9	9.069	50.115
1994	4,9	3,3	4,0	58,7	29,2	100,1	9.295	49.432
1995	5,4	2,9	4,3	52,8	34,6	100,0	9.613	50.209
1996	5,8	9,1	4,2	48,2	32,8	100,1	10.204	52.120
1997	7,0	4,8	4,0	54,9	29,2	99,9	13.614	54.818
1998	6,8	2,9	5,0	50,5	34,8	100,0	11.563	57.204
Average	7,1	3,5	4,8	47,0	37,6			

When comparing the relative shares one must keep in mind that the industrial structures are not identical - although roughly similar since all four countries are developed market economies. The differences in the industrial structures are reflected in the tables. That is, the shares of "movers" that come into the HEI&RD sector from different sectors is an indication of the size of this sector in the country. As discussed above the sectoral breakdown used here is a very coarse one. It lumps together large sectors like all manufacturing sectors into one "goods". In the same manner transport, water, postal services are aggregated into "services (related) to goods". On the other hand it focuses on the ICT sectors and HEI&RD, sectors that have small shares of total employment and in absolute numbers are dwarfed by meta-sectors like services related to humans, which include public administration, non-university education, health etc. All of them are large branches in terms of employment.

The basic feature of the four tables is that the HEI&RD sector as expected has a lot of internal job mobility. Nearly half of those moving are moving within this part of the labour market. The other great labour market is in services related to humans (administration, health, education etc.).

There are no very obvious trends in the inflow mobility; the relative shares are roughly the same at the end of the period as they were at the beginning. But the rates vary quite a bit from year to year. And these variations seem to reflect real phenomena, since they are not related to the changes in the statistical system.

The relationship between the shares to the "Goods" (producing) sector and ICT is interesting. As expected Sweden and Finland have higher shares of movers to both "Goods" and "ICT". But it is a bit surprising that the shares of mobile persons to "Goods" are not that different, the Swedish and Finnish shares of inflow from ICT is several times higher, being at a very low level in Norway and Denmark. On the other hand, the relatively high share inflow from "Services products" in Denmark is not easy to explain. This might again be caused by different national practices in classifying this type of firms.

5.3 Outflow mobility 1988 – 1998 by sector

In the following, we present the sectoral composition of the outflow mobility from the HEI&RD sector.

Table 7: Outflow mobility from HEI&RD by sector of destination, Denmark 1989-1997. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	14,3	1,0	12,4	44,3	27,4	99,4	5.406	29.081
1990	15,4	3,9	14,8	33,8	31,3	99,2	4.442	27.894
1991	11,3	1,0	10,8	50,0	23,9	97,0	5.084	26.622
1992	11,2	4,2	13,7	37,0	32,9	99,0	3.968	26.867
1993	6,1	3,2	17,1	41,3	29,5	97,2	4.601	27.855
1994	6,8	9,3	20,8	26,7	35,8	99,4	4.377	27.838
1995	7,6	3,1	13,3	58,7	16,9	99,6	6.893	28.298
1996	3,1	2,6	18,4	44,0	31,7	99,8	6.587	29.930
1997	4,2	3,1	17,2	46,2	27,5	98,2	6.425	30.933
Average	8,9	3,5	15,4	42,4	28,5			

Table 8: Outflow mobility from HEI&RD by sector of destination, Finland 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	4,8	1,1	2,5	68,7	23,0	100,1	3.112	14.648
1989	11,9	3,6	5,8	40,6	38,2	100,1	5.241	16.835
1990	10,5	4,4	3,9	51,2	30,0	100,0	4.580	16.922
1991	5,2	4,2	2,5	59,0	29,1	100,0	4.248	17.535
1992	3,3	4,2	2,0	57,8	32,7	100,0	3.940	19.020
1993	5,4	7,7	2,6	54,1	30,2	100,0	3.175	20.238
1994	8,5	7,3	3,5	46,7	34,0	100,0	3.286	20.870
1995	7,2	8,7	2,9	57,1	24,2	100,1	4.765	20.906
1996	7,0	7,1	3,0	52,0	31,1	100,2	5.234	23.019
1997	7,1	13,7	4,3	46,0	29,0	100,1	5.346	25.035
1998	8,6	7,4	4,0	42,9	37,1	100,0	5.309	26.399
Average	7,2	6,3	3,4	52,4	30,8			

Table 9: Outflow mobility from HEI&RD by sector of destination, Norway 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	11,5	3,3	11,0	30,9	43,4	100,1	2.182	18.795
1989	13,3	1,9	8,3	40,2	36,2	99,9	2.172	18.611
1990	8,2	1,5	4,8	58,0	27,5	100,0	2.646	19.262
1991	7,6	1,4	5,3	50,1	35,6	100,0	3.008	20.244
1992	10,3	1,4	12,0	46,2	30,1	100,0	2.541	20.445
1993	4,8	1,1	4,5	68,4	21,1	99,9	3.558	21.304
1994	5,5	1,3	5,0	59,4	28,7	99,9	3.694	20.801
1995	10,6	3,0	8,9	41,7	35,9	100,1	2.887	20.662
1996	10,7	4,6	7,1	36,8	40,9	100,1	3.229	27.468
1997	9,9	4,7	7,3	36,2	41,9	100,0	3.740	27.076
1998	11,0	5,3	7,1	35,1	41,4	99,9	4.026	29.404
Average	9,4	2,7	7,4	45,7	34,8			

Table 10: Outflow mobility from HEI&RD by sector of destination, Sweden 1988-1998. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	8,7	3,1	5,0	34,7	48,6	100,1	11.157	44.842
1989	9,0	4,9	5,4	33,9	38,1	91,3	12.559	46.161
1990	8,3	4,5	7,4	32,4	40,0	92,6	11.018	45.304
1991	4,5	2,2	3,0	56,0	27,7	93,4	12.277	44.748
1992	9,2	1,8	4,0	44,5	34,4	93,9	7.099	44.650
1993	6,4	3,2	3,1	55,6	26,4	94,7	7.883	44.625
1994	7,3	4,9	3,4	56,3	24,5	96,4	9.678	45.980
1995	9,2	5,1	4,2	53,8	24,1	96,4	9.501	47.123
1996	8,7	8,3	3,8	50,6	24,9	96,3	9.456	48.780
1997	8,1	7,0	3,7	55,6	21,7	96,1	12.717	51.161
1998	9,2	9,8	4,0	47,2	25,6	95,8	10.816	53.915
Average	8,1	5,0	4,3	47,3	30,5			

As was the case with the inflow rates, the outflow rates vary considerably, but there are still some clear trends in the shares of mobile persons. There is a decline in the "Goods" in Denmark, going from around 15 per cent down to less than 5 per cent; not being near 10 per cent after 1992. As the more detailed tables below will show it is especially the core industrial sectors such as wood, pulp and paper, printing, oil refining, chemical industry, rubber, plastics and metal & machinery that gets a declining share of the mobile persons from HEI&RD. But this decline does not reflect itself in a clear rising trend in the other sectors.

The Danish outflow to the ICT sector is markedly higher than the inflow with an "outlier" in 1994 of 9,3 per cent. In the rest of the period the share fluctuating well below 5 per cent. The ICT sector's share is rising in Finland, Norway and Sweden. In Norway it has a U-shape, where ICT 1988 has a high share. This most probably reflects the fact that in the eighties, Norsk Data attracted a lot of highly skilled persons and with the decline and fall of Norsk Data, outflow to the ICT sector declined. The outflow then rose again from the mid-nineties in step with the upturn and dot.com period. In Sweden and Finland the shares – as the inflow – are significantly higher than in Norway and Denmark. In Finland, in 1997, we again observe this "peak" of 13 per cent – not an extreme outlier given that the rate of movers from HEI&RD to ICT was around 7-8 per cent in the preceding years.

In Sweden there is a pro-cyclical U shape in the number of people leaving the HEI&RD sector, being significantly reduced in the years following the 1992 downturn in the Swedish economy. A slight U-shape is also felt in the Danish numbers. In Norway and Finland a slight U-shape is probably made invisible by the growth in the HEI&RD sector as a whole. The growth in Norway and Finland is greater than in Sweden. In Denmark there is no growth in the HEI&RD at all in this period, but these differences in employment growth go beyond the scope of this report.

5.4 Outflow 1988 – 1998 by scientific fields

In this part we will take a closer look at the relationship between the scientific field and mobility patterns. For reasons of exposition we use three major scientific fields:

- Medical, including dental
- (Natural) science and engineering
- All other scientific fields, mainly social science and humanities.

There will be three tables in sequence for each country. The three tables will be medicine, natural science and engineering and then the "other fields". We will be looking for both differences between the three fields in each country, but mainly to compare those differences between countries.

This is a way of decomposing the outflow tables above in order to see what share of the overall shares of movers is caused by persons with their highest achieved education in one of the three categories. As above it is the HEI&RD sector that is the delivering sector.

It should be mentioned that the size of the population in each country and scientific field seems plausible. The rule of thumb is that Denmark, Finland and Norway have populations of roughly the same size and Sweden, being nearly twice the size, should have nearly the double. This rough rule holds with the exception that in the medical field, the Swedish population is significantly more than twice as big. On the other hand natural science and the "other" fields are somewhat smaller in Sweden that we should expect according to the rule of thumb. The detailed investigation needed to sort out this exception from the rule of thumb could not be done within the framework of this project. The mobility patterns are as expected roughly similar, which we see as an indication that the populations are comparable.

Table 11: Outflow mobility from HEI&RD by sector of destination, Denmark 1989-1997, medical subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	2,7	0,0	2,9	51,3	42,7	99,6	513	1.249
1990	5,4	0,0	4,0	20,1	69,6	99,1	349	1.350
1991	13,0	0,1	12,3	21,5	52,9	99,8	845	1.675
1992	2,0	0,0	2,3	46,4	49,1	99,8	558	1.428
1993	6,4	0,0	6,7	32,2	54,3	99,6	267	1.249
1994	6,1	0,0	3,8	18,6	71,0	99,5	393	1.290
1995	3,8	0,0	2,2	52,7	41,1	99,8	448	1.268
1996	4,3	0,0	1,2	41,1	53,1	99,7	324	1.354
1997	4,0	0,0	29,8	19,6	46,0	99,4	372	1.463

Table 12: Outflow mobility from HEI&RD by sector of destination, Denmark 1989-1997, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	16,1	3,5	14,2	51,5	13,4	98,7	1.287	7.471
1990	24,4	5,0	23,1	27,4	19,0	98,9	1.329	7.563
1991	8,6	2,9	13,1	53,3	13,7	91,6	1.461	7.340
1992	24,6	4,5	16,2	31,9	21,4	98,6	1.238	7.822
1993	9,1	2,6	25,1	38,0	16,9	91,7	1.333	8.195
1994	19,2	6,9	20,4	33,6	19,3	99,4	1.189	7.954
1995	20,7	3,6	10,4	54,8	10,0	99,5	2.201	8.247
1996	10,0	4,0	25,4	44,1	16,4	99,9	1.356	7.986
1997	6,9	4,3	32,3	44,9	10,9	99,3	1.796	8.642

Table 13: Outflow mobility from HEI&RD by sector of destination, Denmark 1989-1997, other fields subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	15,3	0,3	13,1	40,7	30,3	99,7	3.039	13.628
1990	12,3	3,9	12,1	38,6	32,4	99,3	2.406	12.194
1991	12,2	0,4	9,1	56,9	20,5	99,1	2.412	10.673
1992	5,9	5,1	15,2	37,5	35,4	99,1	2.024	10.686
1993	4,7	3,8	14,5	43,6	32,9	99,5	2.843	11.008
1994	1,6	11,7	23,4	25,0	37,9	99,6	2.738	11.287
1995	1,1	3,1	15,9	61,4	18,0	99,5	4.175	10.963
1996	1,1	2,4	17,5	44,2	34,5	99,7	4.845	12.142
1997	3,0	2,8	9,8	49,0	32,9	97,5	4.022	11.706

Table 14: Outflow mobility from HEI&RD by sector of destination, Finland 1988-1998, medical subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	1,1	0,0	1,1	63,4	34,3	99,9	268	850
1989	4,9	0,0	6,2	31,6	57,4	100,1	469	1.065
1990	4,9	0,0	2,5	37,3	55,3	100,0	365	961
1991	2,7	0,0	4,2	41,6	51,5	100,0	406	1.026
1992	1,9	0,3	2,5	45,6	49,7	100,0	366	1.158
1993	3,7	0,0	2,7	22,0	71,5	99,9	295	1.363
1994	2,3	0,0	2,3	32,8	62,5	99,9	384	1.372
1995	3,6	0,0	2,6	36,3	57,5	100,0	388	1.342
1996	2,9	0,2	1,8	36,1	58,9	99,9	543	1.511
1997	3,3	0,0	2,4	26,0	68,3	100,0	457	1.582
1998	1,8	0,2	1,8	24,4	71,8	100,0	496	1.615

Table 15: Outflow mobility from HEI&RD by sector of destination, Finland 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	8,5	2,5	2,0	70,3	16,7	100,0	945	5.554
1989	18,0	5,9	2,9	46,3	26,9	100,0	1.975	6.407
1990	13,0	5,7	2,7	57,5	21,1	100,0	1.713	6.464
1991	7,3	5,5	1,6	65,6	20,0	100,0	1.572	6.801
1992	4,3	6,4	2,0	65,9	21,4	100,0	1.461	7.256
1993	8,4	11,1	2,0	58,9	19,6	100,0	1.000	7.797
1994	12,1	12,3	2,3	48,9	24,4	100,0	1.273	8.258
1995	11,0	10,1	2,3	60,3	16,3	100,0	1.936	8.397
1996	10,6	11,1	3,2	53,0	22,2	100,1	1.898	9.229
1997	9,9	15,8	4,4	50,4	19,5	100,0	2.038	9.822
1998	13,2	12,3	3,6	44,1	26,8	100,0	1.995	10.517

Table 16: Outflow mobility from HEI&RD by sector of destination, Finland 1988-1998, other fields subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	3,5	0,5	2,9	68,7	24,4	100,0	1.899	8.244
1989	8,7	2,7	7,8	38,0	42,8	100,0	2.797	9.363
1990	9,7	4,2	4,8	48,9	32,3	99,9	2.502	9.497
1991	4,3	4,0	2,9	57,6	31,3	100,1	2.270	9.708
1992	2,8	3,3	1,9	54,3	37,6	99,9	2.113	10.606
1993	4,0	7,2	2,9	56,5	29,4	100,0	1.880	11.078
1994	7,1	5,1	4,8	48,3	34,7	100,0	1.629	11.240
1995	4,8	8,9	3,4	57,8	25,0	99,9	2.441	11.167
1996	5,3	5,7	3,1	54,4	31,6	100,1	2.793	12.279
1997	5,6	14,3	4,5	46,0	29,6	100,0	2.851	13.631
1998	6,5	5,3	4,8	45,2	38,3	100,1	2.818	14.267

Table 17: Outflow mobility from HEI&RD by sector of destination, Norway 1988-1998, medical subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	2,8	0,0	10,6	20,6	66,1	100,1	180	1.086
1989	5,5	0,0	3,7	25,8	65,0	100,0	217	1.119
1990	0,8	0,4	4,6	48,1	46,0	99,9	239	1.101
1991	2,9	0,0	2,9	41,1	53,2	100,1	280	1.149
1992	2,9	0,6	14,6	29,2	52,6	99,9	171	1.099
1993	3,0	0,0	0,4	52,0	44,6	100,0	271	1.141
1994	3,1	0,3	1,0	60,6	34,8	99,8	287	1.170
1995	1,7	0,4	5,6	34,9	57,3	99,9	232	1.220
1996	1,8	0,9	3,6	21,1	72,6	100,0	223	1.527
1997	0,0	0,0	0,9	22,5	76,6	100,0	222	1.517
1998	1,9	0,0	7,5	20,6	70,1	100,1	214	1.654

Table 18: Outflow mobility from HEI&RD by sector of destination, Norway 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	14,1	6,3	5,0	40,0	34,6	100,0	697	5.628
1989	14,0	3,7	5,7	51,4	25,2	100,0	706	5.669
1990	12,1	3,3	2,8	63,7	18,0	99,9	815	6.155
1991	12,8	3,0	2,8	54,8	26,5	99,9	965	6.517
1992	15,2	1,9	6,8	55,5	20,6	100,0	1.041	6.648
1993	7,1	1,9	2,9	73,7	14,4	100,0	1.314	6.919
1994	7,3	2,9	3,6	59,7	26,6	100,1	1.154	6.496
1995	15,4	5,4	5,4	47,9	25,9	100,0	1.006	6.436
1996	16,8	9,1	6,0	38,0	30,0	99,9	1.042	8.241
1997	15,5	9,0	6,0	39,5	29,9	99,9	1.192	7.961
1998	16,6	10,4	5,1	37,5	30,3	99,9	1.287	8.876

Table 19: Outflow mobility from HEI&RD by sector of destination, Norway 1988-1998, other fields subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1988	5,5	1,7	7,9	37,6	47,2	99,9	635	4.686
1989	5,4	1,0	7,5	42,2	44,0	100,1	614	4.685
1990	2,4	0,4	3,6	60,5	33,0	99,9	917	5.049
1991	3,5	0,7	4,4	48,6	42,7	99,9	1.073	5.559
1992	3,1	1,3	10,8	47,1	37,7	100,0	779	5.577
1993	1,7	0,7	4,0	67,8	25,8	100,0	1.211	5.939
1994	2,8	0,4	4,7	62,5	29,6	100,0	1.257	6.212
1995	4,3	1,7	7,0	46,0	41,0	100,0	1.081	6.385
1996	5,3	1,6	6,0	41,8	45,3	100,0	1.302	9.655
1997	4,8	2,4	5,9	39,2	47,7	100,0	1.480	9.830
1998	5,8	2,5	6,3	38,7	46,7	100,0	1.586	10.874

Table 20: Outflow mobility from HEI&RD by sector of destination, Sweden 1989-1998, medical subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	4,3	0,1	3,9	16,3	75,4	100	1.005	3.940
1990	5,6	0,2	4,6	16,0	73,5	100	888	4.026
1991	2,5	0,0	2,0	43,7	51,8	100	1.192	4.184
1992	5,5	0,1	1,6	31,4	61,4	100	886	4.530
1993	9,0	0,2	3,0	22,2	65,6	100	576	3.963
1994	6,4	0,0	2,6	46,6	44,4	100	738	4.001
1995	5,6	0,2	3,5	52,1	38,6	100	945	4.479
1996	5,5	0,1	2,0	54,7	37,7	100	980	4.651
1997	5,4	0,5	3,8	45,6	44,7	100	1.055	4.477
1998	7,3	1,0	4,2	38,5	49,0	100	1.021	4.898

Table 21: Outflow mobility from HEI&RD by sector of destination, Sweden 1989-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	23,6	9,9	8,0	27,0	31,6	100,0	1.553	9.877
1990	19,0	16,5	7,9	25,7	31,0	99,9	1.566	10.665
1991	14,9	9,0	4,5	43,6	27,9	100,0	1.352	10.970
1992	19,1	5,5	5,3	45,5	24,6	100,0	1.139	12.305
1993	13,8	10,1	3,8	53,9	18,4	100,0	1.480	12.651
1994	14,8	9,5	3,3	53,9	18,5	100,0	2.029	13.283
1995	18,2	11,6	4,8	46,4	19,0	100,0	2.352	14.541
1996	17,7	21,4	3,5	39,2	18,2	100,0	2.339	14.684
1997	19,1	18,8	3,6	41,0	17,6	100,0	2.729	14.551
1998	18,6	23,4	4,4	33,7	19,9	100,0	2.341	15.270

Table 22: Outflow mobility from HEI&RD by sector of destination, Sweden 1989-1998, other fields subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Services (products)	HEI & R&D	Services (humans)	Sum %	Movers	Total
1989	6,8	8,6	7,3	27,7	49,5	99,9	2.220	10.421
1990	6,0	2,7	6,9	24,1	60,3	100,0	2.179	11.332
1991	4,5	1,1	4,8	45,0	44,6	100,0	2.242	11.602
1992	4,6	1,1	4,4	45,7	44,2	100,0	1.743	13.249
1993	3,5	1,3	3,7	50,3	41,1	99,9	1.790	13.207
1994	3,7	1,7	4,8	55,0	34,7	99,9	2.160	13.966
1995	4,0	3,0	3,5	58,4	31,0	99,9	2.780	15.036
1996	4,0	3,9	4,6	55,3	32,3	100,1	2.593	15.785
1997	3,7	5,5	5,5	48,1	37,3	100,1	2.861	16.382
1998	5,2	8,1	4,4	43,5	38,7	99,9	2.612	17.139

There are as expected some clear differences between the disciplines in all countries. The medical subgroup has an insignificant share going to the ICT sector. The ICT is not a big sector compared to the others, but it has been expanding. That persons with natural science and engineering and science background are the main source of recruitment comes as no surprise, but that the medical fields is so different from the social sciences, humanities etc. in relation to the ICT sector is puzzling.

There are some differences in the patterns of the natural science and engineering subgroup. Sweden, Finland and Norway have rising, and consequently, a high share going into ICT at the end of the period. Denmark has a lower and more stable one, but there are some problems with the quality of the data in some of the years where share of firms lacking NACE codes makes the number of persons working in non-classified firms significant[13]. But still the fact that the natural science and engineering persons in Denmark do not have a significantly higher share than the "other" field subgroup is not what one would expect, and is markedly different from the other countries.

5.5 University and R&D sector – outflow 1988 – 1998, science and engineering

In the previous section we analysed the outflow from the HEI&RD sector of persons from our three categories of scientific fields. Below we go into further detail looking first at outflow from the University sector, then from the R&D sector. There is reason to believe that universities and R&D institutes have different mobility patterns, since they have different employment procedures and different roles in the national system of innovation. Strictly speaking the R&D sector, defined as NACE 73, also includes private business research, but in the Nordic countries this sector is mainly composed of non-profit institutes sponsored by public authorities in various ways and to varying degrees.

In this section we only study those educated in science and engineering since they are the core group for technological innovation processes which are supposed to be of primary importance for the international, industrial competitiveness of a country.

We have also increased the level of detail in the sectoral breakdown. The HEI&RD sector is decomposed into universities and R&D institutes. In addition, education is separated from "Services for Humans", here abbreviated to Srv-H for reasons of space. As discussed in the first

[13] The percentage of firms lacking NACE classification is not shown in the tables.

part of this report we have not had access to data that allow us to identify tenured persons at the university and experienced researchers at the R&D institutes. We have also chosen to look at all persons with natural science and engineering education at university level and not only the highly educated, i.e. with at least 5 years of study. Consequently we probably capture a lot of younger, more mobile persons and that is most likely the reason why the overall mobility rates are high, especially in Finland. That might be reflecting a higher level of registration of part-time, young employees. The high degree of intra-university mobility and low mobility to the R&D institute sector in Finland may also be caused by a different classification of university-near institutions. This is the reason why the Finnish data do not distinguish between natural and social sciences in the R&D institute sector. For reasons explained above, comparable tables for Denmark could not be produced.

Table 23: Outflow mobility from University sector by sector of destination, Finland 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1988	10,1	3,3	1,6	6,8	11,5	6,8	60,0	635	2.705	23,5
1989	20,3	6,0	3,2	11,9	25,8	9,3	23,5	1.209	2.558	47,3
1990	13,7	4,1	2,5	12,5	22,4	6,7	38,1	945	2.634	35,9
1991	5,4	3,4	1,5	11,6	16,9	8,5	52,7	981	2.717	36,1
1992	3,5	4,0	1,5	15,2	19,7	2,5	53,5	1.243	2.819	44,1
1993	8,2	6,4	2,4	6,8	17,9	4,6	53,6	658	3.768	17,5
1994	12,0	11,2	2,1	8,1	24,0	5,0	37,6	857	3.909	21,9
1995	10,6	8,3	2,0	7,3	13,3	5,2	53,3	1.279	3.536	36,2
1996	9,7	7,2	3,2	7,3	15,2	10,4	47,0	1.360	4.019	33,8
1997	12,0	10,1	3,1	9,7	21,5	6,7	36,9	1.162	4.559	25,5
1998	12,0	10,0	3,6	10,7	16,4	11,2	36,1	1.453	4.674	31,1

Table 24: Outflow mobility from University sector by sector of destination, Norway 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1988	10,0	3,6	5,0	40,9	27,7	7,3	5,5	220	1.991	11,0
1989	7,6	1,8	5,8	49,6	18,8	5,8	10,7	224	2.050	10,9
1990	7,3	1,4	0,8	55,9	15,7	3,7	15,2	356	2.229	16,0
1991	13,9	3,0	3,9	38,1	26,8	9,5	4,8	231	2.215	10,4
1992	14,2	3,2	3,9	42,9	22,7	5,7	7,4	282	2.386	11,8
1993	8,7	4,8	4,4	40,1	23,4	9,1	9,5	252	2.512	10,0
1994	8,1	4,0	4,3	26,5	18,7	8,4	30,0	347	2.067	16,8
1995	10,4	6,8	5,9	18,0	39,6	4,1	15,3	222	2.121	10,5
1996	16,6	6,7	6,7	8,9	26,7	3,4	31,1	495	4.165	11,9
1997	10,3	6,9	4,6	24,0	28,7	4,0	21,5	679	4.360	15,6
1998	14,6	10,0	5,0	11,6	28,5	4,3	26,0	603	4.522	13,3

Table 25: Outflow mobility from University sector by sector of destination, Sweden 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1989	20,2	6,9	7,4	11,4	29,0	3,6	21,4	796	4.305	18,5
1990	16,6	8,4	8,3	12,0	29,5	4,5	20,7	715	4.719	15,2
1991	10,5	5,9	3,1	10,5	23,1	4,4	42,4	797	4.968	16,0
1992	15,2	3,6	5,4	15,5	22,7	5,6	32,0	466	5.170	9,0
1993	11,1	8,4	3,2	17,1	18,0	5,2	37,1	633	5.466	11,6
1994	12,4	7,8	3,3	10,2	19,8	2,7	43,8	912	5.619	16,2
1995	13,4	8,6	3,7	7,7	17,3	1,9	47,5	1.062	5.955	17,8
1996	16,4	8,7	4,9	15,0	16,0	3,0	36,0	1.012	6.272	16,1
1997	16,0	11,9	4,1	17,3	19,1	3,4	28,1	1.048	5.929	17,7
1998	16,7	13,0	4,0	16,1	21,7	2,1	26,5	978	6.254	15,6

Table 26: Outflow mobility from R&D institutes sector by sector of destination, Finland 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1988	5,2	1,0	2,9	53,5	10,0	3,5	23,9	310	2.214	14,0
1989	14,5	5,7	2,5	52,6	12,0	1,8	10,8	396	1.657	23,9
1990	12,2	7,6	3,0	51,0	8,9	2,3	15,0	509	1.842	27,6
1991	10,5	9,0	1,7	49,4	8,1	3,0	18,3	559	1.902	29,4
1992	8,7	19,7	4,6	35,3	14,2	2,8	14,7	686	2.039	33,6
1993	8,8	20,2	1,2	46,5	12,9	1,2	9,4	381	2.106	18,1
1994	12,3	14,4	2,6	52,2	13,0	1,9	3,6	383	2.202	17,4
1995	11,6	13,7	3,0	51,0	9,4	2,6	8,7	661	2.258	29,3
1996	13,0	20,8	3,0	38,7	11,3	2,2	11,0	628	2.353	26,7
1997	7,2	23,3	6,2	48,2	7,0	0,9	7,3	432	2.468	17,5
1998	16,2	18,5	3,7	24,5	20,3	4,4	12,4	587	2.612	22,5

Table 27: Outflow mobility from R&D institutes sector by sector of destination, Norway 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1988	15,9	7,5	5,0	16,1	28,3	6,1	21,0	477	3.637	13,1
1989	17,0	4,6	5,6	29,0	21,8	3,7	18,3	482	3.619	13,3
1990	15,9	4,8	4,4	35,3	14,6	2,4	22,7	459	3.926	11,7
1991	12,5	3,0	2,5	36,2	18,1	5,3	22,3	734	4.302	17,1
1992	15,5	1,4	7,9	37,9	14,2	3,4	19,5	759	4.262	17,8
1993	6,7	1,2	2,5	67,7	8,5	1,6	11,8	1.062	4.407	24,1
1994	6,9	2,4	3,2	49,7	23,0	3,3	11,4	807	4.429	18,2
1995	16,8	5,0	5,2	14,2	19,6	1,3	37,9	784	4.315	18,2
1996	17,0	11,3	5,5	18,5	29,3	0,7	17,7	547	4.076	13,4
1997	22,4	11,7	8,0	18,9	25,5	0,8	12,7	513	3.601	14,2
1998	18,4	10,8	5,3	28,9	26,9	1,2	8,5	684	4.354	15,7

Table 28: Outflow mobility from R&D institutes sector by sector of destination, Sweden 1988-1998, science and engineering subgroup. Per cent and absolute numbers.

Year	Goods	ICT	Srv-P	R&D	Srv-H	Educ.	Univ.	Movers	Total	All
1989	27,1	12,9	8,6	12,8	28,1	2,2	8,2	757	5.572	13,6
1990	20,9	23,4	7,5	10,9	25,5	2,9	8,8	851	5.946	14,3
1991	21,3	13,5	6,5	17,3	24,3	4,1	13,0	555	6.002	9,3
1992	21,8	6,8	5,2	29,1	18,4	3,6	15,0	673	7.135	9,4
1993	15,8	11,3	4,3	40,0	12,9	2,0	13,7	847	7.185	11,8
1994	16,7	10,9	3,3	41,1	13,6	1,5	12,8	1.117	7.664	14,6
1995	22,1	14,1	5,8	27,1	17,2	1,6	12,0	1.290	8.586	15,0
1996	18,6	31,1	2,5	22,3	16,1	1,4	7,9	1.327	8.412	15,8
1997	21,0	23,0	3,3	29,2	13,2	1,2	9,0	1.681	8.622	19,5
1998	20,0	30,8	4,7	21,2	15,3	1,7	6,2	1.363	9.016	15,1

Mobility rates from universities and R&D institutes turn out to be rather equal in magnitude. With the available data we have not been able to quantify the well known differences in mobility between tenured university personnel and other core research staff on the one hand and the large group of degree-holding administrative staff and young persons on the other.

There are several significant differences. First of all in Finland there is a higher share of sector internal mobility, from university sector to university sector, from R&D sector to R&D sector. In Norway the R&D sector is just as likely as the new sector, with Sweden in between. In Sweden the "Goods" sector and the ICT sector have significant shares, for ICT especially in the last three years.

Another sector that gets a fair share of the mobile persons is Services related to humans. Most probably this reflects the rise in highly skilled technological consultancy services which offer well-paid employment, where there is room for use and development of the human capital.

5.6 Sectoral mobility for persons with a science and engineering university education

In order to get a better understanding of the mobility described above, we have compiled input/output tables for the mobility of all persons with a science or engineering education, counting across the seven sectors of out study. The input/output tables for the mobility from 1997 to 1998 in the four countries is shown below.

The purpose of the input/output tables of all persons with (natural) science and engineering background is to look at the mobility of this type of human capital form the R&D institutes and universities in relation to those mobile from the other sectors of the economy. There are several aspects of such comparisons and here we will just look at one of them, the question whether the universities and R&D institutes are "ivory towers", i.e. have too little mobility in relation to the other sectors. One way of studying this is to look at the rate of intra-sectoral mobility. In the tables we have italicised the diagonal elements, that is the intra-sectoral mobility rate.

Table 29: Input/output table for science and engineering personnel, Finland 1997-1998. Per cent.

Sector 1998 Sector 1997	Goods	ICT	Serv-P	R&D	Serv-H	Educ	Univ	Sum
Goods	*65,4*	7,9	6,2	2,2	14,1	1,6	2,7	100,0
ICT	3,6	*78,4*	3,6	6,7	4,9	1,5	1,3	100,0
Serv-P	14,1	22,1	*46,0*	2,1	12,4	2,0	1,3	100,0
R&D	16,2	18,5	3,7	*24,5*	20,3	4,4	12,4	100,0
Serv-H	10,5	5,8	4,2	3,1	*65,8*	3,9	6,7	100,0
Educ	1,9	2,1	1,5	1,0	7,5	*82,6*	3,4	100,0
Universities	12,0	10,0	3,6	10,7	16,4	11,2	*36,1*	100,0

Table 30: Input/output table for science and engineering personnel, Norway 1997-1998. Per cent.

Sector 1998 Sector 1997	Goods	ICT	Serv-P	R&D S&E	R&D H&SS	Serv-H	Educ	Univ	Sum
Goods	*60,6*	4,7	12,0	0,7	0,0	21,0	0,6	0,4	100,0
ICT	10,3	*55,4*	20,2	1,0	0,0	12,2	0,3	0,7	100,1
Serv-P	25,6	16,1	*39,5*	1,0	0,1	15,5	1,2	1,1	100,1
R&D S&E	19,7	11,7	5,5	*26,8*	0,3	27,3	0,8	7,9	100,0
R&D H&SS	2,0	0,0	2,0	38,0	*14,0*	22,0	6,0	16,0	100,0
Serv-H	17,7	8,4	9,4	1,6	0,1	*58,0*	2,2	2,6	100,0
Educ	11,5	3,3	4,0	0,6	0,2	21,2	*52,6*	6,5	99,9
Universities	14,6	10,0	5,0	11,1	0,5	28,5	4,3	*26,0*	100,0

Table 31: Input/output table for science and engineering personnel, Sweden 1997-1998. Per cent.

Sector 1998 Sector 1997	Goods	ICT	Serv-P	R&D S&E	R&D H&SS	Serv-H	Educ	Univ	Sum
Goods	*59,7*	7,5	11,6	1,4	0,1	17,6	1,7	0,5	100,1
ICT	6,4	*66,8*	11,3	0,9	0,1	13,4	0,5	0,6	100,0
Serv-P	10,1	7,6	*58,9*	0,5	0,1	19,4	3,0	0,5	100,1
R&D S&E	16,8	24,7	6,1	*19,3*	1,1	21,9	2,9	7,4	100,2
R&D H&SS	3,3	5,9	4,5	10,8	*7,4*	41,3	3,3	23,4	99,9
Serv-H	4,7	3,0	5,8	0,5	0,1	*76,7*	8,0	1,3	100,1
Educ	2,1	0,8	2,9	0,3	0,1	27,8	*63,8*	2,1	99,9
Universities	7,4	5,6	3,3	9,0	1,9	31,4	6,3	*35,1*	100,0

Comparing the intra-sectoral mobility rates of the university and R&D institute sector with other sectors we see that they are lower. Of course most of the other sectors are much "broader" that is they are heavily aggregated "meta" sectors. But the ICT sector is a rather "narrow" sector, and the natural science and engineering persons from this sector tend to stay in the ICT sector.

If the choice of sector was random then a group of persons should have a distribution over the sectors in relation to their size. If we divide the share of movers in a sector by the sectors share of the employment the resulting indicator would show the over/under representation of the sector. In Table 32 below we have shown this indicator for the Norwegian data displayed in Table 30.

Table 32: Input/output table for science and engineering personnel, Norway 1997-1998. Movers to total employment indicator.

Sector 1998 / Sector 1997	Goods	ICT	Serv-P	R&D S&E	R&D H&SS	Serv-H	Educ	Univ
Goods	2,3	0,8	0,7	0,3	0,3	0,5	0,2	0,1
ICT	0,4	28,8	0,7	1,0	0,5	0,4	0,1	0,3
Serv-P	0,5	1,3	2,2	0,2	0,2	0,5	0,3	0,2
R&D S&E	0,6	4,1	0,3	46,8	6,4	0,9	0,2	7,8
R&D H&SS	0,2	2,0	0,3	26,4	116,0	1,0	0,8	17,9
Serv-H	0,3	0,9	0,4	0,4	0,6	2,0	1,1	0,7
Educ	0,2	0,3	0,2	0,1	0,5	0,7	9,5	0,9
Universities	0,3	2,5	0,2	10,0	19,3	1,1	0,9	24,7

The important point here is not the great variations in the size of the indicator, but whether a sector only has one value above one – and if that is the diagonal element, i.e. the intrasectoral rate. We see here that the natural science and engineering persons coming from the research sector have more than one value above one that is not a diagonal element. For the R&D sector natural science and engineering persons going to the ICT sector, the indicator is 4,1. The university persons go to ICT, R&D and Services Humans. Of course the persons with natural science and engineering background working in the *social science* R&D institutes are very like to stay there or go to *natural science* R&D institutes, but this is a very special group. Such an indicator is of course not the answer to the question whether academia is too isolated – it is just a first indication, a starting point for further quantitative and qualitative analysis.

6 Summary

The aim of his report has been primarily explorative. We have approached data of this kind regarding mobility from the research-producing sector (higher education institutions and R&D institutes) for the first time more looking for patterns than answering one particular policy question.

6.1.1 High rates of mobility

As many studies now confirm the Nordic mobility rates are high. Seldom below 10%, as a general rule around 15% in job-to-job mobility for people above 25 years, and not infrequently higher. The mobility rates calculated on the basis of the Labour Force Survey tend to be more than five percentage points lower.

This raises the question of whether it is the register data that overestimate the mobility or the Labour Force Survey data that tend to underestimate it - or a combination of the two. The well known problems related to "artificial" changes of enterprise and establishment numbers do point in the direction of an overestimation of mobility by register data. The high mobility, i.e. over 25 per cent that we have seen many examples of in this study, indicates that this might be an important factor in certain sectors. Before we are able to explain the difference between the rates calculated from the Labour Force Survey and those calculated on the basis of register data one should be cautious when it comes to measures to stimulate mobility on an economy wide scale or for researchers in particular.

6.1.2 Science - industry relationship and mobility

As pointed out above there is no overwhelming evidence of lack of mobility between the university and R&D institute sector. The human mobility must always be analysed as part of an analysis of the many other knowledge diffusion mechanisms that exists between academia and industry and other sectors of the economy. Even if the rate of internal mobility was high, this "isolation" could be compensated by other knowledge diffusion interfaces.

This said there are several questions that merit further research. Among them is to which degree the lower share of mobile persons in Norway and Denmark to the ICT sector is mainly caused by the fact that the ICT sector as defined here includes telecom. The roles of Nokia and Ericsson in this merit further study. There are also different patterns of mobility from the universities, Norway and Sweden having less intra-mobility than Finland. But one should expect a fairly high share of intra university mobility.

6.1.3 The need for high quality data

As often is the case one important aspect of such an exercise is to reveal problems with definitions, data quality and not least access to data. Problems with the latter have caused the actual sectoral breakdowns to be less harmonised than we originally planned.

When it comes to definitions and data quality the conclusion is of course that register data is an excellent data source: economy wide coverage, cost-efficient to use, allowing both very

aggregated and very detailed studies at the same time. But of course there is room for improvement.

In order to study the mobility of both university and R&D institute researchers, access to data that can identify the scientific personnel of these institutions is the key to all kind of science-industry, triple-helix type studies. The Norwegian Research Personnel register is an example of such a register, and the construction and not least harmonisation of such data sources in the Nordic countries would be a very important step forward.

Another important step forward would be to have a more detailed industrial classification of research enterprises, both public and private. There exists already a nomenclature used in the Nordic statistical work on R&D statistics[14] that is more detailed - and we believe - adequate for analysis of researcher mobility and industry-science relations in general. The fifth, "national" digit of NACE could be used in a common way to classify firms and institutions.

If these two improvements were made the register data of the Nordic countries could be the basis for detailed, more policy oriented and less exploratory research than this report.

[14] Cf. Analyseinstitut for forskning (AFSK) "Nordisk FoU statistikk for 1997 og statsbudsjettanalyse for 1999" (Nordic R&D statistics and analysis of state budget").

7 References

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Appendix – Tables with 20 sector breakdown

On the following pages there are tables from Denmark, Finland, Norway and Sweden with a 20 sector breakdown. Breakdowns with this granularity are sometimes referred to as "two digit NACE", but actually the 2 digit level in the NACE classification has 64 groups so still there is a high degree of aggregation. Even with this level of aggregation there are many empty cells when we are looking at such a small subgroup as those moving in and out of the HEI&RD.

The breakdown is not totally identical for all the countries. Denmark, Norway and Sweden are identical, but due to the change of industrial classification there is no data from Denmark before 1994. The previous classification, ISIC Rev. 2 did not separate natural science and social science. There was only one sector for research. In fact Norway did introduce the NACE classification in 1995, but in this case we have reclassified the firms in the previous years using first and foremost firm ID numbers, secondly the most frequent NACE code related to ISIC codes when there is a one-to-many relationship from ISIC to NACE. Our Danish colleagues have not had access to the register data in a way that allows such modifications of the NACE codes.

On the Finnish data, the ISIC - NACE problem has been solved by classifying the research sector according to institutional characteristics.

It is beyond the scope of this report to do a detailed analysis of these tables. This level of detail is more useful when answering more specific hypotheses or policy questions. The missing values in many cells show that in some sectors this detailed level is hardly useful, the numbers become small and "jumpy" and a higher aggregation is needed if the trends are to emerge from the statistical noise.

Table 33: Inflow and outflow to/from HEI&RD, Denmark 1994-1997, decomposed by sector. Per cent.

	Inflow				Outflow			
Sector	**1994**	**1995**	**1996**	**1997**	**1994**	**1995**	**1996**	**1997**
Agriculture, forestry, fishing	0,2	0,1		1,6	2,4	0,2	0,1	
Mining, quarrying							0,1	
Consumer goods	0,4	0,1	0,1	0,2	0,2	0,3	0,3	0,2
Wood, paper, oil, chemical industry	1,4	2,0	2,6	0,9	2,3	1,5	1,6	3,0
Metals, machinery (not ICT)	6,1	2,7	0,5	3,7	1,4	3,9	0,8	0,7
Other manufacturing n.e.c.	0,1							
Energy and water	0,2		0,1		0,2	1,6		
Construction	0,2	1,3	1,7	3,2	0,3		0,1	
Universities	16,4	35,8	29,4	20,7	12,7	42,0	26,5	21,8
Other higher educational institutions	7,8	10,6	12,1	13,5	6,9	12,4	13,7	11,4
Other educational institutions	11,6	10,7	5,9	8,6	6,5	3,8	9,0	6,0
Research institutes (Natural)	5,7	3,4	3,1	10,8	6,4	3,4	3,3	12,4
Research institutes (Human)	0,5	0,3	2,2	0,6	0,8	0,8	0,6	0,6
Office computing and electr. equip.	0,2		1,7		3,0	0,5	1,9	0,3
Telecommunications	0,1				0,2	0,1	0,9	0,3
Computer and related activities	0,6	0,5	0,4	0,5	6,5	2,7	0,8	2,9
Health activities	14,7	6,9	9,5	10,1	14,7	3,6	10,0	6,7
Other community services	10,2	11,3	11,5	10,9	14,7	9,6	12,7	14,8
Trade, hotels, restaurants	11,3	6,4	11,6	2,7	4,0	4,4	2,6	4,4
Transport, post, communications	4,2	1,9	2,2	0,4	3,0	1,9	1,8	0,2
Financial intermediation	0,8	0,3	1,9	0,3	3,0	1,8	1,8	3,5
Other services	7,1	5,4	3,3	11,1	10,9	5,3	11,3	10,6
Unknown	0,2							
In all %	100	100,1	100,1	100	100,4	100,1	100,1	100,3
Number of movers	3.852	8.084	6.200	6.496	4.377	6.893	6.587	6.425
Number in all	27.448	29.503	29.632	31.030	27.838	28.298	29.930	30.933

Table 34: Inflow mobility to HEI&RD, Finland 1988-1998, decomposed by sector. Per cent.

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
01: Agriculture, forestry, fishing	0,7	0,6	0,9	0,7	0,7	0,6	1,3	2,2	0,8	0,7	0,6
02: Mining, quarryin	0,1	0,1	0,0	0,0	0,1	0,0	0,1	0,2	0,1	0,2	0,0
03: Consumer goods	0,6	0,7	0,5	0,4	0,2	0,5	0,3	0,4	0,4	0,3	0,4
04: Wood, pulp and paper, printing	2,4	2,1	1,6	1,7	2,8	1,5	1,6	1,4	1,7	1,8	1,8
05: Metals, machinery	3,1	4,3	3,4	1,7	1,4	1,2	1,3	1,2	1,2	0,9	1,7
06: Office accounting, computers	2,1	4,5	0,4	2,8	3,4	6,2	5,6	2,8	6,6	2,1	3,6
07: Other manufacturing n.e.c	0,2	0,1	0,1	0,2	0,1	0,2	0,1	0,1	0,2	0,0	0,2
08: Energy and water	0,1	0,1	0,1	0,2	0,2	0,4	0,2	0,2	0,2	0,2	0,1
09: Construction	0,5	0,8	0,4	0,7	0,4	0,3	0,1	0,3	0,2	0,2	0,3
10: Wholesale and retail sale, hot	2,3	1,5	2,6	2,2	2,1	2,8	2,1	2,1	2,0	1,9	2,7
11: Transport, storage, post, comm	1,0	0,8	0,5	0,5	0,1	0,3	0,3	0,3	0,5	0,6	0,5
12: Telecommunications	0,2	0,3	0,3	0,2	0,1	0,1	0,1	0,0	0,2	0,2	0,2
13: Financial intermediation	1,1	0,6	0,9	0,9	0,5	0,6	0,2	0,5	0,2	0,3	0,3
14: Computer and related activitie	0,4	0,5	0,9	1,0	0,6	0,8	0,8	0,6	0,8	1,1	0,9
15: Other mainly private services	3,1	4,3	4,4	3,6	3,3	3,5	3,6	5,6	3,6	4,3	4,8
16a: Universities	38,2	31,5	36,5	40,5	51,2	41,1	40,6	36,9	44,8	32,5	36,3
16b: Other higher education	0,1	0,1	0,0	0,0	0,7	0,3	0,1	0,1	0,9	3,0	3,8
17: Other education	6,4	5,7	5,6	6,2	7,7	5,0	5,2	5,9	7,5	19,1	15,3
18a: Public research institutes	12,3	21,2	16,1	11,1	4,2	9,9	13,8	10,7	9,4	12,5	4,7
18b: Research institutes, PNP sect	0,3	0,2	0,1	0,4	0,2	0,2	0,5	0,5	0,2	0,5	0,3
18c: Other research institutes	0,8	1,2	2,3	1,8	2,1	3,6	1,1	3,1	1,6	2,0	1,8
19: Health activities	9,7	4,9	6,4	6,4	8,5	8,4	8,6	6,8	6,1	6,6	8,5
20: Other public services	14,3	14,0	15,8	16,9	9,7	12,4	12,4	18,4	10,9	9,0	11,0
In all %	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Number of movers	5.707	5.986	5.862	6.675	6.959	5.440	5.516	8.876	8.762	8.374	9.076

Table 35: Outflow mobility from HEI&RD, Finland 1988-1998, decomposed by sector. Per cent.

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
01: Agriculture, forestry, fishing	1,2	1,3	1,3	0,6	0,8	0,9	1,2	0,5	0,7	0,6	1,2
02: Mining, quarryin	0,0	0,0	0,0	0,1	0,0	0,0	0,1	0,1	0,1	0,1	0,0
03: Consumer goods	0,6	0,8	0,5	0,2	0,2	0,3	0,5	0,3	0,5	0,3	0,6
04: Wood, pulp and paper, printing	1,2	3,8	2,9	2,0	0,9	1,6	2,8	2,5	2,3	2,5	1,2
05: Metals, machinery	1,2	4,2	4,9	0,8	0,8	2,2	3,2	3,1	2,6	2,4	1,2
06: Office accounting, computers	0,4	1,6	2,4	2,9	3,3	6,6	5,3	7,0	5,1	10,5	0,4
07: Other manufacturing n.e.c	0,3	0,5	0,1	1,0	0,1	0,0	0,2	0,2	0,1	0,2	0,3
08: Energy and water	0,1	0,3	0,2	0,2	0,1	0,2	0,2	0,1	0,3	0,3	0,1
09: Construction	0,3	0,9	0,6	0,4	0,5	0,1	0,2	0,4	0,5	0,4	0,3
10: Wholesale and retail sale, hot	1,6	3,4	2,0	1,7	1,1	2,1	2,2	2,2	2,3	3,1	1,6
11: Transport, storage, post, comm	0,3	0,6	1,1	0,2	0,4	0,3	0,5	0,4	0,4	0,3	0,3
12: Telecommunications	0,0	0,2	0,2	0,5	0,4	0,0	0,3	0,3	0,3	0,6	0,0
13: Financial intermediation	0,6	1,8	0,7	0,6	0,5	0,3	0,9	0,4	0,4	0,6	0,6
14: Computer and related activitie	0,6	1,9	1,8	0,8	0,5	1,1	1,7	1,4	1,5	1,9	0,6
15: Other mainly private services	2,6	8,4	5,6	3,1	2,7	5,1	6,7	4,7	4,3	4,7	2,6
16a: Universities	52,5	22,4	33,6	43,6	45,6	39,4	31,7	39,7	38,8	30,0	52,5
16b: Other higher education	0,0	0,0	0,0	0,5	0,2	0,2	0,3	0,3	5,3	0,6	0,0
17: Other education	9,1	9,8	6,9	7,6	4,8	7,5	7,3	5,9	6,3	6,2	9,1
18a: Public research institutes	14,6	16,1	15,0	13,2	11,0	10,1	12,8	13,3	9,1	12,1	14,6
18b: Research institutes, PNP sect	0,1	0,2	0,2	0,3	0,2	0,2	0,3	0,2	0,1	0,1	0,1
18c: Other research institutes	1,1	1,5	2,2	2,0	0,7	3,3	1,4	3,0	2,7	3,0	1,1
19: Health activities	4,0	7,1	5,5	5,9	4,3	7,1	8,2	5,9	7,0	8,3	4,0
20: Other public services	7,6	13,0	12,1	12,0	21,1	11,4	11,8	8,1	9,5	11,0	7,6
In all %	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Number of movers	3.090	5.225	4.555	4.248	3.968	3.197	3.276	4.767	5.284	5.641	3.090

Table 36: Inflow mobility to HEI&RD, Norway 1988-1998, decomposed by sector. Per cent.

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture, forestry, fishing	2,7	2,4	2,3	2,4	2,3	1,8	1,1	0,9	1,7	0,7	1,3
Mining, quarrying	1,2	1,4	0,8	0,7	0,9	1,1	0,6	0,6	0,5	6,0	0,3
Consumer goods	1,4	1,4	1,7	0,5	1,2	1,1	0,7	0,6	0,8	0,6	0,9
Wood,p aper, , oil, chemicals	2,2	2,3	2,2	4,2	3,1	1,5	1,6	1,2	1,3	1,3	1,7
Metals, machinery (not ICT)	0,1	0,5	0,6	1,0	0,4	0,2	0,1	0,1	0,2	0,1	0,2
Other manufacturing n.e..c.	2,1	2,6	3,8	3,6	1,7	1,9	0,9	0,9	1,1	0,9	1,0
Energy and water	0,4	0,4	2,3	0,5	0,4	0,6	0,2	0,1	0,3	0,2	0,2
Construction	2,1	1,9	1,8	2,0	1,6	2,1	0,9	0,8	0,9	0,5	0,7
Office accounting, computers	0,3	0,7	0,6	0,4	0,6	0,3	0,0	0,1	0,1	0,2	0,2
Trade, hotels, restaurants	10,3	8,4	8,3	7,6	6,6	7,8	5,5	5,7	6,1	4,2	6,9
Transport, post, communications	3,0	1,8	1,7	2,1	2,4	3,0	1,8	1,9	2,3	1,1	1,7
Telecommunications	0,6	0,4	0,4	0,3	0,3	0,2	0,1	0,6	0,2	11,7	0,6
Financial intermediation	1,0	1,5	1,4	1,1	1,3	1,9	1,8	1,3	1,1	0,8	0,9
Other services	11,5	9,8	8,7	9,9	6,9	7,9	7,0	6,1	5,4	4,3	6,2
Computer and related activities	1,6	1,4	1,4	1,1	1,8	1,6	1,0	0,8	0,8	1,1	0,8
R&D Natural science	9,7	7,9	7,3	8,8	17,8	10,6	6,6	6,5	9,8	6,5	12,0
R&D Social science	2,0	2,0	1,9	1,6	1,4	2,2	4,1	17,1	5,0	1,9	2,7
Other community services	14,3	17,3	13,1	15,1	13,5	14,5	13,0	26,2	15,7	25,0	17,3
Other Education	7,2	9,1	8,0	12,5	8,8	9,6	8,8	7,9	7,5	5,1	7,9
Universities	8,5	13,1	18,2	9,7	11,2	14,7	30,4	6,5	23,0	17,6	23,3
Health	18,0	13,7	13,3	15,1	16,0	15,2	13,5	14,1	16,1	10,2	13,2
In all %	100,2	100,0	99,8	100,2	100,2	99,8	99,7	100,0	99,9	100,0	100,0
Number of movers	1.471	1.351	1.248	1.175	1.473	1.456	2.074	2.852	3.229	3.740	4.026

Table 37: Outflow mobility from HEI&RD, Norway 1988-1998, decomposed by sector. Per cent.

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture, forestry, fishing	1,7	1,3	1,2	1,4	1,2	1,2	1,0	0,9	0,9	1,3	0,7
Mining, quarrying	2,4	2,7	2,3	3,9	4,7	2,4	1,2	1,0	2,0	2,4	2,9
Consumer goods	1,2	0,6	0,6	0,9	1,0	1,2	1,1	0,8	0,8	0,7	0,9
Wood,p aper, , oil, chemicals	3,1	4,3	2,8	3,0	3,2	2,6	2,1	3,2	2,8	1,8	1,9
Metals, machinery (not ICT)	0,4	1,0	0,1	0,2	0,2	0,2	0,1	0,3	0,2	0,2	0,4
Other manufacturing n.e..c.	3,0	6,4	4,2	3,1	2,6	1,3	1,6	2,9	2,4	2,2	2,8
Energy and water	1,0	0,5	0,2	0,2	0,5	0,2	0,3	0,6	0,5	0,5	0,5
Construction	2,1	1,0	0,8	1,2	1,5	1,1	1,1	0,9	0,9	0,9	0,9
Office accounting, computers	1,1	0,4	0,5	0,8	0,5	0,1	0,1	0,2	0,6	0,6	0,4
Trade, hotels, restaurants	8,0	6,9	4,2	5,3	5,6	5,0	4,9	4,8	4,3	4,6	4,4
Transport, post, communications	2,4	1,8	0,8	1,4	1,8	1,9	1,7	2,2	1,2	1,3	1,1
Telecommunications	0,7	0,6	0,5	0,6	0,4	0,5	0,5	0,3	0,3	0,7	0,9
Financial intermediation	1,9	1,2	1,1	1,3	1,0	2,2	1,0	1,7	1,4	0,9	1,1
Other services	13,9	8,4	9,0	9,6	7,5	6,7	6,5	6,6	10,6	9,1	13,0
Computer and related activities	1,8	0,5	1,0	1,0	1,2	1,6	1,5	2,5	3,6	3,4	4,0
R&D Natural science	6,3	9,7	8,7	12,3	21,8	13,7	10,3	7,2	9,4	15,2	12,2
R&D Social science	3,9	2,6	2,8	2,8	2,9	2,9	6,8	4,6	2,0	2,6	1,7
Other community services	16,2	15,0	18,9	17,5	11,7	16,6	11,3	17,2	14,8	16,3	15,8
Other Education	7,1	6,4	7,9	9,9	8,4	9,1	7,5	3,7	4,8	6,0	4,9
Universities	8,4	14,1	20,0	10,6	12,5	16,4	30,4	29,4	25,4	18,3	21,2
Health	13,5	14,7	12,3	13,1	9,9	13,2	8,7	9,0	10,9	11,0	8,2
Sum	100,1	100,1	99,9	100,1	100,1	100,1	99,7	100	99,8	100,0	99,9
Number of movers	1.350	1.553	1.432	1.499	1.799	1.743	2.400	3.898	3.145	5.206	3.725

Table 38: Inflow mobility to HEI&RD, Sweden 1989-1998, decomposed by sector. Per cent.

Sector	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture, forestry, fishing	1,1	1,0	1,1	0,7	0,4	0,3	0,3	0,3	0,3	0,4
Mining, quarrying	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,1
Consumer goods	0,5	2,9	0,5	0,5	0,6	0,5	0,4	0,4	0,4	0,5
Wood, paper, oil, chemicals	3,1	3,1	1,8	6,3	2,6	2,3	1,8	2,1	4,0	3,1
Metals, machinery (not ICT)	0,2	0,1	0,1	0,2	0,2	0,1	0,1	0,1	0,1	0,2
Other manufacturing n.e.c.	3,6	3,1	1,8	5,1	2,8	2,1	2,3	2,6	3,9	3,5
Energy and water	0,3	0,4	1,1	0,4	0,3	0,5	0,3	0,2	0,4	0,3
Construction	0,4	0,6	0,5	0,6	0,8	0,2	0,4	0,4	0,4	0,2
Office accounting, computers	2,1	1,7	1,0	1,1	0,8	3,2	2,0	8,7	4,9	1,5
Trade, hotels, restaurants	3,8	4,6	3,3	4,0	4,2	3,0	2,5	2,6	3,5	3,4
Transport, post, communications	1,4	1,7	1,2	0,9	0,7	0,8	0,6	0,6	0,8	1,0
Telecommunications	0,4	0,3	0,2	0,2	0,3	0,4	0,3	0,7	0,4	0,5
Financial intermediation	0,6	1,0	0,5	0,7	0,5	0,6	0,7	0,6	0,4	0,7
Other services	6,8	7,9	6,1	6,8	7,0	4,7	4,5	4,5	5,1	6,8
Computer and related activities	1,3	1,8	1,6	1,4	1,1	1,0	1,1	1,6	1,8	1,8
R&D Natural science	4,9	4,8	4,0	8,2	13,8	17,6	12,6	10,2	14,3	11,6
R&D Social science	2,7	2,8	2,7	4,8	5,9	2,5	2,3	1,7	4,5	2,1
Other community services	11,9	11,5	13,4	13,5	10,4	9,0	8,7	7,9	14,0	13,3
Other Education	11,9	11,9	8,3	9,8	9,7	7,8	10,1	9,0	6,4	10,0
Universities	20,0	17,0	35,5	21,3	24,6	33,3	38,0	33,5	25,2	29,0
Health	23,2	21,8	15,4	13,5	13,2	10,1	10,7	12,2	9,3	10,0
Sum	100,2	100	100,1	100,0	100,0	100,0	99,7	99,9	100,1	100,0
Number of movers	4.354	4.353	5.024	4.631	4.124	4.922	6.056	6.343	6.764	5.429

Table 39: Inflow mobility to HEI&RD, Sweden 1989-1998, decomposed by sector. Per cent.

Sector	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture, forestry, fishing	1,2	0,9	0,6	0,6	0,2	0,4	0,4	0,5	0,4	0,8
Mining, quarrying	0,1	0,0	0,1	0,1	0,0	0,1	0,0	0,1	0,1	0,0
Consumer goods	0,7	0,5	0,6	0,3	0,8	0,3	0,2	0,5	0,3	0,4
Wood, paper, oil, chemicals	3,9	3,9	2,5	3,8	3,7	3,8	4,0	4,1	4,0	3,7
Metals, machinery (not ICT)	0,1	0,1	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,2
Other manufacturing n.e.c.	4,5	3,6	2,2	3,9	3,0	3,5	4,4	3,8	4,8	4,7
Energy and water	0,8	0,6	0,3	0,3	0,3	0,3	0,3	0,2	0,3	0,4
Construction	0,6	0,6	0,4	0,3	0,2	0,2	0,3	0,4	0,3	0,7
Office accounting, computers	1,8	4,1	1,4	0,7	2,2	2,3	2,8	6,5	4,2	6,3
Trade, hotels, restaurants	4,2	4,2	2,5	2,7	2,2	2,0	2,7	2,2	2,6	2,6
Transport, post, communications	1,0	1,0	0,5	0,5	0,3	0,4	0,4	0,4	0,6	0,4
Telecommunications	0,4	0,4	0,2	0,1	0,3	0,2	0,4	0,4	0,8	0,3
Financial intermediation	1,0	1,0	0,6	0,4	0,7	1,2	0,6	0,6	0,8	1,0
Other services	9,2	9,1	6,6	5,4	5,7	5,9	6,3	6,1	6,7	8,4
Computer and related activities	5,0	2,4	1,4	1,3	2,0	2,2	2,7	3,3	5,1	6,2
R&D Natural science	5,1	5,3	4,5	9,2	17,2	16,3	10,4	12,1	15,1	13,0
R&D Social science	2,7	2,8	2,8	5,8	3,4	1,7	1,8	1,8	1,6	1,8
Other community services	11,5	15,3	10,6	10,3	11,5	10,0	8,6	8,7	8,6	9,1
Other Education	7,9	9,2	8,3	8,7	7,0	5,5	4,4	4,9	6,2	6,5
Universities	17,2	15,0	37,1	27,3	26,9	35,3	40,6	34,9	28,1	24,0
Health	21,2	20,0	16,6	18,4	12,3	8,3	8,6	8,4	9,3	9,6
Sum	100,1	100,0	100,0	100,2	100,0	100,0	100,0	100,0	100,0	100,1
Number of movers	4.778	4.633	4.786	3.768	3.846	4.927	6.077	5.912	6.645	5.974

Table 40: Outflow mobility from HEI&RD, Sweden 1989-1998, decomposed by sector. Per cent.

Sector	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agriculture, forestry, fishing	1,2	0,9	0,6	0,6	0,2	0,4	0,4	0,5	0,4	0,8
Mining, quarrying	0,1	0,0	0,1	0,1	0,0	0,1	0,0	0,1	0,1	0,0
Consumer goods	0,7	0,5	0,6	0,3	0,8	0,3	0,2	0,5	0,3	0,4
Wood, paper, oil, chemicals	3,9	3,9	2,5	3,8	3,7	3,8	4,0	4,1	4,0	3,7
Metals, machinery (not ICT)	0,1	0,1	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,2
Other manufacturing n.e.c.	4,5	3,6	2,2	3,9	3,0	3,5	4,4	3,8	4,8	4,7
Energy and water	0,8	0,6	0,3	0,3	0,3	0,3	0,3	0,2	0,3	0,4
Construction	0,6	0,6	0,4	0,3	0,2	0,2	0,3	0,4	0,3	0,7
Office accounting, computers	1,8	4,1	1,4	0,7	2,2	2,3	2,8	6,5	4,2	6,3
Trade, hotels, restaurants	4,2	4,2	2,5	2,7	2,2	2,0	2,7	2,2	2,6	2,6
Transport, post, communications	1,0	1,0	0,5	0,5	0,3	0,4	0,4	0,4	0,6	0,4
Telecommunications	0,4	0,4	0,2	0,1	0,3	0,2	0,4	0,4	0,8	0,3
Financial intermediation	1,0	1,0	0,6	0,4	0,7	1,2	0,6	0,6	0,8	1,0
Other services	9,2	9,1	6,6	5,4	5,7	5,9	6,3	6,1	6,7	8,4
Computer and related activities	5,0	2,4	1,4	1,3	2,0	2,2	2,7	3,3	5,1	6,2
R&D Natural science	5,1	5,3	4,5	9,2	17,2	16,3	10,4	12,1	15,1	13,0
R&D Social science	2,7	2,8	2,8	5,8	3,4	1,7	1,8	1,8	1,6	1,8
Other community services	11,5	15,3	10,6	10,3	11,5	10,0	8,6	8,7	8,6	9,1
Other Education	7,9	9,2	8,3	8,7	7,0	5,5	4,4	4,9	6,2	6,5
Universities	17,2	15,0	37,1	27,3	26,9	35,3	40,6	34,9	28,1	24,0
Health	21,2	20,0	16,6	18,4	12,3	8,3	8,6	8,4	9,3	9,6
Sum	100,1	100,0	100,0	100,2	100,0	100,0	100,0	100,0	100,0	100,1
Number of movers	4.778	4.633	4.786	3.768	3.846	4.927	6.077	5.912	6.645	5.974

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STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst. Fra 1. januar 2003 er STEP – Senter for innovasjonsforskning en del av SINTEF Teknologiledelse.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth. As of January 1st 2003, STEP – Centre for Innovation Research is part of SINTEF Industrial Management.