Analyseinstitut for Forskning

Knowledge transfer by labour mobility
In the Nordic countries

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Knowledge transfer by labour mobility

in the Nordic countries[1]

By

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[1] For full details of the work and results, see:
Svein Olav Nås et al.: **Formal competencies in the innovation systems of the Nordic countries: An analysis based on register data.** STEP Report R-06/98. 1998. The report is available from the Internet address http://www.step.no/reports/Y1998/0698.htm.
Ebbe K. Graversen: **Formal Competencies in the Danish National Innovation System.** AFSK Report 1999/4. 1999. The report is available from the Internet address http://www.afsk.au.dk/ftp/formalcomp/formalc.pdf.

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1. Introduction

Indicators that involve human resources serve as an important complement to the traditional R&D statistics concerned with R&D spending and R&D performance. The mobility of highly qualified personnel is an important vehicle for knowledge flows, and indicators of this movement can help us map important linkages in innovation systems. Mobility indicators can further be used to evaluate the effects different policy measures have on areas of education, research, labour markets, regional development, etc. In this paper the results from the work of an OECD focus group on skills and mobility of human resources are presented. The focus of the analysis is to investigate to what extent register data on employees can be utilised to study stocks and flows of personnel in a national innovation systems perspective. The stock of knowledge is a parameter used as an indicator for the potential in a knowledge-based economy and the mobility rates of human resources are assumed to reflect the innovation potential. The registers contain information on each single employee in the four countries in the study (Sweden, Norway, Finland and Denmark), including information regarding their age, education and employment at any particular time. This information is used partly to compare stocks of employees with different types of education across industrial sectors, and partly to describe flows of personnel between sectors. In the sectoral breakdown a particular attention has been given to higher education institutions (HEIs) and research institutes. Whereas the analyses of stocks can be said to describe the nodes in the innovation systems, the flow analysis adds to our capability of establishing and describing the links in the systems. By adding in information on knowledge creation, such as information on innovative activity or R&D expenditures, the methodology allows for tracking of knowledge flows within the innovation systems. So far, however, such additional information has not been utilised.

Mobility of highly educated labour is perhaps the most obvious mechanism of knowledge transfer. It should however be noted that, just as there is mobility without any significant knowledge transfer, so do knowledge flows and transfers take place without any prolonged physical mobility of individuals as the channel for the knowledge flow. The rapid development of information and communication technologies has made room for forms of knowledge transfer in which no permanent human mobility (if any) is involved. Knowledge transfer mechanisms other than labour-mobility include co-operations; temporary exchanges and placements of staff; various types of networks; buyer-supplier relationships; R&D collaborations; etc. In light of this, other applicable indicators include co-authorships, co-citations, co-patenting, number of external contacts and co-operations, branch specific common activities, etc. Therefore, one should be aware that this approach to mapping nodes and links in national innovation systems only covers one among many different aspects,

which together constitute the system. In particular we will argue for the need to combine labour mobility data with other sources of information regarding knowledge creation and use, such as R&D statistics, innovation surveys and indicators for more embodied knowledge flows like investments in machinery and equipment.

Although the experiences of the approach have revealed that this is a feasible and productive line of research to expand our knowledge about innovation systems, there are indeed methodological problems involved – even when comparing countries with many similarities such as the Nordic countries. The problems mainly relate to differences in industrial structures and education systems, resulting in problems with coding and updating of registers. Despite these problems we are confident, that we have presented a reasonable comparative picture of the Nordic countries. At an overall level we find the same main structures in all four countries, but naturally there are also clear differences on a more detailed level. The chapter is organised as follows: First, we present some of the methodological problems and choices involved, including experiences from previous work. Second, we present the main results from the analyses, and third, we highlight some of the policy issues brought forward by the work.

2. Previous work and methodological issues

The chosen approach to establish links in national innovation systems is relatively new. Even though the importance of humans as vehicles for transferring knowledge has been recognised for a long time[2], suitable data - that is register data - has not been available until recently.[3] Various studies have been carried out in the fields of social mobility and labour marked studies that are partially relevant. But most of these studies have been based on specialised surveys. Consequently there is not much previous research to draw upon in this work.

[2] This have been emphasised by many of the most influential writers on the issue of national innovation systems and related topics. See for instance Edquist, Charles (ed.): **Systems of innovation. Technologies, institutions and organizations**. Pinter, London and Washington 1997. Freeman, C.: **The 'National System of Innovation' in historical perspective**. Cambridge Journal of Economics, Vol. 19: 5-24. 1995. Lundvall, Bengt-Åke (ed.): **National systems of innovation. Towards a theory of innovation and interactive learning**. Pinter Publishers, London 1992. Nelson, Richard (ed.): **National innovation systems. A comparative analysis**. Oxford University Press, New York, Oxford 1993. Nelson, Richard R. and Sydney Winter: **An evolutionary theory of economic change**. Harvard University Press, Cambridge, Massachusetts and London 1982. OECD: **Technology and the economy: The key relationships**. OECD, Paris 1992.

[3] For an overview of data and related studies see: Mikael Rosengren: **An Inventory of National Priorities and Availability of data in OECD Countries to Quantify Science and Technology Personnel Mobility Patterns.** OECD NESTI/TIP/GSS Workshop, 17 June, Room Document No. 2. 1998.

Mobility of personnel to and from the research institute sector has however been studied in Norway.[4] The mobility rates were found in the range of six to eight percent, i.e. considerably lower than the rates found in this study using register data. There are various plausible reasons for this discrepancy like different collection methods etc., which we will not go into here, although the differences illustrate the importance of comparability in the data used for the statistics. The mobility rates have to be defined equally and based on identical data sources before comparisons of figures become plausible and relevant. However, developments and trends in the data seem to be generally valid independent of which source used to create the actual numbers.

Recent work using the same register data in Norway shows that the *business-service sector* acts as a sort of second knowledge-infrastructure since it both recruits and supplies skilled manpower from a much wider range of sectors/branches than any other sector/branch.[5] Stock data also shows that the educational level in business services is equal to the public sector. A study of the employment of natural scientists and engineers in industry in Sweden showed that human resources mapping might provide a more accurate picture of a country's technological strength than R&D spending statistics, especially for non-manufacturing sectors.[6] The same study concluded that PhD mobility seemed like a weak mechanism of knowledge transfer, at least in the period of 1990-1993. Another Swedish study concerning the internationalisation of qualified scientists and engineers showed that firm strategy regarding the recruitment and internationalisation of human resources differ significantly between European countries, and that cultural factors play a non negligible role.[7]

[4] Results are documented in a series of STEP reports: Heidi Wiig and Vemund Riiser: **Forskermobilitet i instituttsektoren 1991** (11/92) [Researcher mobility in the Norwegian institute sector 1991], Heidi Wiig and Anders Ekeland: **Forskermobilitet i instituttsektoren i 1992** (8/94). The latter contains comparisons with similar studies in other countries. There was also studies of mobility of university personnel: Heidi Wiig and Anders Ekeland: **Naturviternes kontakt med andre sektorer i samfunnet** (6/94) [Mobility of natural scientists in Norway]; As a part of this research there was written a theoretical paper: Johan Hauknes: **Modelling mobility of researchers** (9/94) exploring the use of various mathematical models in light of some empirical regularities. The Norwegian Institute for Studies of Research and Education (NIFU), has for many years collected data and conducted studies, but mainly on mobility between the different parts of the established research system, i.e. the HEI and research Institute sectors.

[5] Nås, Svein Olav, Ekeland, Anders & Hauknes, Johan: **Formell kompetanse i norsk arbeidsliv 1986-1994** [Formal competencies in Norwegian labour markets 1986-1994]. STEP working paper A-05 1998.

[6] Stenberg, L., Gustafsson, E. & Marklund, G.: **Use of human resource data for analysis of the structure and dynamics of the Swedish innovation system**. Research Evaluation, volume 6, N° 2, August 1996, pp121-132. 1996.

[7] Euro QSE.

In Denmark there have been carried out studies of job creation and destruction that used some very interesting methods addressing problems related to “business demography” based on register data. Similar techniques are now explored in other countries.[8] Business demography is one of the main methodological challenges for mobility and knowledge transfer studies.

A basic assumption underlying our work is that mobility of personnel between organisations or institutions indicates that there is also a knowledge transfer taking place. This is of course true to a varying degree. It depends – among other things - upon each person’s ability and opportunity to learn from the organisation where he or she is employed. We expect that this depends upon the length of the employment and the education of the person – variables that are available for the analysis. In addition the exact position or occupation in the organisation will influence the learning that is taking place. Such information is, however, not available at present.

Several choices have been made regarding the level of detail, population, years studied, and what constitutes labour mobility. First, by 'employed' we mean an individual who is employed at least one of the years studied in the present paper. Second, we have defined *mobility* as a change of workplace (establishment). We could have chosen other bases for mobility, such as change of organisation, geographical change, etc., but have decided that a change of work establishment is the most solid mobility indicator available. An added criterion could be used, such as change of sector, but we argue that such a level of detail in the sector classification eventually would influence the mobility rates too much. Third, we have striven to arrive at a sectoral breakdown that reflects the characteristics of each country’s national innovation system (NIS). For practical reasons we have chosen to include what are arguably the most important NIS sectors*, the higher education institutes (HEI)* and *the R&D institutes* (including the industrial research institutes). These two sectors also show some significant differences between the four countries. In addition there are nine industrial or public sectors.[9]

One of the principal interests in mobility data is that human resources are supposed to represent knowledge bases and flows of knowledge within economies or innovation systems. There exist many forms of knowledge, such as formal knowledge, skills, competencies, codified knowledge, tacit knowledge, etc. The indicator denoting type of knowledge in this

[8] For an overview see Per Vejrup Hansen: **Virksomhedsdemografi: overlevelse og vækst i nye virksomheder** [Business demography, survival and growth in new firms], Samfundsøkonomen 2, 1993.

[9] The breakdown of sectors is important for how mobility patterns and rates come out. In the main reports 42 sectors are used at the most disaggregated level.

study is the level and field of formal education. The use of formal education as an indicator has clear advantages as a knowledge-indicator on a large scale, since indicators of other forms of knowledge would demand very elaborate means of data collection and collation. An alternative might be occupational classification, but not all OECD countries collect such data, and the classifications differ.[10]

Although highest achieved formal education has its clear limitations as a knowledge indicator, it is probably the best we have so far. In the case of indicators involving the highly educated (including those with research credentials) the degree of specialisation is so high that formal knowledge is probably a more than acceptable indicator of knowledge. It is much more difficult to assess the impact and extent of knowledge transfer associated with tenure and experience. But one could use a combined indicator of education and characteristics of a person's occupational career. Strict compatibility of data from different countries is very difficult to achieve. Whatever indicators of flows being studied, they must naturally also be related to stock of the same or broader categories, as well as population sizes.

There is also a strong need for a thorough understanding of the institutional conditions of the individual countries. Discrepancies in institutional and educational systems necessarily reduce the value of direct comparisons, since they are only possible on a very broad and basic level. Our work shows that even when comparing four countries that are so similar in many respects, there is still work to be done to make comparisons analytically meaningful.[11] It is a limitation to our approach that we have not yet been able to take international mobility into account, not even between the Nordic countries.[12] This includes both permanent mobility between countries, and temporary exchange of personnel.

[10] See Peter Elias: **Occupational classification (ISCO-88): Concepts, method, reliability, validity and cross-national comparability**, Labour marked and social policy – Occasional papers No 20, OECD, available on OLIS. 1996.

[11] The numbers used and calculations made in the Danish and Finnish tables for the mobility rates into job are calculated a little different from the Swedish and Norwegian numbers. As this might have consequences for the 'mobility rate in' for each sector, the text primarily focuses upon the 'mobility rate out' of each sector.

[12] Although the Nordic countries have tried to make an inter-Nordic labour marked there are various formal and practical obstacles still to be overcome. For an overview see Johan Roos: **Hinder för Nordisk forskarmobilitet** [Obstacles for inter-Nordic researcher mobility], TemaNord, 1994:526. 1994.

3. Mobility rates

Mobility of employees is by no means a marginal phenomenon. Between 20 and 25 percent of the employees are recorded to have left their employer one year later (table 1). There is a general higher mobility in Sweden, Denmark and Finland than in Norway. The level is roughly the same for the group of higher educated as for all employees independent of education, although the group of higher educated represents a slightly lower degree of mobility than for all employees. In Finland this pattern is somewhat reversed, whereas in Denmark this trend is stronger than in the other countries. When excluding those leaving active work force, an opposite pattern emerges: Higher education gives a higher degree of mobility. This suggests a higher education level among the younger part of the active work force, assuming that this part of the population has the highest degree of mobility. Again the Danish figures differ from the overall picture, primarily because of an easier and cheaper lay-off policy and a higher degree of unemployment which gives higher mobility rates among the ones with short education.

Table 1: Mobility rates for all employees and for employees with higher education by scientific field and country. Percent of employment first year

Type of employees	Type of mobility rate	Sweden[1]	Norway	Finland	Denmark[2]
All employees	Out of job	24.0	20.1	23.3	27.2
	Job to job	16.2	12.4	11.5	18.2
All higher educated employees	Out of job	23.4	18.6	23.9	21.8
	Job to job	19.5	12.8	17.9	16.4
Natural sciences and engineering	Out of job	22.4	19.9	23.3	22.2
	Job to job	19.0	14.6	17.8	17.4
Medical fields of science	Out of job	25.1	21.4	26.7	22.9
	Job to job	21.9	14.7	21.2	16.8
Social sciences, humanities and others	Out of job	23.3	17.4	23.6	21.2
	Job to job	19.2	11.7	17.4	15.8

Out of job type of mobility: Including persons leaving active work force. Job to job type of mobility: Excluding those leaving active work force.
[1] For Sweden only persons working in establishments with valid NACE codes both years are included.
[2] The Danish numbers are based on a full sample of higher educated individuals and a random sample on one percent of the remaining population.

If mobility or turnover in employment were at the level recorded here for every single enterprise each year, the total staff would have been changed within only four to five years if everybody had the same propensity to change job. But, as we all know, there are large individual and group differences. There are “stayers” and “movers”. In addition an important cause of mobility is entry and exit of enterprises. A large share of mobility results from enterprises going out of business or being restructured in such a way that their identity number change in the registers upon which we base our definition of mobility. To what extent this is “real” mobility depends on the definition of the “birth” and “death” of a firm, i.e. on

business demography. The Danish and Finnish figures are corrected for artificial mobility caused by changes in ownership etc. among existing firms.

One could argue that changing job should be the core focus when studying knowledge transfers, as this includes persons bringing their knowledge from one workplace to another. On the other hand, the turnover in companies resulting from retirement and other reasons for leaving, facilitates the employment of new employees, be they from another company, from unemployment or newly graduated candidates. All of these groups bring new knowledge into the organisation and contribute to the flow and renewal of knowledge.

3.1 Formal education

The distribution of highly educated (ISCED76=6+) employees by scientific field is of interest due to the potential innovation power for the different sectors of the industry, assuming that people with a high education possess more innovative knowledge than individuals with low and intermediate level types of education. This is an assumption that might be discussed and reflected upon, although not in the present paper.

As figure 1 shows, social sciences, humanities and other fields dominate the overall picture, with Sweden on top with a 69 percent share and Denmark with the lowest share of 54 percent of all highly educated employees. Within this field Norway and Finland represent the intermediate level of the four countries, with respective shares of 63 percent and 61 percent. The intermediate discipline of the three is constituted by natural sciences and engineering, varying from a 18 percent share in Sweden to a 28 percent share in Finland, supplemented by 22 percent in Norway and 25 percent in Denmark. Medical and health related disciplines amount to the smallest group in all the countries, with a share varying from 11 percent to 21 percent of all highly educated employees.

Despite these differences, the numbers between the Nordic countries do not deviate too much from each other. However, the Danish numbers also allow a further comparison by gender (figure 2). This reveals a large gap in the distribution of personnel to ‘medical and health related disciplines’ and ‘natural sciences and engineering’.

Figure 1: Stock of highly educated employees (ISCED=6+) by disciplines and country, 1995. Percent

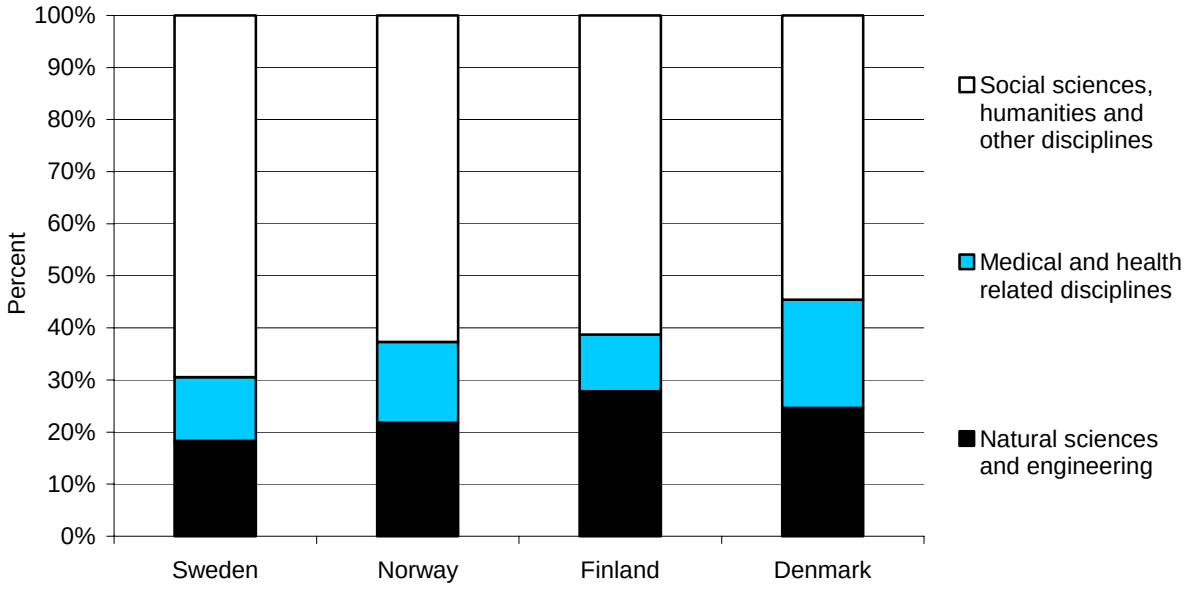
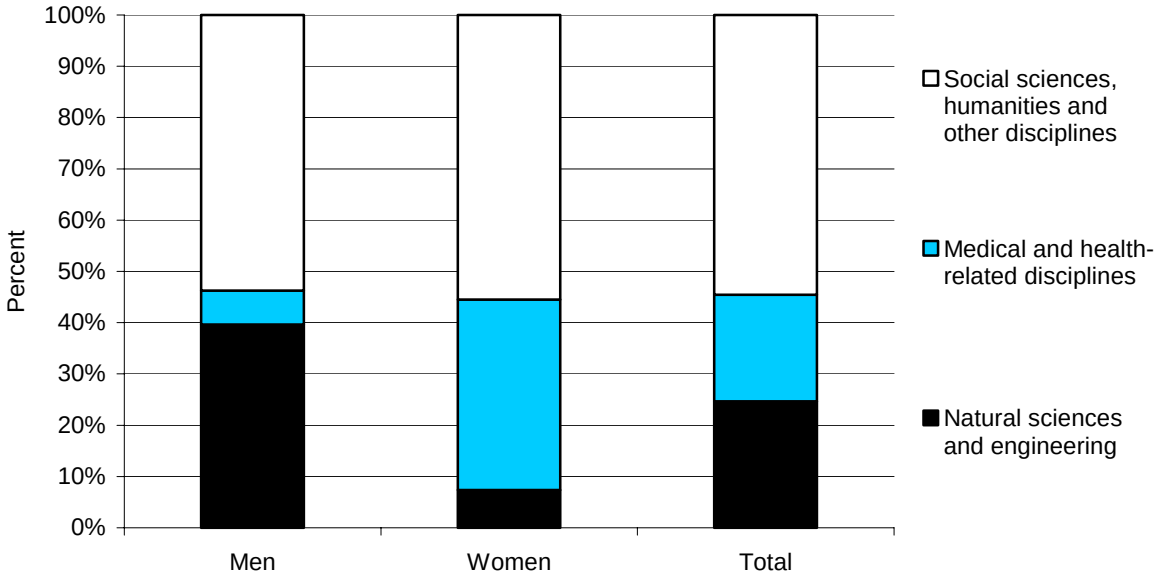


Figure 2: Stock of highly educated employees by scientific field and gender in Denmark, 1995. Percent



While 40 percent of all highly educated men are employed within natural sciences and engineering, the corresponding number for women is only seven percent. Similarly the share of men employed in medical and health related disciplines is only seven percent, while the equivalent for women is 37 percent. Regarding the distribution to social sciences, humanities and other disciplines, men and women both have a similar share of around 54 percent. The Danish gender distribution also shows that there is a somewhat larger share of women

leaving active work force than men, and correspondingly a larger share of men shifting job than women. The share of stable employees (without job shift) is however the same for men and women. These differences and similarities between the sexes both exist for higher educated employees and for all employees in Denmark.

Both men and women with higher education tend to have a lower mobility than for the entire population independent of education. This Danish pattern corresponds with the national numbers independent of gender in Norway and Sweden, whereas in Finland higher educated employees have as we have seen a larger mobility rate than the work force at large.

In order to get an idea of the degree of stability of employment over a longer time span, we have looked up how many of the employees in Norway in 1986 that are found with the same establishment in 1994; an eight-year period. The results show, that almost one-third of the employees is found with the same establishment after eight years (32 percent of the employees in 1986 and 31 percent of the employees in 1994). A similar Swedish exercise revealed that over a 7-year period from 1986 to 1993, only 20 percent of the original employees are found with the same establishment. Even if this uncovers some degree of stability, it implies that between 70 percent and 80 percent of the employees stay with their employer less than 7-8 years. In consequence, exchanging personnel bring a lot of new knowledge into the organisations – and a lot of knowledge is necessarily lost. Finding the correct balance between these two tendencies is a major challenge for human resource management in the firm.

Breaking down mobility rates by type of higher education reveals much the same patterns between the countries as overall mobility, with generally higher mobility rates in Sweden, Finland and Denmark than in Norway (table 1).[13] There are broad similarities on this aggregated level, but also many differences yet to be explained, like the variations between "job to job'' and "out of job" mobility between fields of study and countries. Bringing in one extra year allow us to decompose mobility of the middle year according to both inflow and outflow. Combining inflows with outflows and the stable employees results in a total of nine categories. The possible states include employees with the same employer during all three years, employees changing employer from previous year or to the subsequent year, and

[13] Finland and Denmark have to a certain degree corrected for "false" mobility. If a majority of the employees in an establishment in year T has changed employer collectively in year t+1, they have considered the change of employer identification number as an statistical artefact. Overall this lowers their mobility rate by 2-3 percentage points. But since we do not have a "benchmark practice" on how "births" and "deaths" of firms are handled in the business registers of the Nordic countries it is hard to tell which rates are the most comparable ones; the mobility rates corrected for artificial mobility or the ones not corrected for this.

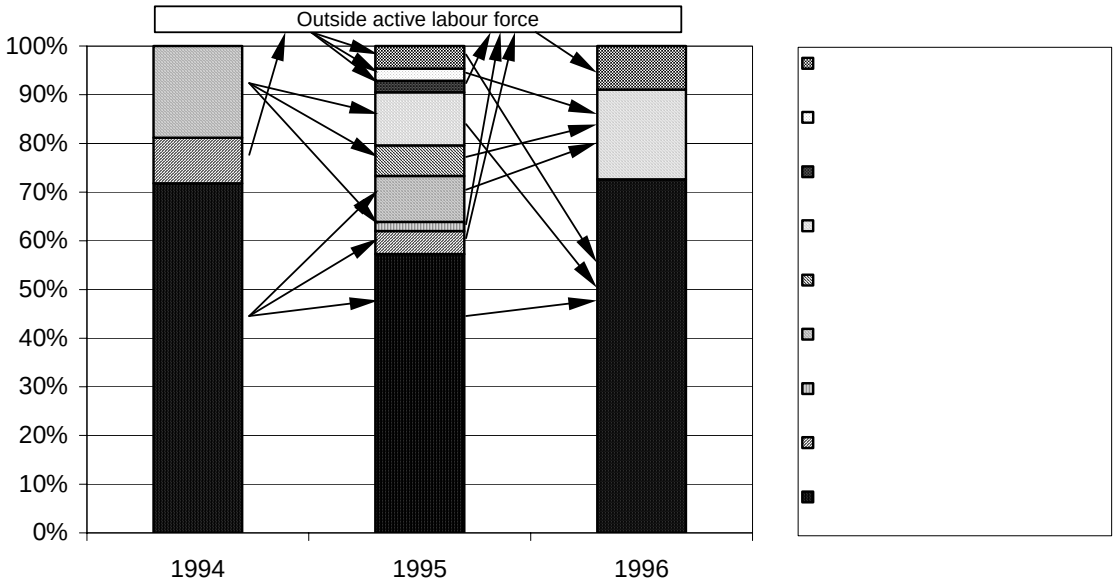
persons that are neither active in the workforce the previous year nor the following year. The total for each year is set at 100 percent.

The results reveal a high degree of turnover (figures 3A and 3B). Only around 60 percent of the employees stay with the same employer in the sense that they have the same employer three years in a row, see the middle chart bar in figures 3A and 3B. National differences in this share are small, 62 percent for Norway and Finland and 57 percent for Denmark. (Numbers for Finland are not presented in this paper). In other words, the mobility rate when taking both inflows and outflows into account is around 40 percent over a two-year period. Inflows are marginally greater than outflows, indicating a small increase in employment.

As the figures illustrate, mobility takes on many forms. The majority of mobility involves those who change status from one year to the next, and then become stable (within our short time horizon of one extra year). Among these are employees who continue to work for the same employer also in the following year. This group will encompass those who have accumulated experience working for one employer and may be viewed as the most valuable recruit for the subsequent employer. The group of employees that have accumulated work experience with one employer before starting work with a new employer accounts for around 7-11 percent of total employment (Norway, Finland and Denmark). In addition there is a small group of “experienced workers” who are employed for each of the three years, but who change employer each year. These may be called “experienced nomads”, and they make up around 3-6 percent of total employment (Norway, Finland and Denmark). Another group of ‘nomads’ involves those who were not employed in the first year; work for an employer the next year, but who change employer again the subsequent year. Such “inexperienced nomads” involve, probably to a large degree, newly educated looking for a suitable job. This group is even smaller, only around two percent of the total workforce.

Figure 3A: Permanent and mobile employees by type of mobility. Norway 1992-1994. Percent

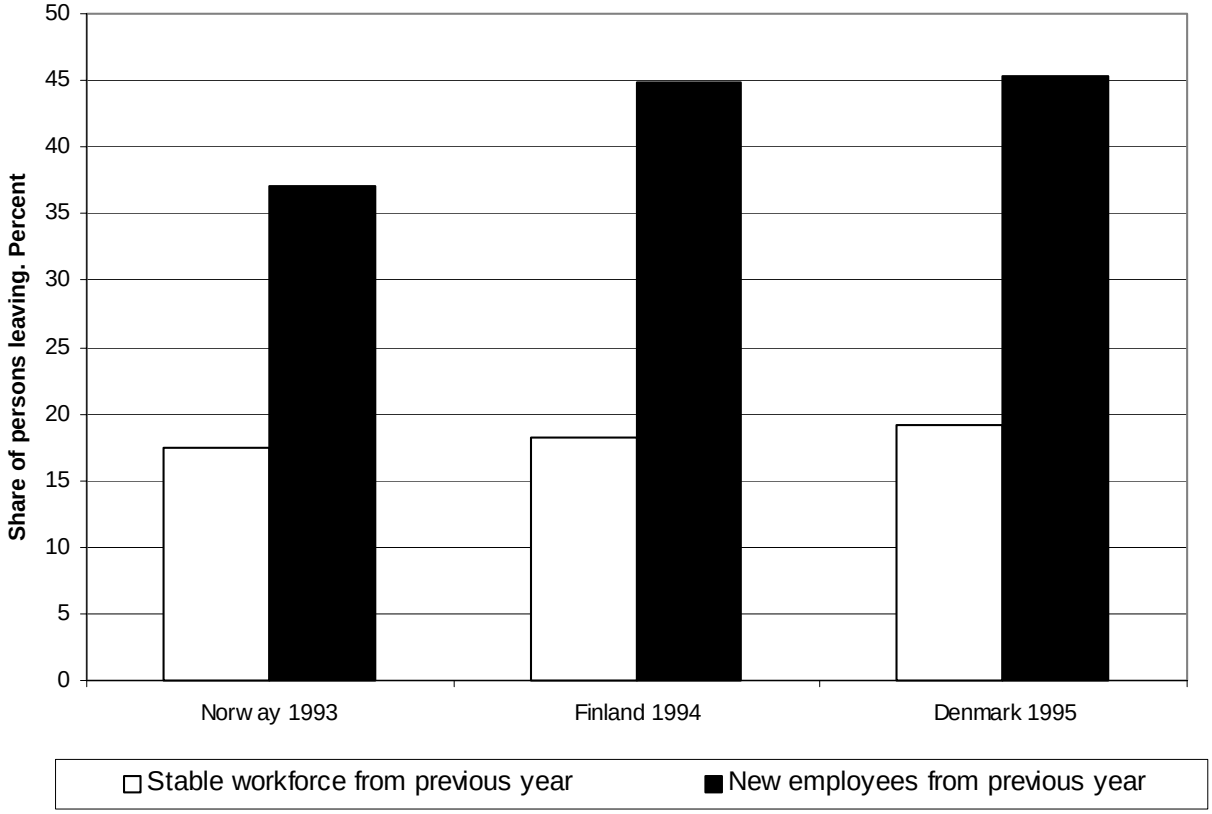
Figure 3B: Permanent and mobile employees by type of mobility. Denmark 1994-1996. Percent



It is possible to separate two distinct groups from the mobility patterns above: Those who were not employed by the same employer previous year ("new employees"), and those who were employed by the same employer the previous year ("stable workers"). Checking their employment status the following year allows us to compute mobility rates separately for these groups. As is evident from figure 4 below, the patterns are clearly different. From the group of stable workers, about 17-20 percent (Norway, Finland and Denmark) have left by

the following year, whereas as many as 37-45 percent (Norway, Finland and Denmark) of the new employees have left the following year. From the perspective of the employer, the loss of experienced workers is assumedly more serious than the loss of new recruits. The high mobility rate among the new employees should probably be interpreted as representing a kind of trial and error process, a sort of 'shopping around' situation for the employer as well as for the employee.

Figure 4: Mobility rates for "stable employees" and "new employees" by country. Percent



"Stable employees" has the same employer previous year while "new employees" does not have the same employer previous year.

4. Sectoral flows

By bringing industrial and public sectors into the analysis it is possible to map knowledge flows in terms of labour mobility between the specified sectors. This is illustrated in figures 5-8 for higher educated personnel in the four countries separately. The presentation is focused around in- and outflows from two distinct types of NIS institutions; universities and other higher education institutions, and research institutes. The patterns emerging show both similarities and differences between the countries. A more detailed breakdown for all the four countries is presented in tables 2-5 below.

4.1 Sweden

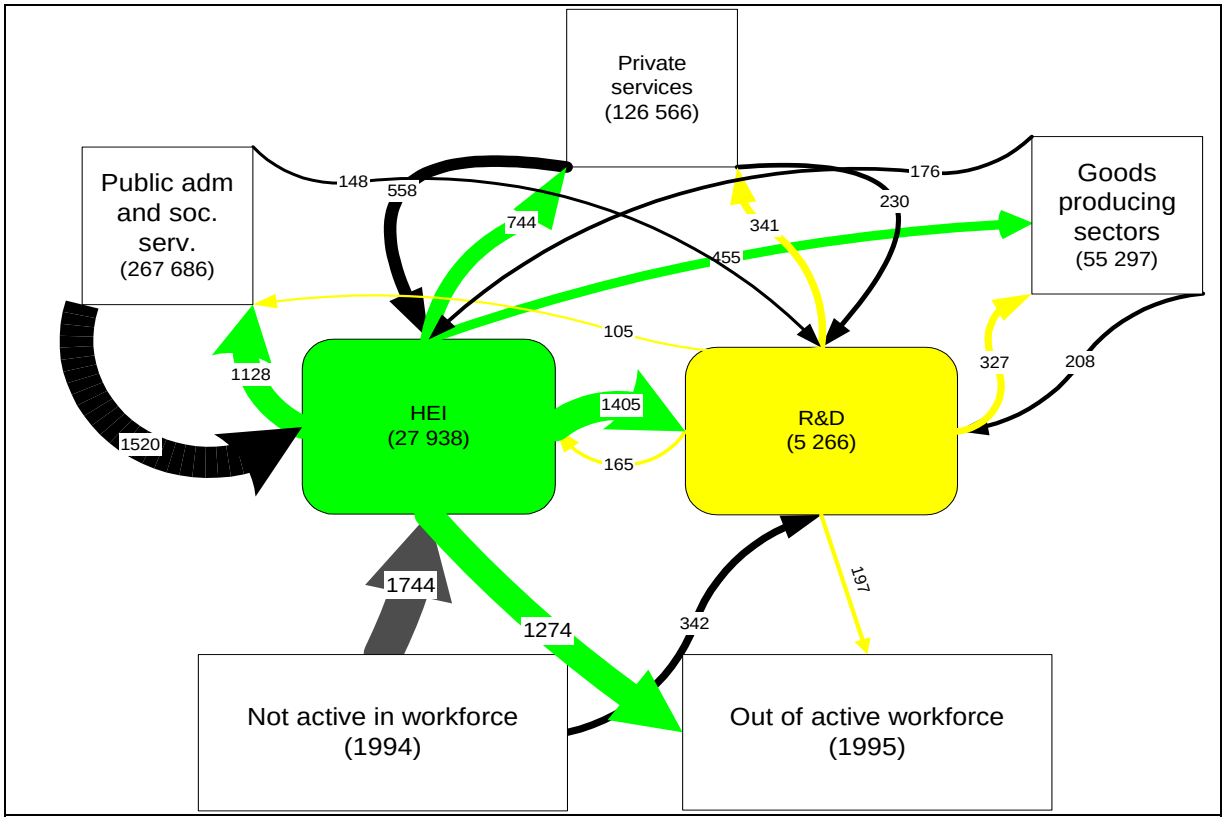
In the Swedish case, the basic pattern of mobility for personnel with higher education is very much the same as for the flow of all employees. Internal flows are important for all sectors. Flows concentrate around the higher education sector (HEI), due to its larger size compared to the R&D institutes.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

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

As is the case with all employees, the net flow of persons with higher education move out of NIS institutions to goods producing sectors and private services. Again we find that the net flow for the public sector goes in the opposite direction. This pattern counts for all the Nordic countries.

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

Figure 5: Mobility of employees with higher education by delivering and receiving sectors in Sweden 1994-95. Absolute numbers



To characterise the “degree of openness” towards sectors outside the NIS institutions themselves, one can simply calculate the difference between total mobility and the share of persons changing jobs within the NIS institutions. Doing this reveals R&D institutes as substantially more interactive with other sectors of the economy than institutions of higher education. Around 50 percent of those leaving a position in a higher education institution change to another job in the same sector or to one in an R&D institutes. For those leaving a job in an R&D institute, the same share is only about 30 percent, meaning that these employees carry their expertise to a larger part of the economy. In addition comes a somewhat higher mobility rate out of R&D institutes than from higher education institutions. In numerical terms, however, the education institutions are more important due to their larger size, and consequently disseminate and receive greater numbers of highly educated workers. This is particularly so in the Swedish case, where higher education institutes are about five times larger than R&D institutes in terms of personnel with higher education.

Table 2: Mobility of employees with higher education by delivering and receiving sectors

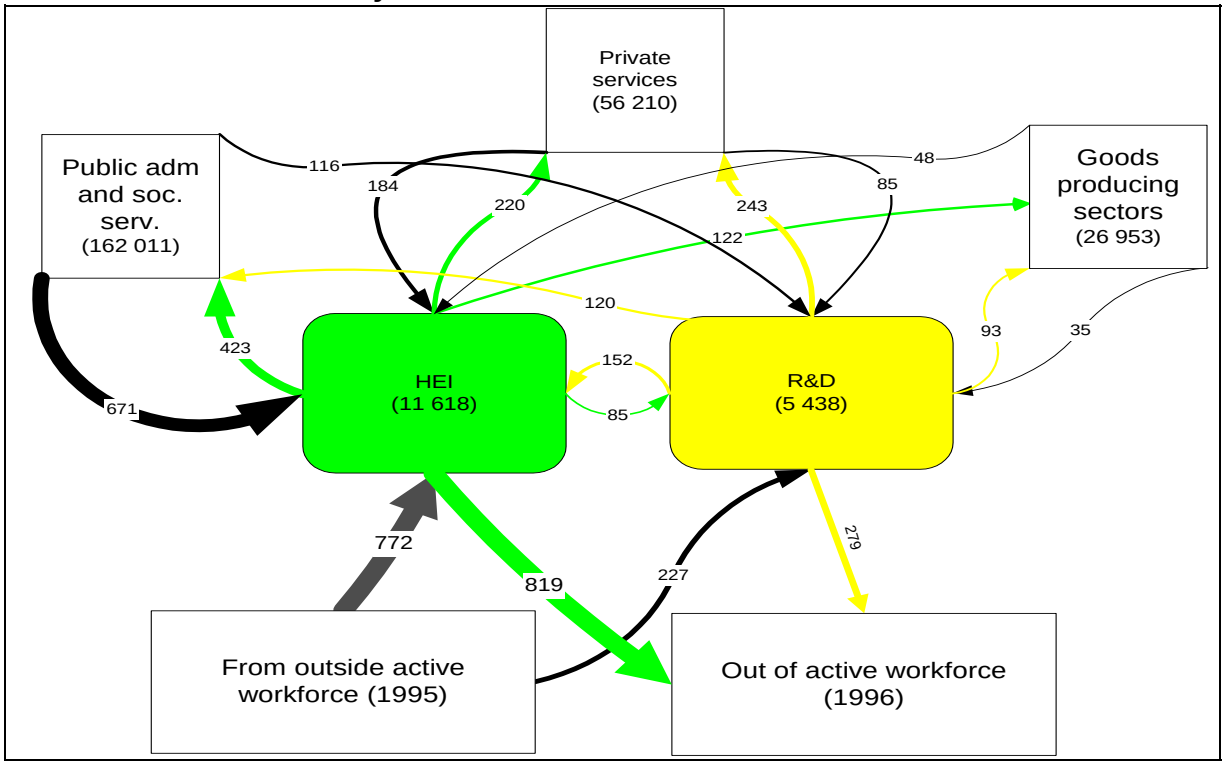
Delivering sectors (1994) → **Sweden** ↓ Receiving sectors (1995)	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence, health and social work	Other non-public services	Out of active work force	N persons moving	N persons employed 1995	Mobility rate in
Primary sectors. Mining. Oil	8.9	0.4	0.4	0.3	0.1	0.3	0.4	0.1	0.1	0.3	0.6	0.6	444	2252	19.7
Manufacturing	9.1	38.8	9.3	11.9	7.2	4.1	11.9	23.5	6.8	2.1	3.6	10.7	8989	46126	19.5
Utilities and construction	1.4	1.2	11.3	0.8	1.3	0.5	2.4	0.8	0.4	0.6	0.4	1.4	847	5560	15.2
Trade. Hotels. Restaurants	2.6	6.9	8.1	21.2	4.2	3.9	6.5	4.0	1.3	1.7	2.7	6.7	4969	21536	23.1
Transport. Storage. Communication	1.8	2.0	1.8	2.8	19.9	3.0	3.3	7.1	0.6	0.7	1.4	3.1	2132	12534	17.0
Financial services. Real estate	0.4	0.9	0.9	1.8	1.7	28.8	3.9	0.7	0.5	0.5	0.5	1.9	1775	12397	14.3
Business services	12.1	16.3	21.7	17.0	15.9	22.1	25.5	12.4	6.6	5.7	6.8	13.6	11289	51511	21.9
R&D institutes	0.0	2.2	1.0	0.7	0.8	0.6	1.1	13.8	22.8	0.4	0.6	1.2	2027	4861	41.7
Higher education institutions	3.0	1.7	0.8	1.3	1.1	1.5	2.0	12.4	16.8	4.2	3.9	6.2	4637	26547	17.5
Public adm. Health, social	17.4	5.4	16.6	12.5	11.6	10.5	12.4	7.9	18.3	36.4	23.2	42.7	41376	284093	14.6
Other non-public services	10.7	1.9	2.0	2.4	3.2	2.2	4.1	1.3	3.1	3.7	19.7	5.9	2002	6374	31.4
Out of active work force	26.9	21.1	22.6	25.2	30.5	20.8	23.6	14.7	20.7	30.4	31.3	-	3492	3492	100
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	475	7605	929	5143	2001	1907	9604	845	6118	42900	1623	3734			
N persons employed 1994	2283	44742	5642	21710	12403	12529	49826	3679	28028	285617	5995	3734			
Mobility rate out	20.8	17.0	16.5	23.7	16.1	15.2	19.3	23.0	21.8	15.0	27.1	100			

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

4.2 Norway

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

Figure 6: Mobility of employees with higher education by delivering and receiving sectors in Norway 1995-96. Absolute numbers



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

R&D institutes. This should be considered in relation to the greater degree of mobility from R&D institutes to higher education than in the other direction, a difference that more or less balances this picture. Therefore, it seems that the mobility patterns to a certain degree reflect a typical career pattern moving from R&D institutes to higher education, and subsequently changing positions within the higher education sector.[14]

As above, "the degree of openness" of the NIS institutions (i.e. their interaction with sectors other than themselves) is calculated as the difference between total mobility and the share of persons changing jobs within the NIS institutions, keeping the personnel leaving active work force outside. In the Norwegian case this reveals a somewhat lower degree of mobility from R&D institutes to other sectors outside the NIS institutions than in Sweden. On the other hand the openness of HEIs in Norway is higher than in Sweden. Still, the openness of the NIS institutions to other sectors in Norway is somewhat higher in the R&D sector than in the HEIs. However, in terms of the number of highly educated employees that change working situation, the importance of institutes of higher education is greater, in part due to their larger size.

In Norway, the shares of those moving from both types of NIS institutions to manufacturing industries are limited to four to five percent, which is the same level as for the working population as a whole, independent of education. Again this result differs from what is witnessed in the Swedish case, where the links from R&D institutes to manufacturing were far stronger than from higher education institutions. The dominating links from R&D institutes in Norway are with business services. 17 percent of higher educated employees leaving R&D institutes move to this sector – a clearly higher share than for higher education institutions. A similar structure was found for Sweden, although manufacturing receives a higher share of the mobile personnel than business services. In Finland and Denmark the link between R&D institutes and the business sector is not this strong, and the link to other sectors, such as public administration (both countries) and transport, storage and communication (DK), are stronger.

[14] But the mobility in the HEI-sector is dependent on the classification of that sector. It is not obvious which organisational level that corresponds to "establishment" in this sector, and statistical practice is different in the different countries.

Table 3: Mobility of employees with higher education by delivering and receiving sectors

Delivering sectors (1995) → **Norway** ↓Receiving sectors (1996)	Primary sectors. Mining. Oil	Manufacturing	Utilities and construction	Trade. Hotels. Restaurants	Transport. Storage. Communication	Financial services. Real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence. Health and social work	Other non-public services	Out of active work force	N persons moving	N persons employed 1996	Mobility rate in
Primary sectors. Mining. Oil	27.4	1.5	1.1	1.2	0.7	0.7	1.7	3.2	1.0	0.4	0.7	1.6	963	6183	15.6
Manufacturing	3.7	38.4	9.2	6.9	4.4	3.3	6.6	4.8	4.2	1.2	3.2	6.3	3551	15911	22.3
Utilities and construction	0.5	1.9	28.5	1.6	1.7	1.5	2.1	0.9	0.5	0.6	1.2	1.9	1050	5181	20.3
Trade. Hotels. Restaurants	19.8	7.3	4.5	28.8	5.7	3.6	6.9	3.1	1.5	1.9	3.0	6.7	3655	13127	27.8
Transport. Storage. Communication	3.0	3.8	2.0	2.8	30.6	1.9	4.1	0.6	0.4	0.6	1.0	3.0	1580	6280	25.2
Financial services. Real estate	0.6	0.7	1.3	1.7	1.4	31.7	2.2	1.3	1.0	0.3	0.7	1.6	930	6050	15.4
Business services	6.0	12.1	11.8	14.9	10.9	14.6	36.5	17.2	4.5	2.6	6.6	12.7	6355	23669	26.8
R&D institutes	1.0	0.6	0.3	0.5	0.5	0.4	0.7	14.0	3.8	0.4	1.1	1.6	710	5110	13.9
Higher education institutions	0.6	1.1	0.6	1.1	1.2	1.5	1.1	14.6	22.4	2.5	3.4	5.4	2318	11781	19.7
Public adm. health, social	6.9	4.2	11.8	12.5	12.5	5.3	8.6	11.6	19.6	55.5	22.5	53.7	25165	160168	15.7
Other non-public services	0.5	1.3	1.3	1.6	1.7	1.0	1.7	1.2	2.8	1.6	22.0	4.5	1804	8663	20.8
Out of active work force	29.6	26.5	27.0	26.0	27.7	33.0	26.7	26.9	38.0	32.0	34.2	-	15026	15026	100
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	1296	3232	958	3412	1381	972	5232	1038	2155	27008	1748	14308			
N persons employed 1995	6516	15592	5089	12884	6081	6092	22546	5438	11618	162011	8607	14308			
Mobility rate out	19.9	20.7	18.8	26.5	22.7	16.0	23.2	19.1	18.5	16.7	20.3	100			

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

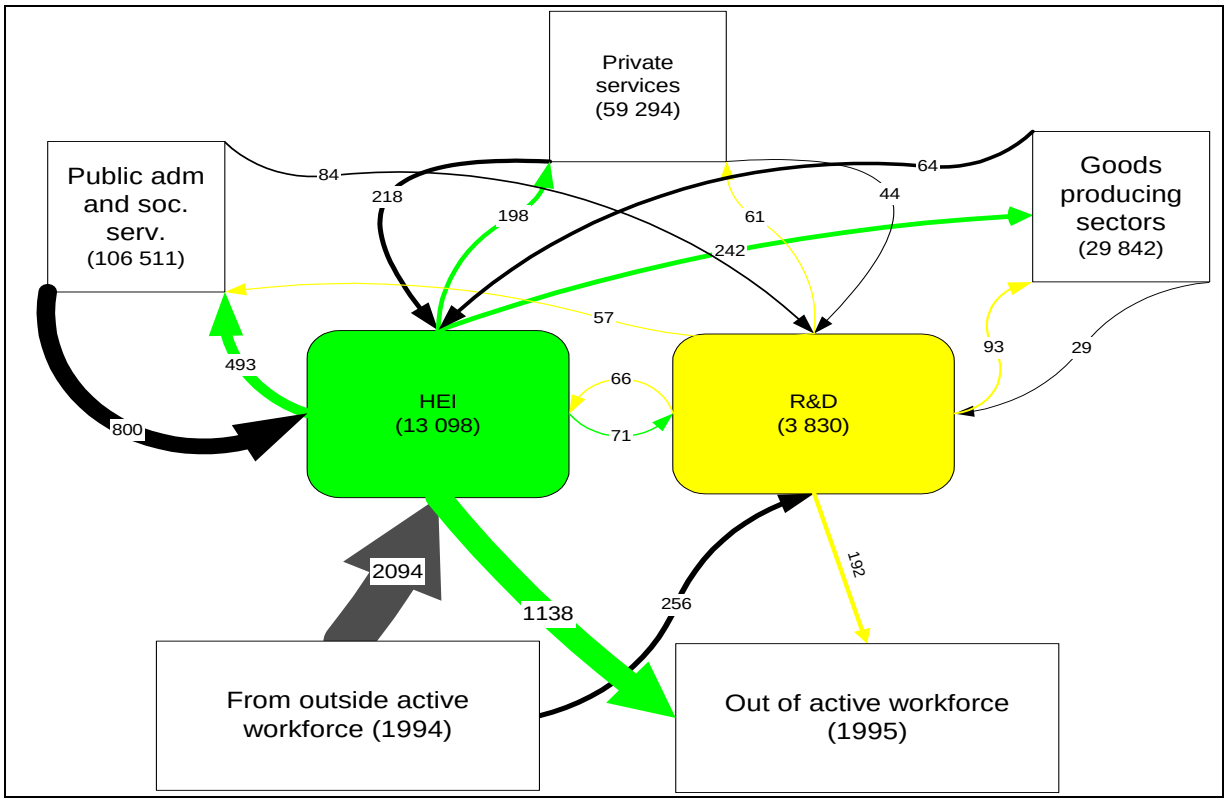
Looking at disappearance from the active work force, a large share of persons who change job situations actually move out of the active work force. This share – as expected - is however lower for the highly educated than for the workforce at large. Focusing on the NIS institutions, a somewhat greater share leaves the active workforce from higher education institutions than do from R&D institutes. This aspect is a common feature for all the Nordic countries. Why this is so is not obvious. Our hypothesis is that this is because there are more temporary employees at the higher education institutions in terms of visiting scholars, assistants leaving to study abroad, to do military service etc.

4.3 Finland

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

For R&D institutes, a somewhat greater share of those with higher education who change their work situation go to manufacturing than was the case for all employees independent of education (10 percent). This is somewhat higher than in the Norwegian case (5 percent) and the Danish case (4 percent), but considerably lower than the 23 percent found in Sweden. The same kind of difference is not found for higher education institutions. On the other hand, links to business services, which were found to be rather important for Sweden and Norway, seem to be somewhat weaker in Finland.

Figure 7: Mobility of employees with higher education by delivering and receiving sectors in Finland. Absolute numbers



The Finnish case is particularly different from the three other countries in the share of personnel changing employer from one R&D institution to another. This share is as high as 39 percent, with the comparable numbers as low as 13-14 percent for the other countries. In addition, there is a much higher mobility rate of persons leaving institutes of higher education than from R&D institutes. As a result, the degree of openness to other sectors seems to be smaller in the Finnish case than in the other Nordic countries. In fact, there is more interaction from higher education institutions to other sectors outside the Finnish NIS institutions than there is from R&D institutes, both in relative terms and in absolute numbers.

Another aspect of the Finnish case, that differs from the Norwegian, Swedish and Danish cases, is the greater difference in the ratio between the highly educated and all employees related to leaving active workforce. This share is particularly high for *all employees*; 41 percent of employees in HEIs and 47 percent in R&D institutes leaving active work force. The comparable shares for the highly educated are down to 26 percent and 25 percent.

Table 4: Mobility of employees with higher education by delivering and receiving sectors

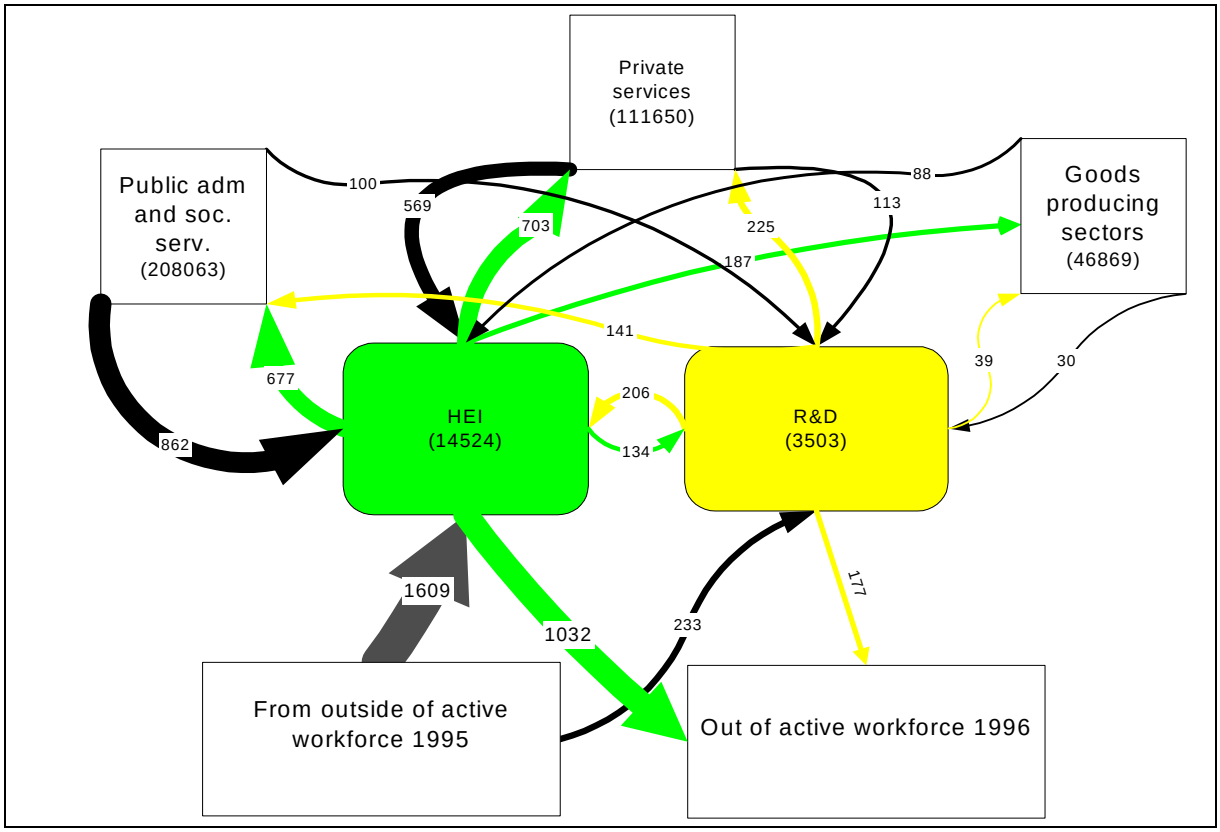
Delivering sectors (1994) → **Finland** ↓ Receiving sectors (1995)	Primary sectors. Mining. Oil	Manufacturing	Utilities and construction	Trade. Hotels. Restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutions	Public adm, defence, health and social work	Other non-public services	From Outside active workforce	N persons moving	N persons employed 1995	Mobility rate in
Primary sectors. Mining. Oil	17.0	0.3	0.4	0.5	0.2	0.1	0.5	1.5	0.1	0.1	0.6	1.0	377	2439	15.5
Manufacturing	5.8	56.8	11.4	11.7	5.4	2.3	10.7	9.9	5.3	1.2	5.4	14.7	8061	26512	30.4
Utilities and construction	0.3	1.5	34.5	0.7	1.5	0.2	1.9	0.5	0.1	0.1	0.3	2.0	888	3271	27.1
Trade. Hotels. Restaurants	3.5	5.9	2.8	37.6	3.7	1.6	4.1	1.4	0.9	0.5	2.6	7.0	3357	13382	25.1
Transport. Storage. Communication	1.0	1.4	1.0	2.2	47.7	0.7	1.9	0.4	0.2	0.2	0.7	2.3	1244	4845	25.7
Financial services. Real estate	0.0	0.5	0.4	0.7	0.2	65.2	2.2	0.3	0.2	0.3	0.7	1.2	2087	6683	31.2
Business services	4.5	5.9	10.1	7.2	5.7	7.6	38.3	4.8	3.3	1.5	4.5	12.2	5777	23065	25.0
R&D institutes	0.6	0.4	0.1	0.2	0.1	0.2	0.5	39.2	1.6	0.3	0.3	1.3	794	3846	20.6
Higher education institutions	1.3	0.9	1.0	1.5	0.3	0.5	1.3	8.5	34.5	2.9	4.1	10.8	4787	13558	35.3
Public adm, health, social	6.7	5.1	5.5	6.5	4.1	2.9	7.5	7.3	11.4	67.2	14.9	38.0	28582	107842	26.5
Other non-public services	2.9	1.1	0.6	1.2	1.6	1.0	1.7	1.0	0.0	0.0	0.0	4.9	1184	11694	10.1
Out of active workforce	56.1	19.8	30.7	28.7	28.1	17.5	28.3	24.7	26.3	17.2	55.4	-	12229	12229	100
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	312	5944	690	2813	955	2416	4643	778	4327	27251	2447	19300			
N persons employed 1994	2374	24395	3073	12838	4556	7012	21931	3830	13098	106511	12957	19300			
Mobility rate out	13.1	24.4	22.5	21.9	21.0	34.5	21.2	20.3	33.0	25.6	18.9	100.0			

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

4.4 Denmark

The Danish mobility rates from both NIS institutions are roughly the same at about 26 percent of all highly educated employees. This is somewhat higher than for Sweden, Finland and Norway, whose NIS mobility rates vary from 18 to 23 percent. Of those moving to sectors other than the NIS institutions, the majority of personnel moves to public sector and private services. The R&D personnel primarily moves to 'transport, storage and communications', while the majority of personnel from HEIs moves to business services. The high degree of mobility from R&D institutes to 'transport, storage and communications' (16 percent) is unique in a Nordic context. The great mobility exchange between HEIs and private services is however similar to the Swedish pattern. The mobility exchange between HEIs and public sector is slightly weaker in Denmark than in Sweden, although stronger than in Norway and Finland. The mobility level from both NIS institutions to public sector is only slightly lower than to the largest receiving sectors.

Figure 8: Mobility of employees with higher education by delivering and receiving sectors in Denmark. Absolute numbers



As for Sweden and Norway the internal mobility rate in Denmark is higher for the HEIs than for the R&D sector, although this rate is somewhat higher in Denmark than in Sweden and Norway. In Denmark the share of R&D personnel moving to HEIs is six times higher than the share of HEI personnel moving to R&D institute.

The Danish net flow between sectors differs from the other Nordic countries by having a greater positive net flow from the NIS sector to public sector. Whereas Norway, Sweden and Denmark have a positive net flow from the NIS sector to public sector for employees with education within the natural sciences and engineering, in addition Denmark is the only country with such a positive net flow for all employees independent of education. In other words, the Danish NIS institutions only have a positive net flow from the highly educated in public sector. This might indicate a more narrow recruitment from public sector to NIS institutions in Denmark than in the other Nordic countries.

Considering the 'openness' of the Danish NIS institutions to other sectors, the numbers place Denmark more or less on the average for all the Nordic countries. The Danish 'openness' is however characteristic by having the same degree of 'openness' in both R&D institutes and HEIs.

When comparing the Danish figures on mobility of highly educated out of active work force with the remainder Nordic countries, both similarities and differences emerge. Like in Sweden and Norway, public sector in Denmark has a relatively high rate of mobility out of active work force. Unlike the other Nordic countries, 'utilities and construction' has the second highest mobility rate out of active work force in Denmark. In addition, the average mobility rate for all sectors is in this respect somewhat lower in Denmark than in the other Nordic countries.[15]

The Danish HEIs have a greater mobility rate out of active work force than the R&D sector. This pattern is common for all the Nordic countries. When seeing the mobility rates out of active work force for highly educated in relation with the respective rates for all employees independent of education, two differences are identified: First, the mobility rate out of active work force among the highly educated is lower than for all employees. Second, the internal difference between the R&D sector and HEIs for highly educated personnel is higher than the respective difference for all employees.

[15] Due to certain irregularities in the basic figures from the different countries, an overall mobility rate out of active work force is excluded.

Table 5: Mobility of employees with higher education by delivering and receiving sectors

Delivering sectors (1995) → **Denmark** ↓ Receiving sectors (1996)	Primary sectors. Mining. Oil	Manufacturing	Utilities and construction	Trade. Hotels. Restaurants	Transport. Storage. Communication	Financial services. Real estate	Business services	R&D institutes	Higher education institutions	Public adm. and defence. Health and social work	Other non-public services	From Outside active workforce	N persons moving	N persons employed 1996	Mobility rate in
Primary sectors. Mining. Oil	18.3	0.1	0.1	0.2	2.5	0.1	0.1	0.3	0.3	0.0	0.1	0.6	470	1632	36.5
Manufacturing	31.5	44.9	6.6	11.1	6.1	0.9	7.3	3.6	4.3	1.1	4.7	7.4	9341	34301	25.5
Utilities and construction	0.3	0.3	24.7	1.7	0.3	0.3	3.8	0.3	0.3	0.3	0.1	1.9	1731	8654	20.4
Trade. Hotels. Restaurants	16.3	8.1	1.3	26.5	6.2	4.2	9.9	2.0	1.3	0.9	1.7	6.6	6553	24819	25.6
Transport. Storage. Communication	0.7	0.7	6.2	5.2	43.8	0.7	4.9	16.5	0.8	0.5	0.8	4.1	4479	9750	39.0
Financial services. Real estate	0.0	0.3	0.3	1.9	0.5	56.2	4.1	0.3	0.4	0.4	0.7	2.1	3319	11246	28.6
Business services	16.5	9.1	4.4	13.0	7.6	12.6	34.1	3.9	9.2	2.4	3.5	12.3	11251	39658	25.1
R&D institutes	0.2	0.3	0.1	0.3	0.1	0.1	0.5	13.1	3.5	0.2	1.0	0.8	729	3420	21.9
Higher education institutions	0.6	0.9	0.3	1.3	0.8	0.5	1.7	22.7	29.5	2.0	6.6	5.4	4475	12886	29.6
Public adm., health, social	3.8	7.0	12.2	12.1	10.4	11.4	10.9	15.6	17.5	55.6	23.5	52.6	45371	191373	21.6
Other non-public services	0.2	0.7	10.9	4.2	3.4	1.1	3.3	2.1	6.5	2.2	30.3	6.2	5372	16968	25.6
Out of active workforce	11.7	27.7	33.0	22.5	18.1	12.0	19.5	19.5	26.6	34.4	27.1	-	25287	25287	100
Total[1]	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**			
N persons moving (=100)	677	9329	1950	7019	4069	3340	9728	907	3874	43804	3957	29720			
N persons employed 1995	1493	36653	8723	26041	11071	11629	43328	3503	14524	208063	19581	29720			
Mobility rate out	45.3	25.5	22.4	26.9	36.8	28.7	22.5	25.9	26.7	21.1	20.2	100			

[1]Total includes a tiny residual category consisting of members of the workforce that were active in unclassified NACE groupings in 1995. The value of this residual varies between 0.01 and 0.5 for each category represented in the table

5. Policy issues and future work

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

The turnover of employees is generally high. Between two consecutive years about a quarter to a fifth of the staff is lost. Of these the larger share shift jobs, while the rest leave the active work force (permanently or for a period). The rate is more or less the same for the higher educated as for all employees, but with some national variations. But the causes for job-shifts might be different. The higher educated might be seeking better pay and/or new challenges, whereas the influence of the business cycle (job creation and destruction) may be more important for other educational groups.

The inclusion of an extra year allows us to integrate new employees who enter firms into our calculations of mobility rates. Doing this reveals even higher mobility rates around 40 percent of the employees in Norway, Finland and Denmark have entered the workplace since the previous year or have left by the following. The newcomers are more mobile than the “old” workers. The probability that a new entrant changes position in the next year is more than twice the probability of old workers leaving a position the subsequent year. Taking age into consideration, the share of stable workers increases with age and the share of mobile workers decreases almost linearly with increasing age.

The analysis of flows between different sectors is dominated by the larger size of the higher education institutions along side R&D institutes. Even if there are significant national differences, some common features emerge across countries: There is a strong link between the public sector and the higher education institutions, and with the exception of Denmark the net direction of flows tends to move from the public sector to institutes of higher education. This is even true for the comprehensive group of the higher educated, albeit with an exception for the natural scientists and engineers. The general direction of net flows for the goods producing and private services sectors is from the NIS institutions into these. The links between R&D institutes and the institutes of higher education are in general relatively weak, with the exception of Sweden where quite a lot of people move from HEIs to R&D institutes. For Norway and Denmark the net direction of flows between the two are the opposite.

Quite a few differences do exist between the countries. It seems for instance that there is somewhat more interaction between manufacturing and the NIS institutions in Sweden and Finland than in Denmark and Norway. In these cases there are instead stronger links in terms of personnel transfers to private services – in particular 'business services' and 'transport, storage and communication'. Comparing the "degree of openness" – the share of mobility out of the NIS sectors - of the two NIS institutions reveals that R&D institutes interact with other sectors to a higher degree than do higher education institutions in Sweden and Norway. In Finland, institutes of higher education are more 'open', in particular because of a high level of mobility between different R&D institutes in Finland. In Denmark, both HEIs and R&D institutes have the same degree of openness to other sectors. Finally, the influx of those that are not active in the work force the year before, and out of the active work force the following year, seem to be particularly high in Finland.

On the whole, Finland, Norway, Denmark and Sweden are quite similar in terms of stocks and flows of human resources. According to the sectoral flows among the highly educated, Sweden and Denmark seem to have certain common features, like Norway and Finland also seem to hold resemblances. This pattern applies to the mobility exchange between the HEI sectors and public sector, and between the HEI sectors and private services. However, the Norwegian economy has for instance not experienced the kind of economic difficulties as the Swedish, Danish and particularly the Finnish economies have. The mobility rates of the latter countries are naturally affected, especially regarding the flows in and out of the active workforce. However, the business cycle in the Nordic countries has been common although lest dramatic in Norway.

Another major difference involves different institutional orientations. In the Swedish research infrastructure, a great deal of industrial research takes place in universities. In Norway and Finland, however, the industrial research infrastructure is concentrated around large industrial research institutes (in particular SINTEF and VTT respectively). In Denmark, however, the orientation is somewhat in between what is seen in Sweden and what is seen in Finland and Norway.

Such differences also leave their mark on the flows between the R&D sector, institutes of higher education and industry in the four countries. Meanwhile, historical differences mark the national systems of higher education, in terms of academic orientation and duration of degree, which have affected relative proportions of, for example, PhDs in the four countries. However, these differences seem to lessen over time as all four countries are adapting their education-regimes to suit international standards.

In terms of educational level and specialisation in different sectors the four countries show very similar patterns when looking at the eleven-sector level. One major difference is however that there is a higher share of highly educated within the primary sectors in Norway, which is due to the Norwegian petroleum industry. Another aspect is a larger share of employees with an ISCED5 level education (12-15 years) within HEIs in Sweden and Norway than in Finland and Denmark. Looking at how natural scientists and engineers are absorbed by "user sectors", Sweden shows a wider distribution of sectors which recruit such employees, which in turn reflects Sweden's relatively larger manufacturing sector.

Even though a large number of persons are shifting jobs or moving in and out of the active work force, not all establishments are equally affected by these changes. Much remains to be done with respect to how many, and which, firms or establishments deliver and receive mobile employees. With our perspective of national innovation systems in mind we have investigated such involvement by the firm units in a very strict and narrow sense, looking at the share of firms having received any personnel from HEI or R&D institutes since the previous year. The results show that well below one percent of the units were involved, but with some sectoral variation. The patterns, however, were very similar for the two countries included in this comparison, Finland and Norway.

Going through the mobility rates and the number of effective delivering and receiving sectors by our 42-sector classification, a great disparity becomes evident between the four countries.[16] Here we can clearly see that although the countries are basically very similar, there are differences between the functioning of the labour markets, the industry recruitment patterns and the interaction between industry and the R&D infrastructure. Overall it seems like national circumstances play a decisive role for mobility at such a disaggregated level.

When studying the mobility flows between the higher education institutions, the R&D sector, the public sector, private services and the goods producing sectors, the differences in research infrastructures and the roles of the HEI and R&D sectors become evident. The HEI and R&D sectors of Norway and Finland are roughly comparable in size, whilst the Swedish and Danish R&D sectors are relatively smaller compared to the respective HEI sectors. Whereas the R&D sector amounts to roughly one fourth of the HEI sectors in Denmark and Sweden, the respective share is about 50 percent in Norway and Finland. This is compensated for by larger HEI sectors in Denmark and especially Sweden than in the

[16] See Nås et al.; Formal competencies in the innovation systems of the Nordic countries: An analysis based on register data, STEP-group, R-06 1998 and Graversen; Formal Competencies in the Danish National Innovation System, 1999/4.

remainder two countries. This pattern applies to all employees independent of education. When focusing upon the highly educated, Sweden is the only country deviating from the other Nordic countries by having a larger HEI sector, and a relatively smaller R&D sector in relation to the HEI sector.

There are greater flows out of the active workforce from the Finnish HEI and R&D sectors than in the remainder Nordic countries, and the interactions between the R&D sector and the service sector seem weaker in Finland compared to Denmark, Norway and Sweden. Norway's R&D sector seems better geared for the service sectors, partly due to its relatively larger size than in the other countries. The flows from HEI to R&D are much stronger in Sweden than in the other countries, whilst the reverse flows are weak. The flows from R&D to HEI in Denmark are by comparison bigger than in the other three countries in relative terms.

In this work the focus has been set on the flows in the labour market, i.e., the flows concerning the employed population. Only one type of mobility has been studied. We have looked solely at the stocks and flows of individuals, ignoring the stocks of firms or organisations, and in most cases the number of organisations are affected by mobility. Further work would include more detailed studies and categorisation of the population outside the labour market (e.g., newly graduated, unemployed, immigrants, emigrants, etc). It would also include more NIS categories and include studies of the impact of mobility of organisations. Yet another aspect includes mobility of persons between countries, in particular of a temporary kind, as for instance within large multinational firms. Such work would be a natural continuation and development of the work presented in this report. A continuation of this work will be undertaken by the same group, and hopefully with the inclusion of Island.

We can conclude that the human resources data we have used provides a solid description of important aspects of each country's innovation systems. The differences that have been found have not been overly surprising, and the data can be said to have confirmed our presuppositions. Nevertheless, our data have shed new light on the four countries in relation to one another and, perhaps most important, they have raised new and more focused questions for how to utilise this data source in future analyses of innovation systems and related topics.