

Human Capital Mobility – A Comparable Knowledge Indicator

Ebbe Krogh Graversen
The Danish Institute for Studies in Research and research Policy
Finlandsgade 4
DK – 8200 Aarhus N.
Denmark

Acknowledgements: Financial support from the Danish Institute for Studies in Research and Research Policy is gratefully acknowledged. Mette Lemming has performed valuable research assistance.

Science and Technology Indicators in the Nordic Countries; chapter 4

Resume:

Peregrinatio academica er den latinske betegnelse for studenter der drog til middelalderens universiteter og lærdomstempler. Efterfølgende drog de ofte tilbage til deres oprindelsessted og uddelte af deres erhvervede viden. I dag er den høje akademiske lærdom til stede overalt i økonomierne, på universiteterne såvel som i virksomhederne. Samtidig er de personlige kundskaber blevet en vigtig brik i udviklingen af nutidens vidensbaserede økonomier. En måde til at måle omfanget af cirkulationen og udvekslingen af viden er via personmobiliteten på arbejdsmarkedet. Personmobilitet er kun et af flere måder hvorpå viden kan udveksles, men den er i modsætning til mange andre indikatorer på vidensudveksling målbar, entydig og sammenlignelig.

Kapitlet bringer sammenlignelige registerbaserede mobilitetsmål for de fire nordiske lande, Danmark, Sverige, Norge og Finland for årene 1994-96. Danmark og Sverige har de højeste job til job mobilitetsrater på knapt 20 procent; Norge har de laveste rater på omkring 12 procent. Samme mønster genfindes i mobiliteten ud af universitets- og R&D-sektorerne. Alle fire lande har høje mobilitetsrater ud af nuværende job på mellem 20 og 25 procent. Mobilitetsraterne er naturligvis præget af det aktuelle stadie som den nationale økonomi befinder sig i, men mobilitetsrater over tid er faktisk relativt stabile, jvf. Bingley et al (1999).

Kapitlet finder en stor udveksling af højtuddannede mellem universitets- og R&D-sektorerne og det omkringliggende samfund. Alene dette indikerer en stor grad af videnscirkulation og vidensudveksling imellem sektorerne i de nordiske økonomier. Omkring en trediedel af den samlede mobilitet i de to sektorer er sektorintern i Finland, omkring en femtedel af mobiliteten er sektorintern i de andre lande; lavest i Sverige. Mobilitetsraterne til og fra sektorerne påvirkes af om sektorerne ekspanderer eller ej. Yderligere findes det i artiklen at en betydelig del af mobiliteten til og fra den private produktionssektor og til og fra service sektorerne er sektorekstern. Omkring hver tredje mobile person forlader eller kommer fra en position uden job. Det er eksempelvis uddannelse, arbejdsløshed, pension, udlandsophold eller lignende.

Internationalt ligger de fundne mobilitetsrater i de nordiske lande på højde med tal for andre lande. Der er tilsyneladende ikke nogen speciel rigiditet på dette område på de nordiske arbejdsmarkeder. De fundne registerbaserede mobilitetsrater er noget højere end tilsvarende interviewbaserede mobilitetsrater fra arbejdskraftundersøgelserne (Labour Force Survey, LFS).

4.1 Mobility and knowledge accumulation

Peregrinatio academica – an academic pilgrimage – was the Medieval Latin term for the students and teachers journey to the places where they could obtain wisdom. Today's educational system functions as the provider of these places of wisdom and individuals extend their knowledge base in a continuous journey through this system. Finally, at the end, they have obtained their final level of formal education. This could either be lower, middle or higher education, where especially the passing to the higher educated corresponds to the medieval level of the 'learned' and 'wise' individuals. Naturally, the share of the population obtaining the higher education is considerably higher today.

Besides the formal education, tacit and informal knowledge obtained through experience and on-the-job training in the individuals working life also adds to the individuals ability stock. However, the informal individual specific knowledge or ability is basically an unknown part of the human capital. It is difficult to formalise and measure in practice for the entire population but the level of formal education is a possible and usable substitute for these 'hidden' abilities especially for the higher educated, c.f. Nås et al (1998).¹

The purpose of the present chapter is to determine the flow of highly educated employees into and out of workplaces characterised by high innovation intensities. Especially, the chapter focuses on the two sectors, Higher Education Institutions, HEI, and Research and Development institutes, R&D. The mobility of employees is or becomes the physical links between the educational sectors and the sectors that uses the obtained wisdom. The mobility and the consequential ability to circulate knowledge are vital parts in the national innovation ability. Mobility numbers for higher educated human resources in four Nordic countries, Denmark, Finland, Norway and Sweden are referred and compared in the chapter. Comparable register based data from Iceland is not available so Iceland is not included in any parts of the tables, figures or discussion. The mobility of individuals is used as an indicator for the exchange of knowledge and innovation potential in the economy. Similarly, the flow or mobility rates between sectors are used to describe the spreading and circulation of knowledge from the 'pyramid of wisdom', see Figure 4.1.

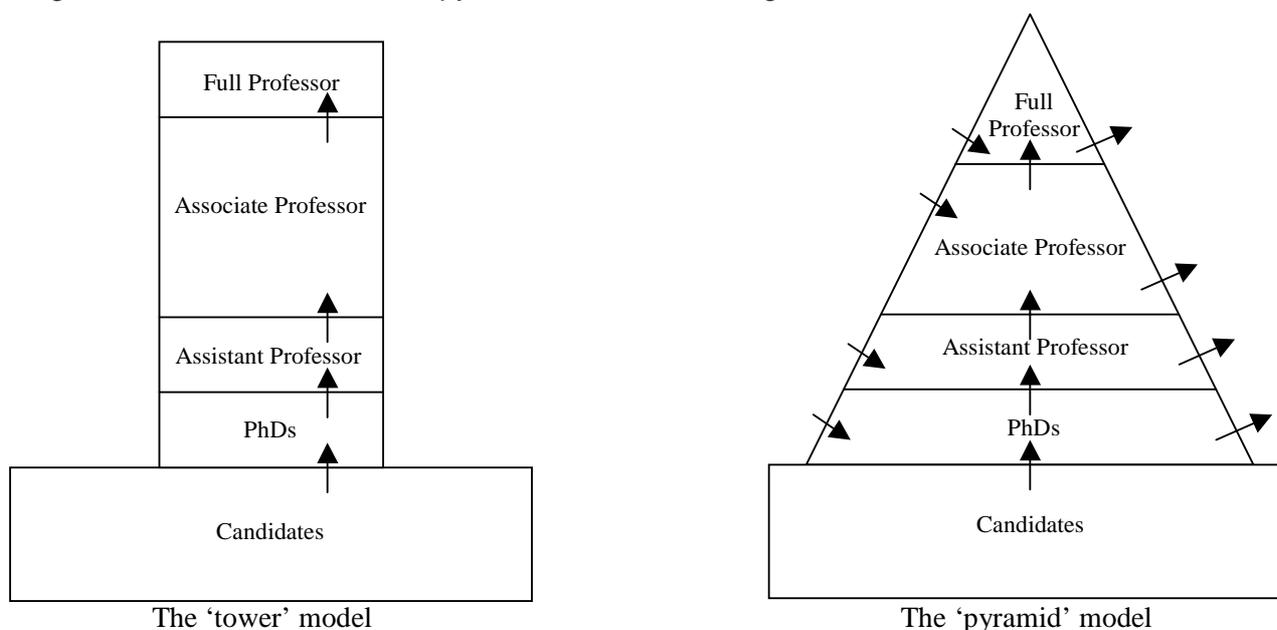
Figure 4.1 illustrates two theoretical models for the way higher education institutions may work in the economy. The 'tower' version recruits new employees to the HEIs solely based on internal promotion of selected candidates to PhDs. These continue as assistant professor, associate professor and finally to full professorships when open positions are available by retirement (dead) of employees. This corresponds to a research sector with no mobility in and out of the higher education institutions, HEI. Conversely, a large mobility into and out of the HEIs indicates an exchange and circulation of the acquired knowledge to the surrounding economy. This is illustrated as a pyramid where there is mobility on all levels and a larger stock at the lower level compared to the tower model. The latter is the preferred in a knowledge-based economy, where innovation is an essential part of the growth.

After the first mobility out of the HEI sector, all further mobility is increasing the circulation of the acquired knowledge. Hence, further mobility into and out of the R&D sector, the private production sectors, and the service sectors etc. add further to the knowledge gains in the economies. The situation where there is a large mobility creates the largest innovation power in the entire economy, creating additional platforms for innovation. Hence, the value-added effects become significant and visible in the growth rates of the economy.

¹ In the Nordic countries these measures are already collected in the national registers by the statistical bureaus. Hence, an analysis can be done without collection of survey information and without bothering individuals and companies further, cf. Nås et al (1998).

A very high mobility rate may cause a reduction in the gains from the knowledge circulation since it takes time to acquire and exchange the knowledge, to bring the knowledge into use and it takes time before an individual is able to transport the acquired knowledge to the next workplace. Hence, the ‘tower’ model in Figure 4.1 does not necessarily illustrate a negative situation although it reduces the knowledge exchange to the surrounding economy. Although there is also a risk that knowledge creation inside the tower may fall due to missing inflow of new knowledge, the tower model may be able to create unique clusters of highly specified knowledge, i.e. centres of excellence.²

Figure 4.1: The ‘tower’ and the ‘pyramid’ model for the higher education institutions, HEI.



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

The ‘pyramid’ model illustrates a world of today where a marked for innovation outside the higher education institutions gives mobility on all levels. Only skill requirements determine whether a person is employed in a job in a certain sector. There is more PhD positions than needed internally at the HEIs, which over time results in an oversupply of qualified individuals on all levels. The ‘pyramid’ model can falsely look like the ‘tower’ model when the HEI sector is expanding rapidly, cf. the Nordic countries in the last decade (Analyseinstitut for Forskning. 1998, 2000, NIFU 1999 and Olsen 1999).

As mentioned above, the justification for large mobility rates is a desire of an exchange of researchers with other non-university research environments in order to increase the national amount of innovation. This can for example be a desire of a significant private sector R&D, a need for ministerial ‘analysis’, advisory or consultancy functions etc. Another motive is the aim to secure the competitiveness of the national research environments to the benefit for the researchers, the research institutes and the community. This is even more important in a knowledge-based economy like the Nordic countries. OECD (1996) concludes that the more than 50 percent of GDP in the major OECD countries is knowledge based. A larger share of employees going into and out of job positions in the ‘pyramid’ model enables a larger flexibility in the research themes and a larger possibility to take up and prioritise new research areas. The desire of an active exchange of researchers between the private and public research environments, the higher education institutions, HEI, and the research and development institutes, R&D, is at the moment increasing both nationally and internationally.

² The ‘tower’ model illustrates an non-existing world where the higher education institutions educate all the candidates and send all non-usable back to the surrounding economy. Only the best are kept for the future recruitment if there are available positions for them. If these chosen join the sector, they never leave it again. This corresponds to the medieval reality.

Physical mobility of individuals is not the only way knowledge circulates between work places. Knowledge can be circulated and exchanged in many other ways. Cooperation, learning by doing, information exchange, consultants, experts, and many other channels create additional knowledge flows and exchange. Similarly, the amount of knowledge exchange also depends of the length of the cooperation period. However, these additional ways of knowledge flows are much more difficult to formalise in order to measure, aggregate and compare and they are not included in this analysis. An inclusion of these aspects of the knowledge circulation in the economy would require extensive and exhaustive comparable survey data, which is not yet available.

However, intra-firm job shifts may still be more important for policy recommendations than inter-firm job shifts. Intra-firm job shifts can partly be measured by large individual-specific wage rate increases or promotion (shift in job category) but excess demand for certain types of skills will also result in wage rate increases. It is possible to compare job shift rates at the firm level while controlling for individual-specific tenure and age. Whether co-operation and networks among firms is a better measure for the innovation power than individual mobility is questionable, since that would require survey data to be measured. At the same time, network initiators can be publicly employed, which may give another incentive structure than in a private sector firm. Co-operation allows small-medium size enterprises (SME) to handle larger innovation projects in the firm and may result in larger production and productivity on the macro level as well.

The main reason for a measure based on physical movements is that such information already exists in public registers. The public registers have well-defined error-corrected information on the entire population for a very long time period.

It may always be difficult to measure the exact amount of knowledge flow represented by a job shift. The major part is the formal knowledge, i.e., education and skill, which is present in the register data. However, a small (or large) amount of informal knowledge flow is also represented by a job shift. An objective measure for this is practically impossible to define for entire populations. The fact that informal knowledge is not a part of the present investigation is probably a minor problem since it includes everybody in the economy. Instead, the major problem using formal education to measure knowledge flows is to measure the knowledge value of experience and short-term job-specific courses. Tenure, labour market experience, skills or geographical mobility do not measure this information perfectly. However, job shift, i.e., labour mobility, is still the event that defines an action and each individual only counts as one, no matter how important the individual is for the establishment. Similarly, it is a minor problem that the registers solely count the employment status in the first week of November. Additional shifts between registrations in two consecutive years will only be measured in some cases as extra jobs. Although the mobility of individuals is an imperfect measure of the exact circulation of formal and informal knowledge in the community, it is a reliable instrument for knowledge in relation to innovation, c.f. Nås et al (1998).

4.2 Mobility rates in the Nordic countries

The present chapter is primarily based on results from Graversen (1999) and Nås et al (1998) supplemented with other sources on researchers in the Nordic countries like Olsen (1999) and Analyseinstitut for Forskning (1998, 2000). The unit used in the analysis is employees and their job mobility between different work places. At the same time, the stock of and mobility rates for the higher educated individuals measure the dimensions for national as well as international economic performance and long-term growth. The Nordic countries register empirical data on the entire population through several public registers. The collected data includes occupational status of the

employees and information on the employer and allows a fully individual specific trace of employees between work places. If the stock of human capital is assumed to represent the stock of knowledge then the flows represents the mobility. Mobility between two organisations, two sectors, or two research institutions then indicates that there is a knowledge transfer, and that there is a common knowledge base.

Mobility is defined in this chapter as movement between two different workplaces from one year to the next.³ Mobility from one job into another adds up to the narrow mobility rate. These job-to-job movers plus the numbers of employees leaving a job without getting another, sum to the wide mobility rate. In the analysis, data from 1994 to 1995 or from 1995 to 1996 is used for four Nordic countries. Table 4.1 refers outflow mobility rates for all employees and for the highly educated employees in the four Nordic countries. Looking at the wide mobility rate, it is often lower than the overall average for the highly educated employees. However, looking at the narrow mobility rate, the opposite is more often the case.

Denmark has the highest mobility rates for all employees among the four Nordic countries. However, for the highly educated, Sweden and Finland have the highest mobility rates. National laws and agreements on the labour markets regarding firing and hiring costs may explain parts of these differences, i.e. the higher the costs, the lower the mobility rates. Similarly, differences in the unemployment rates may influence the mobility rates. A high as well as a low unemployment rate can increase the mobility rate either through a push or a pull effect, and a middle or average unemployment rate is expected to give the lowest mobility rates. However, a long period with low unemployment rates may induce low mobility rates, i.e. the Norwegian case, if a low unemployment rate results in higher attempts to keep the employees at the work place.

Table 4.1: Outflow mobility rates in four Nordic countries, pct.

Country	Period of data	Narrow mobility rate		Wide mobility rate	
		All employees	Highly educated employees ¹⁾	All employees	Highly educated employees ¹⁾
Denmark	1995-96	18	16	27	22
Sweden	1994-95	16	20	24	23
Norway	1995-96	12	13	20	19
Finland	1994-95	12	18	23	24

Note: ¹⁾ Highly educated employees have their highest obtained educational level equal 6 or above on the ISCED-1976 scale.

Wide mobility includes employees leaving active work force. Narrow type of mobility excludes these.

Source: Graversen (1999) and Näs et al (1998).

The difference between the wide and narrow mobility rates indicates a high flow out of jobs into non-working states like unemployment, leave, retirement, and emigration. Emigration counts like non-working no matter what the individuals do abroad, since such information is non-available. Similarly, numbers on inflow mobility rates will show a corresponding difference indicating a high dynamic change in the labour force. On average, newly educated employees compensate for the retired employees. The narrow mobility rate shows the core employees who change directly from on job to another. A high narrow mobility rate for the highly educated in Denmark, Sweden and Finland indicates a high knowledge circulation of core knowledge.

The numbers found in Table 4.1 is higher than earlier expected in the discussion of European ‘euro-sclerosis’, where high unemployment and low growth was linked to a low labour market mobility. The present figures as well as results found by Bingley et al (1999), Dale-Olsen and Rønning (2000)

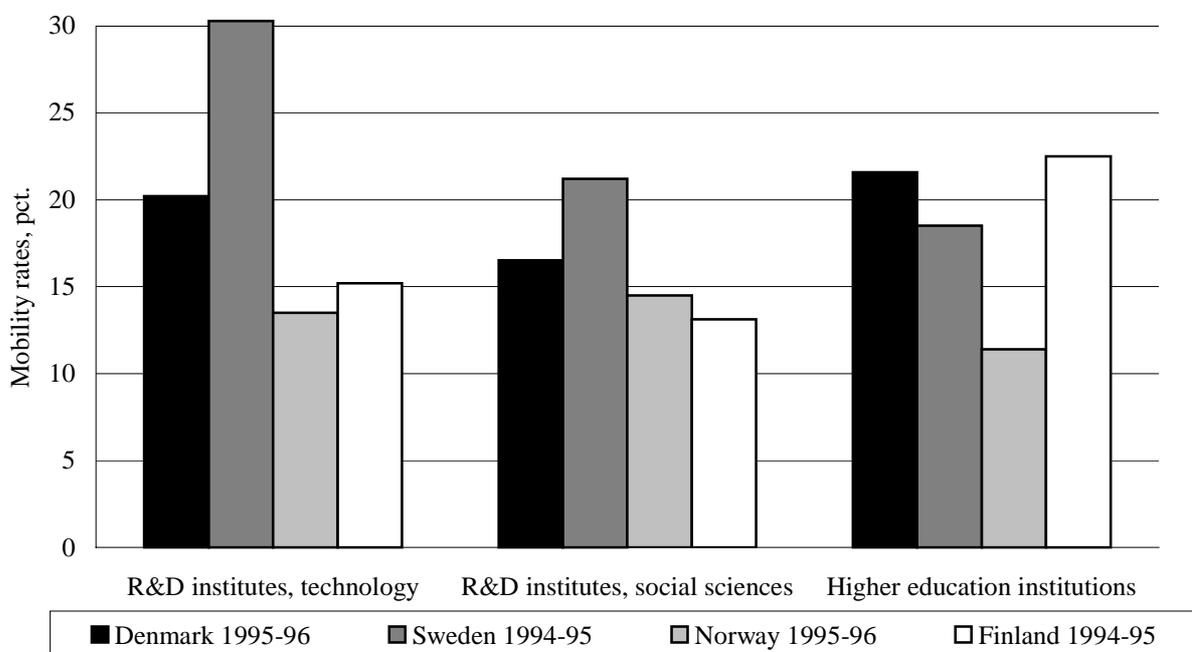
³ The outflow mobility rate is the stock of movers from year t to t+1 over the stock of employees in year t. The inflow mobility rate is the stock of movers from year t-1 to t over the stock of employees in year t.

among others indicates that this is not the case. The Nordic labour market mobility rates equal the corresponding figures for the United States.

Mobility of highly educated employees in Higher Education Institutions and Research & Development Institutes

The first indicator used to describe the size of the cooperation between the R&D sector, the HEI sector and the other sectors in the economy is the overall mobility rates. Especially the highly educated employees in the two research sectors are of interest. Although not all of these employees perform research at the work places, the share that do is considerable. The non-researching employees are employed in administrative jobs etc. Figure 4.2 shows the mobility rates for the highly educated employees in three research sub-sectors for four Nordic countries using the narrow mobility definition, cf. definition under Table 4.1. The mobility rates do not distinguish between mobility to other research sectors and mobility to other sectors in general.

Figure 4.2: Outflow job-to-job mobility rates for highly educated employees in the R&D and HEI sectors in four Nordic countries, pct.



Note: Job-to-job mobility excludes persons leaving the labour force. 'Research institutes, technology' corresponds to the NACE 73.1 code (natural sciences and technology), while 'research institutes, social sciences' corresponds to the NACE 73.2 code (social sciences and humanities). The two sub-sectors of the R&D sector sum to the R&D institutes in Tables 4.2 and 4.3.
Source: Gravensen (1999) and Nås et al (1998).

Norway has the lowest mobility rates in the research sectors while Sweden has the highest. The mobility rates for the three research sectors presented in Figure 4.2 vary between the countries but also between the sectors. In Sweden the mobility rates in the two R&D sectors are higher than the mobility rate in the HEI sector. The opposite is the case for Finland and to a smaller extent for Denmark. Even though there is a clear ranking of the overall average mobility rate in the research sectors with Sweden followed by Finland and Denmark and ending with Norway having the lowest mobility rates, all the countries have research sectors that interact with the surrounding economy. However, there are remarkably large national differences, which to a large degree can be explained by national institutional variation and differences in the economic climate.

The large mobility rate from the HEI sector in Finland indicates a high number of open job positions for the employees at the higher education institutions. This supports the aim of creating a high flow of innovative employees to the surrounding economy. On average, the Swedish and Danish figures only match the Finnish figures when the R&D institutes are included. Norway lies below, creating less open positions for new employees at the high innovative sectors, R&D and HEI.

4.3 Mobility of highly educated employees in R&D and HEI by delivering and receiving sectors

The second indicator of knowledge circulation among the research sectors and the surrounding economy is the distribution of the mobility rate by delivering and receiving sectors. The share of the mobility rate, which is internal recruitment inside the sectors (bold numbers in Tables 4.2 and 4.3) partly explain, which of the two figures in Figure 4.1 that mirrors the present state of the art. Naturally, reality neither equals the 'tower' nor the 'pyramid' model for the distribution of innovative knowledge in the economy. Instead of a one-way knowledge flow, a considerable degree of knowledge circulation characterise the empirical figures, i.e. in support of the 'pyramid' model. Tables 4.2 and 4.3 refer the distribution of into-job and out of job mobility rates for 5 aggregated sectors, which span the entire economy. Of special interest is the R&D sector and the HEI sector since these sectors have the highest innovation intensity of the five sectors.

The decomposed inflow mobility rate for employees in the research sectors distributed by delivering sectors is given in Table 4.2 for the four Nordic countries. The absolute number of employees in the R&D sectors is close to 25 percent of the employees in the HEI sectors except for Norway where the share is closer to 50 percent. However, compared with the other three sectors, the R&D and the HEI sectors are small measured in numbers of employees.

The overall inflow or into-job mobility rate in the research sectors is approximately 20-30 percent but there are large variations among the Nordic countries, c.f. Figure 4.3. A weighted average of the 'inflow mobility rate' gives a rate for the research sectors R&D and HEI in Denmark on 32 percent, in Sweden on 23 percent, in Norway on 18 percent and in Finland on 37 percent. The inflow mobility rate in the R&D sector is higher than the inflow rate to the HEI sector in Sweden while the opposite is the case in the other countries. Especially in Finland and Denmark there is a high mobility into the HEI sectors.

Table 4.2: Into-job mobility of highly educated employees in four Nordic countries by delivering sectors. (Shares and persons. Mobility shares sum horizontally to 100 percent)

Delivering sector ⇒	R&D institutes	Higher education institutions	Private production sectors ¹⁾	Services with respect to products ²⁾	Services with respect to humans ³⁾	Without job in national labour market	Number of persons moving	Number of persons employed	Average mobility rate into present job
⇓ Receiving sector	-----Share of mobility, pct. -----						Obs.	Obs.	Pct.
<u>Denmark 1995-96</u>									
R&D institutes	16	18	4	10	19	32	729	3,420	21
HEI institutions	5	26	2	7	25	36	4,475	12,886	35
Private prod. sectors ¹⁾	0	2	45	21	7	25	11,542	44,587	26
Services wrt. products ²⁾	1	2	8	52	8	29	25,602	60,654	42
Services wrt. humans ³⁾	0	2	2	7	54	34	50,743	208,341	24
<u>Sweden 1994-95</u>									
R&D institutes	7	56	8	8	7	14	2,527	6,457	39
HEI institutions	3	20	3	7	33	33	5,256	27,029	19
Private prod. sectors ¹⁾	3	4	32	22	10	28	12,553	57,082	22
Services wrt. products ²⁾	1	2	12	38	15	29	24,414	103,904	24
Services wrt. humans ³⁾	0	4	3	9	45	37	36,879	288,692	13
<u>Norway 1995-96</u>									
R&D institutes	20	12	5	6	19	32	710	5,110	14
HEI institutions	7	21	2	5	32	33	2,318	11,781	20
Private prod. sectors ¹⁾	2	2	38	18	12	25	5,564	27,069	21
Services wrt. products ²⁾	2	1	11	43	13	27	12,520	49,126	26
Services wrt. humans ³⁾	1	2	2	5	60	31	26,969	168,831	16
<u>Finland 1994-95</u>									
R&D institutes	38	9	4	5	12	32	794	3,625	22
HEI institutions	1	31	1	3	19	44	4,787	11,508	42
Private prod. sectors ¹⁾	1	3	42	12	6	37	9,326	28,711	33
Services wrt. products ²⁾	0	2	8	47	7	35	12,465	43,991	28
Services wrt. humans ³⁾	0	2	2	3	63	28	29,766	112,325	27

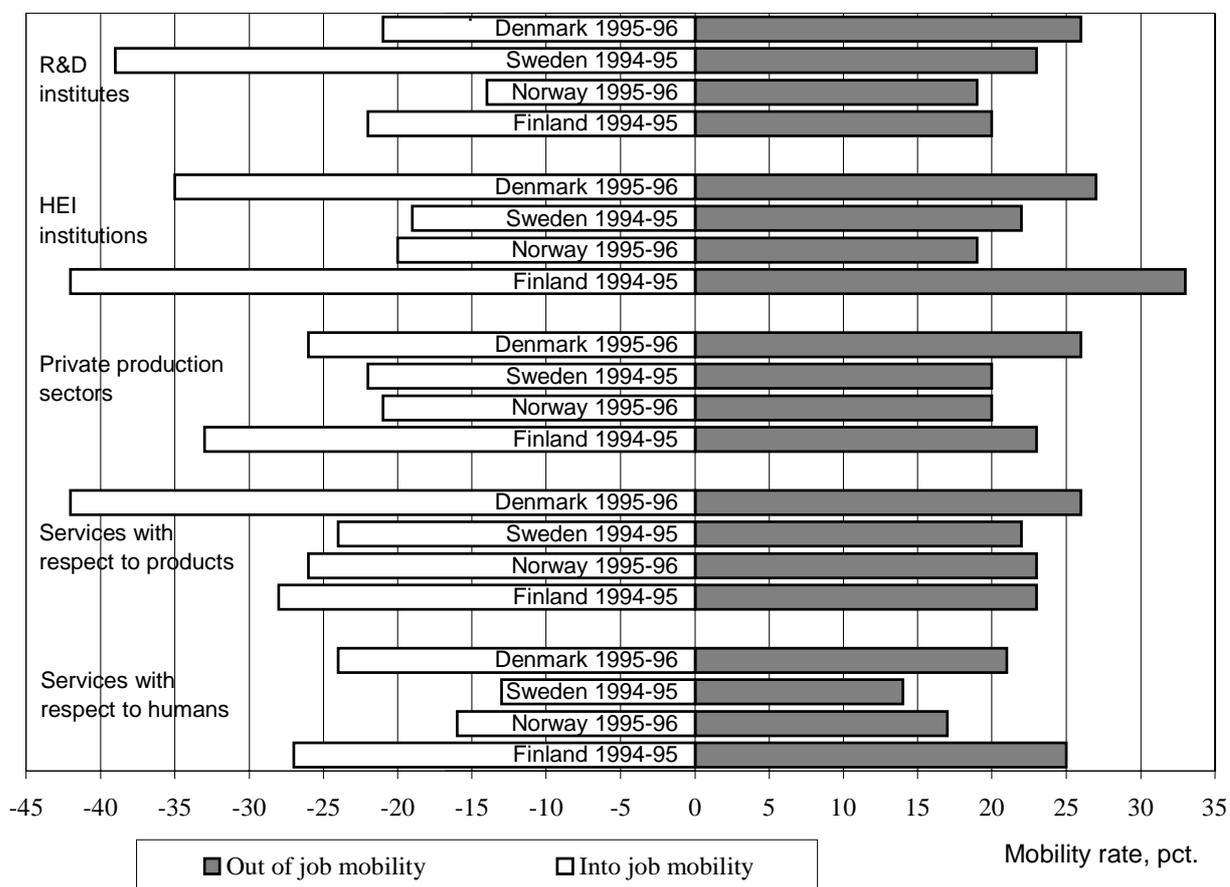
Note: ¹⁾ Agriculture, mining, manufacturing, utilities and construction. ²⁾ Trade, hotels, restaurants, transport, communications, financial intermediation and other services related to products. ³⁾ Private and public health activities, public administration and other community and private services related to individuals.

Source: Graverson (1999) and Näs et al (1998).

The differences in the mobility rates can partly be explained by expanding research sectors, c.f. the development in highly educated employees in the University sector given in Analyseinstitut for Forskning (1998, 2000). The Nordic R&D statistics from Analyseinstitut for Forskning also shows that the change in R&D man-year of highly educated from 1995 to 1997 has been 11 percent for

Denmark, 2 percent for Sweden, 2 percent for Norway and 31 percent for Finland.⁴ The same pattern is found in the difference between the inflow mobility rate in Table 4.2 and the outflow mobility rates in Table 4.3, where the difference roughly measure the net changes in employees in the sectors.⁵ The inflow and outflow mobility rates are also illustrated in Figure 4.3.

Figure 4.3: Mobility of highly educated employees in four Nordic countries by sectors. Pct.



Note: See note at Table 4.2 for an explanation of the sectors.

Using the latter difference measure, the R&D sector is expanding in Sweden, stable in Finland and shrinking in Denmark and Norway. The HEI sector is expanding in Finland and Denmark and more or less stable in Norway and Sweden. Hence, holding everything else stable, mobility rates tend to increase with the overall dynamic changes of the sector size. For example, the share of recruitment employees (PhDs and external paid) in the HEI sector in Norway in 1997 is as high as 44 percent, c.f. NIFU (1999). Such a high number in a non-expanding sector will eventually increase the outflow mobility rates, i.e. the outflow from the bottom of the 'pyramid' in Figure 4.1 will increase in the longer run.⁶ As another example, the increase in the annual number of new educated PhDs has increased by 128 percent in Denmark, by 83 percent in Sweden, 74 percent in Norway and 102 percent in Finland in the period 1990 to 1998, c.f. Olsen (1999).⁷ A continuation of this development will also increase the mobility rates and the knowledge spreading in the economies.

⁴ The similar figures for the increase of R&D man-year is 83 percent in Denmark and 45 percent in Norway in the period 1987 to 1997, 1 percent in Sweden in the period 1989 to 1997 and 56 percent in Finland in the period 1991 to 1997, c.f. Analyseinstitut for Forskning (2000).

⁵ If the inflow mobility rate is higher than the outflow mobility rate then the sector is expanding its number of employees.

⁶ A PhD student count as an employee in Tables 4.2 and 4.3 since a PhD student having a candidate degree is a highly educated individual.

⁷ The number of PhD students in 1997 in Denmark, Sweden, Norway and Finland in 1997 was 4,712, 17,739 inclusive licentiates, 3,800 and 7,229 respectively. The number of new educated PhDs in the countries in 1997 was 952, 1,722, 625 and 934 respectively, c.f. Olsen (1999).

Approximately one-third of the incoming employees in Table 4.2 come from the part of the population who are not employed on the national labour market the previous year. These employees are newly educated, come from abroad, unemployment, leaves, retirement, or disablement. A notable deviation is the considerably lower share in the Swedish R&D sector and the larger share in the Finnish HEI sector. A much larger than average share of the recruitment from the HEI sector in Sweden, 56 percent, and a smaller than average number of effective recruitment sectors in Finland, c.f. Figure 4.4, cause these figures.

Table 4.2 shows that the R&D sector in general has a larger share of the recruitment from the private sector and the product service sector compared to the HEI sector. The opposite is the case from the human service. However, it is among the internal share of the recruitment (bold figures in Tables 4.2 and 4.3) where the largest differences between the countries can be found. The R&D institutes in Sweden recruit mainly in the HEI sector; the R&D institutes in Finland recruit primarily internally. The HEI institutions recruit a minor share from the R&D sector and between 20-30 percent internally. A large part is recruited from the human service sector, especially in Sweden and Norway but also in Denmark and Finland.

The mobility rates in Table 4.2 documents a large cooperation and knowledge circulation into the research sectors in the Nordic countries although the share coming from the private sectors is scarce. However, this is not an unexpected finding due to the academic traditions of clear borders between publicly financed R&D and private sector R&D and production.

Table 4.3 gives the total as well as the shares of the outflow mobility rates from the 5 sectors in the four Nordic countries. The figures illustrate the knowledge flow to the surrounding economy and of special interest are again the R&D and the HEI sectors. The overall outflow mobility rates are approximately equal to the inflow mobility rates except for a few deviations mentioned above. On average, less than one-third of the movers leave the active labour market. These individuals retire, go abroad, gets unemployed, goes on leave etc.

The Finnish HEI sector delivers the largest share internally to other workplaces in the sector, above 35 percent. The same is almost the case for the HEI sector in Denmark. In Norway and Sweden the share for the HEI sector is around 20 percent. The share for the R&D sector is less than the halves in the other countries compared to Finland. The cross deliverance between the R&D and HEI sectors are largest in Denmark and Sweden and smallest in Norway and Finland.

Compared to the other countries Sweden has the highest share of the movers, 24 percent, who moves to the private sector, especially manufacturing, business services and transport etc. The other three countries show similar patterns although to a lesser extent. Lastly, it shall be noticed that the product service and human service sectors receive a large share of the mobile employees from the R&D sector in all countries except Finland. The HEI sector has a large mobility to the human service sector, i.e. health related jobs.

Table 4.3: Out of job mobility of highly educated employees in four Nordic countries by receiving sectors. (Shares and persons. Mobility shares sum horizontally to 100 percent)

Receiving sector ⇒	R&D institutes	Higher education institutions	Private production sectors ¹⁾	Services with respect to products ²⁾	Services with respect to humans ³⁾	Without job in national labour market	Number of persons moving	Number of persons employed	Average mobility rate out of present job
⇓ Delivering sector	-----Share of mobility, pct. -----						Obs.	Obs.	Pct.
<u>Denmark 1995-96</u>									
R&D institutes	13	23	4	23	18	20	907	3,505	26
HEI institutions	4	30	5	2	24	27	3,874	14,524	27
Private prod. sectors ¹⁾	0	1	43	18	10	28	11,956	46,869	26
Services wrt. products ²⁾	0	1	10	55	15	19	24,156	92,069	26
Services wrt. humans ³⁾	0	2	2	4	58	34	47,761	227,644	21
<u>Sweden 1994-95</u>									
R&D institutes	14	12	24	24	11	15	1,336	5,266	23
HEI institutions	23	17	7	9	23	21	6,165	27,938	22
Private prod. sectors ¹⁾	2	2	37	27	10	23	10,768	55,297	20
Services wrt. products ²⁾	1	2	13	42	16	27	22,068	101,558	22
Services wrt. humans ³⁾	0	4	3	9	40	43	40,881	292,694	14
<u>Norway 1995-96</u>									
R&D institutes	14	15	9	23	13	28	1,038	5,438	19
HEI institutions	4	22	6	7	22	38	2,155	11,618	19
Private prod. sectors ¹⁾	1	1	39	19	7	28	5,448	26,953	20
Services wrt. products ²⁾	1	1	9	49	12	28	10,997	47,603	23
Services wrt. humans ³⁾	1	3	2	6	56	32	28,756	170,618	17
<u>Finland 1994-95</u>									
R&D institutes	39	9	12	7	8	25	778	3,830	20
HEI institutions	2	35	6	5	11	31	4,327	13,098	33
Private prod. sectors ¹⁾	0	1	56	14	6	20	6,946	29,842	23
Services wrt. products ²⁾	0	1	10	54	7	27	10,827	46,337	23
Services wrt. humans ³⁾	0	3	2	3	63	24	29,698	119,468	25

Note: ¹⁾ Agriculture, mining, manufacturing, utilities and construction. ²⁾ Trade, hotels, restaurants, transport, communications, financial intermediation and other services related to products. ³⁾ Private and public health activities, public administration and other community and private services related to individuals.

Source: Gravensen (1999) and Nås et al (1998).

From Table 4.3, it is difficult to determine the numbers of significant receiving sectors. Hence, a third indicator on knowledge circulation and knowledge spreading is used to measure this. The measure is the inverse of the Herfindahl index, which calculates the number of sectors that receives a significant number of employees from the delivering sector cf. Nås et al (1998).⁸ The number of receiving sectors

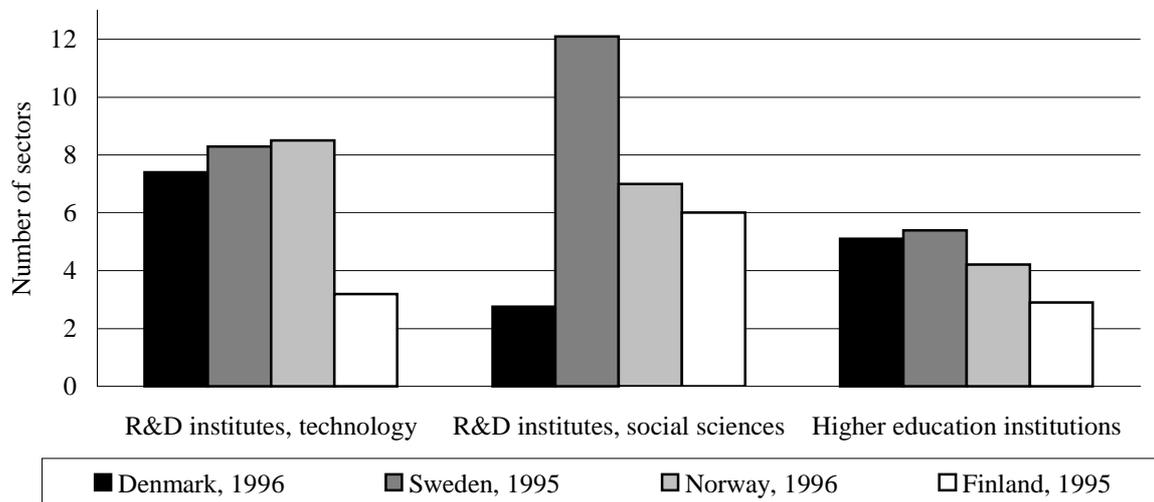
⁸ The inverse Herfindahl index = $[\sum_j s_{ij}^2]^{-1}$, where s_{ij} equals the share of total sum in sector i for sector j , i.e. A_{ij}/A_{ji} . The Herfindahl index is a variance measure and the inverse of it can be interpreted as the average number of receiving sectors. With for example 42 sectors the number of receiving sectors lies between 1 and 42.

is given in Figure 4.4 for the four Nordic countries. The figures in Figure 4.4 support the informal findings in Table 4.3

Figure 4.4 reveals that the Swedish R&D sector distribute its employees, i.e. their knowledge, to the highest number of other sectors closely followed by the Norwegian R&D sector. The number of receiving sectors for the HEI institution sectors is in general lower than for the number for the R&D institute sectors in all countries, except for the research institutes in social sciences and humanities in Denmark. Sweden shows again the highest number of receiving sectors for the HEI institutions followed by Denmark, Norway and Finland.

The overall Nordic perspective shows a higher than average number of receiving sectors in Sweden, an average number in Denmark and Norway and a lower than average number in Finland. However, all the research sectors have a significant number of cooperating sectors into which it delivers knowledge in form of employees.

Figure 4.4: The number of effective receiving sectors out of 42 different sectors for the R&D and HEI sectors in four Nordic countries, pct.



Note: The number of receiving sectors is calculated from an inverted Herfindahl index based on a 42 sector input-output matrix for each country. The 42 sectors are a sub-division of the five sectors used in Tables 4.2 and 4.3 and can be found in Näs et al (1998) or Graverson (1999). 'Research institutes, technology' corresponds to the NACE 73.1 code (natural sciences and technology), while 'research institutes, social sciences' corresponds to the NACE 73.2 code (social sciences and humanities). The two sub-sectors of the R&D sector sum to the R&D institutes in Table 4.2 and Table 4.3.
Source: Graverson (1999) and Näs et al (1998).

4.4 Conclusion

The present chapter uses mobility of highly educated employees to create indicators for knowledge circulation and spreading in the four Nordic countries, Denmark, Sweden, Norway and Finland. Especially, the knowledge flow into and out of the Higher Education Institution sector and the R&D sector is of interest, since these sectors has a high innovation intensity. The distributions of the mobility flow rates show high variations among the countries in the dispersion and circulation of knowledge. High mobility rates indicate that the national research environment cooperates and exchange knowledge with the surrounding economy.

The four Nordic countries have considerable mobility rates for highly educated as well as for all employees. Defining the outflow mobility rate as all outflows over the stock of employees gives rates above 20 percent. Defining the mobility rate as all outflows to new employment over the stock of employees gives rates, which are 5-10 percentage points lower. The highest outflow mobility rates for highly educated employees are found in Sweden and Finland followed by Denmark and Norway.

The outflow mobility rates for the highly educated employees in the research sectors, HEI and R&D, reveals the highest outflow mobility rates for the HEI sector in Finland and Denmark, the lowest in Norway. Sweden has the highest outflow mobility rates for the R&D sector and again Norway has the lowest. However, national variations and institutional differences explain a large fraction of the differences, i.e. expanding the university sector, the R&D sector etc. An even more detailed decomposition of the in- and out-flow mobility rates from 5 aggregated sectors show that the sectors deliver and receive employees to and from all sectors, some more than others. Even though there is a large intra-sectoral mobility, the inter-sectoral mobility is often higher. Additionally, the mobility in and out of jobs corresponds to one-third of the mobility rates, while the other two-thirds of the mobility rates are from or to another job.

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

All in all, the findings in the present chapter document that the research sectors in the Nordic countries do cooperate and have a considerable knowledge exchange with the surrounding economy. Sweden seems to have the largest knowledge circulation into and out of the R&D and HEI sectors followed by Denmark, Finland and Norway in a mixed order depending on the indicator used. Even though a clear ordering of these countries is impossible, they all show evidence of a significant circulation of employees and knowledge.

Internationally the mobility rates for the Nordic countries are close to or equal the figures for other countries. There does not seem to be any significant rigidity in these areas on the Nordic labour markets. The register based mobility rates in the chapter are higher than the corresponding mobility rates based on interview like in the Labour Force Surveys, LFS.

References

- Analyseinstitut for Forskning (1998): *Nordisk FoU-statistik for 1995 og statsbudgetanalyse 1997*, Århus, AFSK, Rapport.
- Analyseinstitut for Forskning (2000): *Nordisk FoU-statistik for 1997 og statsbudgetanalyse 1999*, Århus, AFSK, Rapport.
- Bingley P., T. Eriksson, A. Werwatz and N. Westergård-Nielsen (1999): *Beyond "Manucentrism" – Some Fresh Facts About Job and Worker Flows*, Aarhus, CLS, Working Paper 99-09.
- Dale-Olsen H. and D. Rønningen (2000): *The Importance of Definitions of Data and Observation Frequencies for Job and Worker Flows – The case of Norway 1996-1997*, Tampere, Nordic Workshop on labour market research with register data, Workshop paper.
- Det Kongelige Danske Videnskabernes Selskab (1996): *Forskermobilitet. Et debatoplæg om bevægelighed i forskermiljøerne*, Copenhagen, Rapport.
- Graversen E. K. (1999): *Formal Competencies in the Danish National Innovation System*, Århus, AFSK, Rapport 1999/4.

- Kyvik S. and O. Tvede (1994): *Mobilitetsmønstre blant norske forskere*, Oslo, Utredningsinstituttet for forskning og høyere utdanning, Rapport 14/94.
- NIFU (1999): *Science and Technology Indicators 1999 Norway*, Oslo, NIFU.
- Nås S. O. et al. (1998): *Formal Competencies in the Innovation System of the Nordic Countries: An analysis based on register data*, Oslo, STEP, Report R-06/98.
- OECD (1996): *The Knowledge-based Economy*, Paris, OECD, Report.
- Olsen T. B. (1999): *Doktorgrader og doktorgradsstudenter i Norden. Utviklingen på 1990-tallet*, Oslo, NIFU, Skriftserie nr. 10/99.
- Tvede O. and B. Sarpebakken (1998): *Mobilitet i det norske forskningssystemet i perioden 1989-1995*, Oslo, NIFU, Skriftserie nr. 3/98.
- Tvede O. and B. Sarpebakken (1998): *Rekruttering til norsk forskning: status og behovsanslag mot år 2015*, Oslo, NIFU, Rapport 13/98.