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Human Capital Mobility into and out of Research Sectors in the Nordic Countries

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May 2000

Chapter to be included in a collection of articles on science and technology indicators in the Nordic countries.

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

Introduction

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 formal level of education is a possible and usable substitute for these 'hidden' abilities especially for the higher educated.¹

The purpose of the present chapter is not to describe the flow of students or graduates from the higher educational system into the production or service sector of the economy. Instead, the purpose is to describe the flow of employees into and out of this system from and into the surrounding economy. These employees are or become the links between the places of wisdom and the sectors contributing to and using of this wisdom. The size of flexibility, mobility shares and the ability to circulate knowledge in humans are vital parts in the National Innovation Systems, NIS. Therefore, such numbers are given and compared for higher educated human resources in the four Nordic countries, Denmark, Finland, Norway and Sweden using available register information. The purpose is to find similarities and differences in stock and flow figures for the research sectors; Research and Development institutions, R&D, and Higher Education Institutes, HEI, for the Nordic countries.

The stock of formal knowledge is used as an indicator for the innovation potential in the economy and the mobility rates of human individuals are assumed to reflect the knowledge circulation and exchange. Similarly, the flow or mobility rates between the research sectors

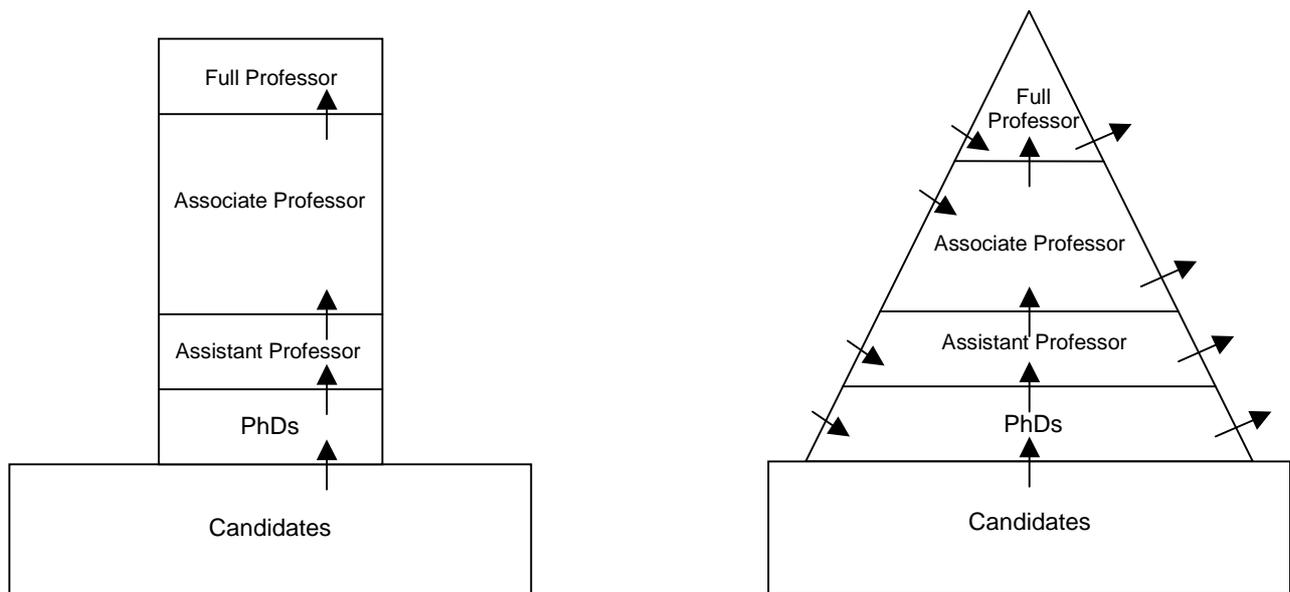
¹ In the Nordic countries these measures are already collected in the national registers at the statistical bureau's. Hence, an analysis can be done without collection of survey information and without bothering individuals and companies further.

and the remaining sectors are used to describe the spreading of knowledge from the ‘towers or pyramids of wisdom’, see Figure 1.

Motivation

A research environment where the recruitment is solely based on internal promotion of selected candidates to PhDs, assistant professor, associate professor and finally to full professorships corresponds to a research sector with no mobility in and out of the workplaces. Free positions are filled with internal movements, free positions are caused by deaths and the research sector can be illustrated as a tower in Figure 1. Conversely, a large mobility on all levels indicates an exchange and circulation of the acquired knowledge at the workplaces. This can be illustrated as a pyramid where there is mobility into the research environment from the surrounding economy and from abroad or vice versa. The mobility can also cover returns or circulations of individuals.

Figure 1: The ‘tower’ and the ‘pyramid’ research environments



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

From the point of view of the National Innovation System, the pyramid in Figure 1 creates the largest innovation power in the entire economy, creating several platforms for R&D, although a to high mobility rate creates losses. It takes time to acquire the knowledge and it takes time before an individuals is able to bring the knowledge to the next workplace. The tower in Figure 1 does not necessarily illustrate a disastrous situation although it contains a severe

risk of a missing knowledge exchange to the surrounding economy. There is also a certain risk of a missing knowledge creation inside the tower due to the missing inflow of new knowledge, although the tower situation may be able to create unique clusters of highly specified knowledge.

The 'tower' model illustrates an extreme world where the research sectors, i.e. the higher education sector, 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.

The 'pyramid' model illustrates another world where a market outside the higher education institutes gives opportunities for mobility on all levels. In this case only skill requirements determine whether a person is employed in a certain job. In this world there can be more PhD positions than needed internally, which over time results in an oversupply of qualified individuals on all levels. The mobility in and out of these sectors illustrates the knowledge circulation in the economy.

Hence, a mapping of the mobility patterns in and out of the higher education institutions, HEI, and the research and development institutes, R&D, gives a picture of the demand and supply of higher educated researchers in the surrounding economy. A higher mobility means a higher knowledge circulation and a wider national knowledge base. An extremely high mobility is undesirable since it takes time for the individual to accumulate a significant additional knowledge stock. Although an individual always has a certain stock of knowledge it shall also be large enough or potential enough to have a value-added effect at the new workplace in order to justify a knowledge movement.

The justification for an economy looking more like the 'pyramid' model than the 'tower' model is a public desire of an exchange of researchers with other non-university research environments in order to solve various problems of public interest. This is for example a desire of a significant private sector research, a need for ministerial 'analysis', advisory or consultancy functions etc.² Besides these motives there is also the aim to secure that the competitiveness of the national research environments to the benefit for the researchers, the

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

research institutes as well as the entire community. 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 priorities new research areas. The desire of an active exchange of researchers between the 'publicly' financed research environments, the higher education institutes, HEI, and the research and development institutions, R&D, is increasing both nationally and internationally.

Methodology and state of the art

The numbers in the present analysis is primarily based on results from Graversen (1999) and Nås et al (1998). The unit used in the analysis is employees and their job mobility between different labour market positions. Although this is an imperfect measure of the exact amount of formal and informal knowledge in the community, it is a reliable instrument for knowledge in relation to innovation, see Nås et al (1998) for a discussion. 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 human mobility between establishments. If the stock of human capital is assumed to represent the base then the flows can represent the links between them. Mobility between two organisations, two sectors, or two research institutions indicates that there is a knowledge transfer, and that there also is a common knowledge base.

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

In the analysis, data from 1994 or 1995 is used for four Nordic countries. A more comprehensive discussion of pros and cons regarding the mobility measures, the use of register data etc. can be found in Graversen (1999) and Nås et al (1998).

Table 1 refers outflow mobility rates for all employees and for the highly educated employees in four Nordic countries. Looking at the wide mobility rate, which includes individuals leaving

the labour force, it is typically lower than average for the highly educated employees. However, looking at the narrow mobility rate, which only includes individuals leaving to another job, the opposite seems to be the case. This documents a lower than average risk of leaving employment for highly educated individuals.

Table 1: Outflow mobility rates in four Nordic countries

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

Note: Highly educated is defined as employees with highest obtained educational level equal 6 or above. Wide type of mobility includes persons leaving active work force. Narrow type of mobility excludes these. Source: Graversen (1999) and Nås et al (1998).

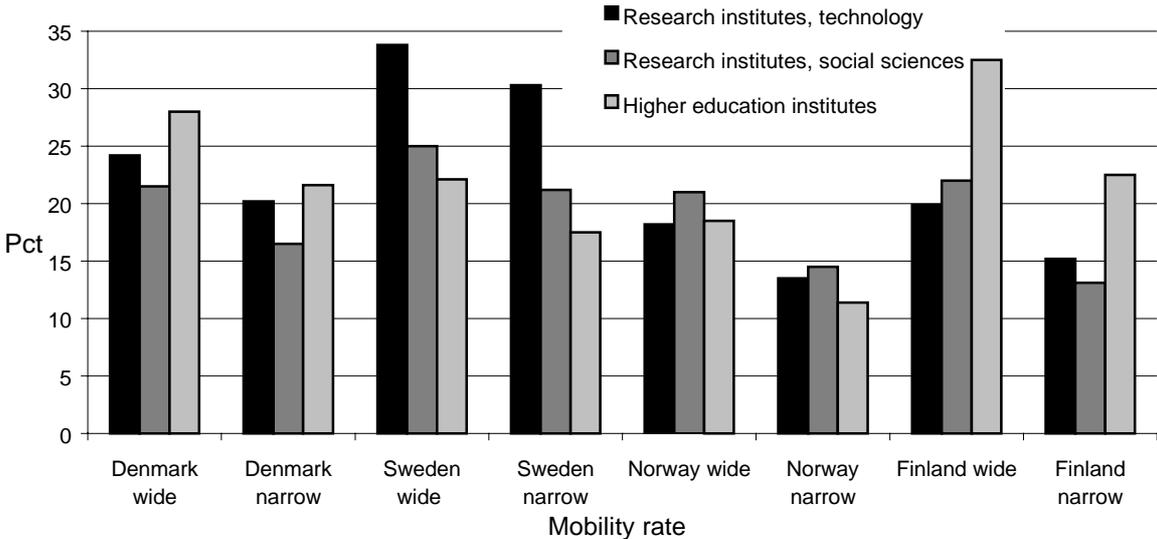
Mobility of highly educated employees in Research & Development institutions, R&D, and Higher Education Institutes, HEI

The first indicator used to describe the size of the cooperation among the R&D sector, the HEI sector and the surrounding economy is to compare mobility rates for these sectors. Especially the highly educated employees in the research sectors are of interest. Although not all of them perform research, the share that do is large. The non-researching employees are employed in administrative jobs etc. Figure 2 shows the mobility rates for the highly educated employees in three research sectors for four Nordic countries using both the wide and the narrow mobility definition, cf. note to Table 1. The mobility rates do not distinguish between mobility to other research sectors and mobility out of the research sectors.

Norway has the lowest while Sweden has the highest mobility rates out of the research sectors. The mobility rates for the three research sectors presented in Figure 2 are approximately equal in the countries Norway and Denmark. This is not the case in the other two countries. 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 much less extent

for Denmark. The overall average mobility rate out of the research sectors is highest in Sweden followed by Finland and Denmark while Norway presents the lowest mobility rates. Hence, all the countries have research sectors that interact with the surrounding but there are remarkably large national differences, which to a large degree can be explained by national institutional variation.

Figure 2: Outflow mobility rates for highly educated employees in the R&D and HEI sectors in four Nordic countries



Note: Wide type of mobility includes persons leaving active work force. Narrow type of mobility excludes these. Source: Graversen (1999) and Nås et al (1998).

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

The next indicator of cooperation among the research sectors and the surrounding economy is the mobility rate from these sectors by delivering and receiving sectors. The share of the mobility rate which is internal recruitment in the sectors explain which of the two figures in Figure 1 that explains the status quo best.

Table 2 refers the decomposed inflow mobility rate for employees in the research sectors by delivering sectors for the four Nordic countries. The number of employees in the R&D sector is close to 25 percent of the employees in the HEI sectors except for Norway where it is close to 50 percent. The overall inflow mobility rate in the research sectors is approximately 20-30 percent but there are large variations among the Nordic countries. A weighted average of the ‘inflow mobility rate’ gives a rate for the research sectors in Denmark on 31.9 percent,

in Sweden on 23.2 percent, in Norway on 17.9 percent and in Finland on 36.9 percent. The inflow mobility rate the R&D sector dominates in Sweden while the opposite is the case in the other countries. The differences in the mobility rates can partly be explained by expanding research sectors. A comparison with Table 3 illustrates roughly that higher 'inflow mobility rates' than 'outflow mobility rates' means an expanding sector measured by employees.

Approximately one-third of the incoming employees to the research sectors come from the part of the population who are not employed on the national labour market. These employees come from education, abroad, unemployment, leaves, retirement, disablement etc. A notable deviation is the considerably lower share in the Swedish R&D sector and the larger share in the Finnish HEI sector. This is caused by a much larger recruitment from the HEI sector in Sweden and a smaller number of effective recruitment sectors in Finland.

The R&D sector has in general a larger recruitment than the HEI sector from the private sectors. The opposite is the case from the public sector and non-public service sector. However, it is among the internal recruitment where the largest differences between the countries can be found. In Sweden the R&D institutes recruit mainly in the HEI sector, in Finland the R&D institutes recruit among them selves. The HEI institutes recruit only one-third of the new employees from other parts of the research sectors. A large part is recruited from the public sector, especially in Sweden and Norway.

The mobility rates in Table 2 documents a large cooperation and knowledge circulation in to the research sectors in the Nordic countries although the contribution from certain parts of the private sectors is scarce. This is not an unexpected finding due to the academic traditions of clear borders between publicly financed R&D and private R&D and production.

Table 2: The distribution of mobile highly educated employees in the R&D and HEI sectors in four Nordic countries by delivering sectors.

Delivering sector	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services real estate	Business services	R&D institutions	Higher education institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Total	Number of persons employed	Mobility rate in
Receiving sector																
Denmark 1995-96																
R&D institutions	0.1	3.7	0.3	2.7	0.6	0.6	6.5	16.3	18.4	13.7	5.2	0	32.0	100	3420	21.3
HEI institutes	0.1	1.8	0.1	2.1	0.8	0.3	3.7	4.6	25.5	19.3	5.9	0	36.0	100	12886	34.7
Sweden 1994-95																
R&D institutions	0	7.7	0.6	1.7	0.7	0.5	4.8	7.3	55.6	5.9	1.3	0.4	13.5	100	6457	39.1
HEI institutes	0.3	2.8	0.2	1.5	0.5	0.7	4.2	3.1	19.7	28.9	3.8	1.1	33.2	100	27029	19.4
Norway 1995-96																
R&D institutions	1.7	2.8	0.4	2.4	1.0	0.6	5.4	20.4	11.5	16.3	2.7	2.8	32.0	100	5110	13.9
HEI institutes	0.3	1.5	0.3	1.6	0.7	0.7	2.4	6.6	20.8	29.0	2.6	0.8	33.3	100	11781	19.7
Finland 1994-95																
R&D institutions	0.3	3.3	0.1	0.9	0.1	0.5	3.0	38.4	8.9	10.6	1.0	0.7	32.2	100	3625	21.9
HEI institutes	0.1	1.1	0.1	0.9	0.1	0.3	1.3	1.4	31.2	16.7	2.1	1.0	43.7	100	11508	41.6

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

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

Finland delivers the largest share internal to the research sectors themselves, above 35 percent. For the HEI sector the same is almost the case in Denmark. In Norway and Sweden the share is around to 20 percent for the HEI sector. The share for the R&D sector is between one-third and one-halfes 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 who moves to the private sector, especially manufacturing, business services and transport etc. The other three countries show the same pattern although to a lesser extent. Lastly, it shall be noticed that the public sector receives a fair share of the mobile employees from the research sectors. The largest part comes from the HEI sector.

Table 3: The distribution of mobile highly educated employees in the R&D and HEI sectors in four Nordic countries by receiving sectors.

Receiving sector	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services real estate	Business services	R&D institutions	Higher education institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Total	Number of persons employed	Mobility rate out
Delivering sector																
Denmark 1995-96																
R&D institutions	0.3	3.6	0.3	2.0	16.5	0.3	3.9	13.1	22.7	15.6	2.1	0	19.5	100	3505	25.9
HEI institutes	0.3	4.3	0.3	1.3	0.8	0.4	9.2	3.5	29.5	17.5	6.5	0	26.6	100	14524	26.7
Sweden 1994-95																
R&D institutions	0.1	23.5	0.8	4.0	7.1	0.7	12.4	13.8	12.4	7.9	1.3	1.3	14.7	100	5266	23.0
HEI institutes	0.1	6.8	0.4	1.3	0.6	0.5	6.6	22.8	16.8	18.3	3.1	2.0	20.7	100	27938	21.8
Norway 1995-96																
R&D institutions	3.2	4.8	0.9	3.1	0.6	1.3	17.2	14.0	14.6	11.6	1.2	0.6	26.9	100	5438	19.1
HEI institutes	1.0	4.2	0.5	1.5	0.4	1.0	4.5	3.8	22.4	19.6	2.8	0.3	38.0	100	11618	18.5
Finland 1994-95																
R&D institutions	1.5	9.9	0.5	1.4	0.4	0.3	4.8	39.2	8.5	7.3	1.0	0.5	24.7	100	3830	20.3
HEI institutes	0.1	5.3	0.1	0.9	0.2	0.2	3.3	1.6	34.5	11.4	0	0.5	26.3	100	13098	33.0

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

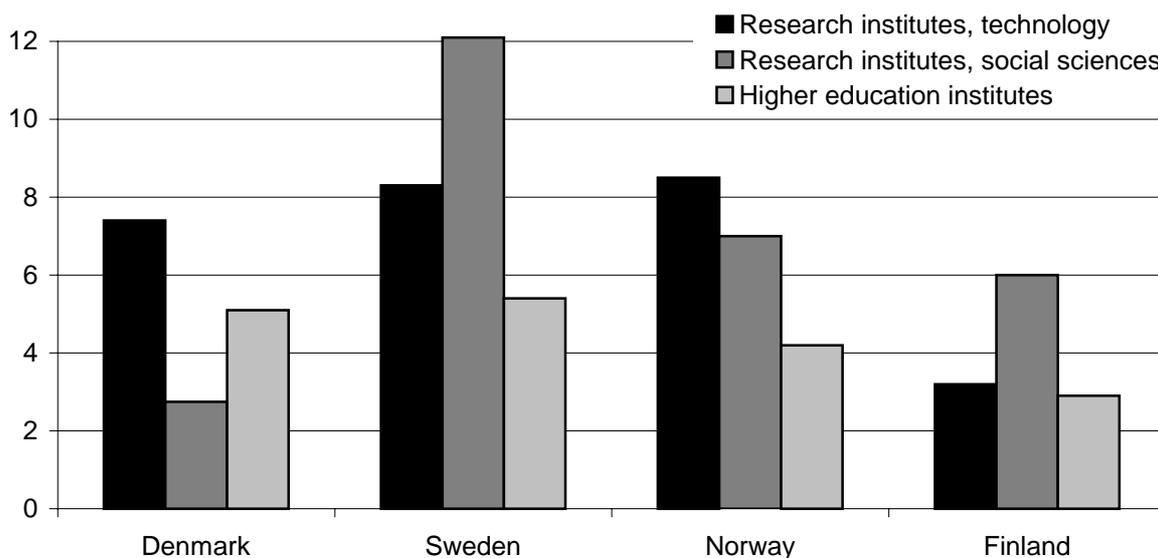
Looking at the numbers in Table 3, it is difficult to distinguish between the numbers of effective receiving sectors. Hence a third indicator on knowledge circulation is to measure this. Such a measure is the number of sectors that receives a 'significant' number of employees from the research sectors. The following findings are the effective number of receiving sectors out of 42, cf. Nås et al (1998). The number of 'significant' receiving sectors is then calculated by the inverse of the Herfindahl index. Figure 3 shows the findings for the four Nordic countries. The findings in Figure 3 supports the findings in Table 3.

The index reveals that the Swedish R&D sectors cooperate with the largest number of other sectors closely followed by Norwegian R&D sectors. The highest number is found for Swedish research institutes in social sciences. In Sweden and Finland this sector has a higher number of sectors with which it cooperates compared with the research institutes in technology sciences. The opposite is the case in Norway and, very clear, in Denmark.

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

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

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



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

Conclusion

The present chapter uses formal education in the four Nordic countries, Denmark, Sweden, Norway and Finland, to find and determine the knowledge flow into and out of the national research sectors. The flow rates show the degree of dispersion and circulation in the national innovation system. A high mobility rate indicates that the national research environment cooperates with the surrounding economy. However, a very high rate is not perfect due to the fact that knowledge accumulation takes time. A world where there are moderate mobility flows in and out of all sectors is preferable. This corresponds to the 'pyramid' modelling of the research sectors.

The four Nordic countries are characterised by considerable mobility rates for highly educated as well as for all employees. Defining mobility rate as all out flow over the stock of employees gives rates above 20 percent. Defining the mobility rates as the flow to new

employment over the stock of employees gives rates, which are 5-10 percentage points lower. The highest mobility rates for highly educated employees are found in Sweden and Finland followed by Denmark and finally Norway.

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

An even more detailed decomposition of the in- and out flow from the R&D and HEI sectors shows that the sectors delivers and receives employees to and from several sectors. Even though there are a large intra-sectoral mobility, the inter-sectoral mobility is even higher.

Calculating the effective number of receiving sectors (out of 42) reveals that the research sectors deliver employees to a significant although low number of sectors. Again Sweden shows the largest dispersion of knowledge into approximately 8 sectors on average, followed by Norway with an average on 6, Denmark with 5 and Finland with 4 effective receiving sectors on average.

All in all, the findings document that the research sectors in the Nordic countries do function more like the 'pyramid' model in Figure 1 than like the 'tower' model. Hence, there is evidence for a high and general cooperation with the surrounding economy giving potential for synergy effects in the national economic growth. 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 various order depending on the measure used. Even though a clear ordering of the three last countries is impossible, they all show evidence of a significant circulation.

Whether the degree of knowledge flow is large enough is difficult to determine. It depends on the national institutional set up. Instead, the mobility from receiving sectors and to delivering sectors lack significance in some of the sectors in some of the countries. This can only be changed by shifts in priorities in the national research policies. Whether it is desirable is out of the scope for the present chapter.

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