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Formal Competencies in the Danish National Innovation System

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Foreword

With this report, the Danish Institute for Studies in Research and Research Policy presents the first of a series of studies about human resources for Science and Technology. The purpose of the present report is to make available greater knowledge about the human resources in Denmark compared to the other Nordic countries.

The stock of knowledge is a parameter used as an indicator for the potential in the knowledge-based economy and the mobility rates of human resources are assumed to reflect the innovation potential.

The report is the Danish equivalent to an analysis performed for OECD in 1998 covering the three Nordic countries, Sweden, Norway and Finland. This report presents and comments on Danish figures and study patterns in labour mobility rates using register data. Data on employment in Denmark is used to analyse the structure and dynamics of the Danish national innovation system. The purpose is to document sizes, similarities and differences between the figures for Denmark and the other Nordic countries. The use of register data in cross-country studies is a relatively new and untested approach.

Karen Siune
Director
Århus, november 1999

Table of contents

1. Motivation and purpose of the project

The Danish economy has changed from an industrial into a knowledge-based economy.[1] For this reason, any information in the form of statistics or analyses of the flows and stocks of knowledge in such an economy is important performance parameters. OECD (1996) writes that more than 50% of GDP in the major OECD countries is knowledge based, which means that 50% of the GDP stems from an efficient distribution and use of human resources in the production. Hence, a growing literature has focused on how we can aggregate human capital to a macro level and how we can rank countries according to their human capital resources and innovation potentials. To establish measures or indicators to ascertain whether an economy fulfils its human capital objectives is basically a statistical problem, while it is a political question whether the results satisfy the national objectives.

Various new instruments have been used to measure human capital resources and the innovation power in the knowledge-based economy. These measures or instruments are complements to the traditional statistics on economic performance, like GDP or the unemployment rate. Backlund et al. state that knowledge and competence are »the most important resources in innovation« and that knowledge and competence are of »major focus of policies aimed at improving the performance of innovation systems«. Hence, innovation seems to be the keyword for further economic development in a knowledge-based economy. The innovation power in the economy is the result of numerous interactions by state, firms and employees, which together form the National Innovation System, NIS. Unfortunately, since these interactions are virtually impossible to measure directly, substitutes in the form of general instruments and indicators are needed to compare innovation resources and potentials among countries.

The present analysis is the Danish equivalent to a three country analysis performed for OECD by Nås et al. The unit used in the analysis is employees in Denmark and their stock of formal education. Although this is an imperfect measure of knowledge in a community, it is a reliable instrument for knowledge in relation to innovation. Individuals with a low-level education may have large job-specific experience, but in general their innovative contribution is small. For highly educated individuals, formal education reflects the

1 The term »knowledge-based economy« stems from the recognition that the distribution and use of knowledge is a major factor for new productivity and economic growth in modern OECD countries. The knowledge-based economy normally follows an industrial-based economy where production in itself was the main objective. A full understanding and mapping of the dynamics of the knowledge-based economy and its relationship to traditional economics have been part of recent OECD research.

innovation potential much better. The present report analyses the stock and flow of knowledge in Denmark by counting individuals in different labour market positions. These movements in a community indicate the potential for innovation, the innovation power. The stocks and mobility rates of human resources map the dimensions for economic performance and long-term economic growth within the National Innovation System. It also illustrates how this kind of knowledge flow works in the innovation process. Mapping the National Innovation System is especially important when »investment in knowledge and capabilities are characterised by increasing (rather than decreasing) returns« (OECD 1996). Investment in knowledge can increase the productivity of the other production factors as well as transform them into new products and processes. This can again contribute to the accumulation of knowledge. The endogenous role of knowledge in the production function has recently resulted in alternative growth models instead of the usual neo-classical models of production, innovation and growth (OECD 1996).

The report presents and comments on Danish figures, following the strategy in Nås et al. (1998), and, like them, we study patterns in labour mobility rates using register data. Data on employment in Denmark is used to analyse the structure and dynamics of the Danish national innovation system. The purpose is to document sizes, similarities and differences between the figures for Denmark and the corresponding figures in Nås et al. for Norway, Sweden and Finland. Besides updated information on mobility rates for these three Nordic countries, their main contribution is an investigation of the comparability of register-based information collected in the three countries. The use of register data in cross-country studies is a relatively new and mainly unproved approach. They conclude that the information found in the national registers is comparable among the three countries if (and only if) it is used with care and common sense. Since we have and use similar register data for Denmark, we can contribute with carefully constructed comparable figures.

Section 2 starts with a discussion of the pros and cons of the chosen methodology in the analysis and ends with a presentation of the register data used in the report. In Section 3, the distribution of formal competencies in Denmark is presented. The highest obtained level of individual formal education is used for this purpose. The distribution of the stock of formal knowledge divided on sectors and educational levels as well as other background characteristics such as gender, age and family type is also given in Section 3. Similarly, we focus on the general knowledge flow measured by job mobility divided on educational level, gender, age and family type in Section 4 and the

knowledge flow measured by individual mobility between sectors in Section 5. Both delivering sectors (outflow) as well as receiving sectors (inflow) are analysed. The focus is on the flow of highly educated (2nd stage of tertiary education, cf. UNESCO) individuals into and out of research jobs and research sectors. The unique link between employees and employers in the register data makes it possible to detect whether the knowledge flow between, for example, the public research sectors and private goods producing sector is positive, negative or insignificant. Section 6 concludes the report and gives suggestions for future work. More detailed tables and figures are referred in the Appendix.

2. Methodology and data source

As the other Nordic countries, Denmark registers empirical data on the entire population through several public registers. The data includes background characteristics such as education, age and gender, various incomes as well as occupational status. Especially the labour market data allows a fully individual specific trace of human mobility between workplaces, i.e., knowledge distribution as well as knowledge circulation in the economy.

Personnel mobility together with stocks of human resources can be used to create indicators for the use and importance of knowledge in companies, sectors, regions, the entire national economy or internationally between countries. These indicators can be used as parts of a National Account on Human Resources. However, the purpose here is not to supply measures to such an account. Instead, the analysis focuses on mapping the national innovation system in terms of stocks, distribution and flows of human resources and on comparison with the other Nordic countries.

2.1 Methodological choices

If the stock of human capital is assumed to »represent the institutions in a national innovation system, then the flows can represent the links between them (or at least one form of linkage). Mobility between two organisations, two sectors, or two NIS institutions indicate that there is a knowledge transfer, and that there also is a common knowledge-base« (Nås et al., p. 4). Following this assumption, we define and refer statistics on stocks and mobility for the entire employed population aged 20-70 years, the subgroup of all highly educated employees, and three subgroups of highly educated employees; namely (1) natural science and engineering, (2) medicine and health, and (3) humanities and social sciences. Mobility is defined as outflow from the workplace (establishment), meaning that the employee does not work at the same work place the following year.[2] The mobility rate is the stock of movers over the stock of employees.

The breakdown by sectors follows Nås et al. in order to get comparable statistics. The chosen 42 sectors are composed of aggregates of different NACE levels. The 42 sectors seem to be more than sufficient to describe the major similarities and differences between the Nordic countries. For presentational and simplifying reasons, an 11-sector aggregate is often used in the text. The 42-sector aggregate is used when suitable, but it is mainly referred as documentation in the Appendix.

2 Other definitions could be chosen as bases for mobility, e.g., change of organisation, geographical change, residence change, wage rate or income change, etc. Like Nås et al., we choose change in work establishment as the most solid mobility indicator for knowledge flows.

In the analysis presented here, only data from the latest available year, 1995, is used. Although data from 1996 exists, it is not possible to construct forward mobility rates for 1996, since there is no labour market information for 1997. The mobility rate is defined in details below.[3]

Although other kinds of knowledge transfers are possible, mobility of highly educated personnel is one of the most obvious. Even though labour mobility does not necessarily always involve knowledge transfers, it is an easy and well-defined measure. The unknown and/or unobserved individual-specific capacity or heterogeneity is a problem, although probably minor. Other kinds of knowledge flows such as co-operations, temporary exchange of employees, network organisations, buyer-supplier relationships, R&D collaborations, etc., all consist of partly unobservable information and are therefore less usable.[4] Naturally, another reason for our choice of measure, namely counting heads, is that this 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 the entire population. The fact that informal knowledge is not a part of the present investigation is probably a minor problem since we perform a large-scale investigation. At the same time, the major focus is on highly educated individuals who are so highly specialised »that the formal knowledge measure is probably a more than acceptable indicator of knowledge« (Nås et al., p. 6). Instead, the major problem when we use 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

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3 An investigation of the variation in mobility rates over time in order to find the »normal« business cycle independent mobility rate is postponed to future research.

4 Intra-firm job shifts may 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). Excess demand for certain types of skills will also result in wage rate increases. However, 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 impossible to judge, 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.

individual only counts as one, no matter how important the individual is for the establishment. Similarly, it is a problem (although minor) that the registers solely count the employment status in the first week of November.[5] Additional shifts between registrations in two consecutive years will only be measured in some cases as extra jobs.

In practice, the entire population contributes to the construction of the National Innovation System and could, therefore, be included in the analysis. However, OECD and Eurostat have defined the HRST (Human Resources for Science and Technology) concept in which persons with higher education levels (ISCED(5)[6] or persons employed in science and technology jobs as professionals (ISCO=2),[7] technicians (ISCO=3) or certain kinds of managers (ISCO=1) is defined as the population of interest for the analysis. For a country-comparative study, such a limitation of data would result in different stocks depending on the different labour markets.[8] At the same time, the ISCO code is not fully implemented in all Nordic countries. Due to the rather complex and incomparable outcome of the definition above, Nås et al. chose to focus on people with certain types of formal education. Similarly, the International Standard Classification of Education, ISCED, is used as the reference classification in this report. Hence, the sub-population for the extensive analysis is highly educated, (ISCED(6), which corresponds to university bachelors and graduates, inclusive PhDs and licentiates. The university graduates are further divided into three fields of science: (1) natural science and engineering, (2) medicine and (3) social sciences, humanities and other scientific fields. The choice of level and grouping for the analysis is driven by the desired comparability with the study by Nås et al.

The industrial classification based on the NACE codes is used to determine the distribution of mobility rates among trades. Since the NACE code is standard in all EEA countries, it can be implemented across most countries. We use the same aggregate levels as in the study by Nås et al. The level of detail in the aggregation varies with the subjective importance that we have in the various sectors. Universities and research institutes are separate categories. Universities are defined as institutions offering PhD level education. Research institutes are further divided into institutes mainly serving industry and/or doing R&D in natural sciences and engineering. All establishments within

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5 This is similar to the register data in the other Nordic countries.
6 ISCED is short for International Standard Classification of Education (cf. UNESCO).
7 ISCO is short for International Standard Classification of Occupation. Statistics Denmark operates with a Danish version called DISCO.
8 As an example, OECD (1999) finds that 13% of the Danish HRST fulfil the ISCO=1 requirement. However, only 28% of these had a third level education. Similar figures for Finland are found at 10% and 39%.

universities are classified as universities. For the manufacturing sector, a 2-digit NACE code is used, while even broader categories have been defined for the service sectors. The aggregation of the NACE classification gives 42 levels. A more aggregated version with 11 levels is used in the description in Sections 3, 4 and 5 to make the results easier to access.

Another subject of importance is the definition of mobility and mobility rates. Individual mobility is defined as an individual-specific shift from one establishment to another, to education, to unemployment or leaving the labour force. The mobility rate in the report is calculated on the basis of outflows, i.e., the number of individuals moving between year t and year t+1 over the stock in year t. Since the IDA register consists of annual data based on the employment status in the first week of November, we cannot measure additional job shifts between the November week in year t and the following November week in year t+1. Hence, our referred mobility rates will be somewhat downward biased.

A discussion of additional problems which may arise from the definition of mobility, the use of NACE codes, the country-specific registration routines, institutional differences and differences in the educational systems in a comparison of the Nordic countries can be found in Nås et al. We rely on their work on refinement of comparable statistics in the following sections and relate the Danish numbers to their corresponding Norwegian, Swedish and Finnish findings.

2.2 Data source

Statistics Denmark collects Danish register information with a unique identification of individuals and companies or establishments. The combination of almost all public registers allows a full record on the entire population, their work places and labour supply, place of living, wealth and earnings, education, etc., together with aggregate information at the company or sector level, such as number of employees and branch. Statistics Denmark has prepared a register-based database, which we use in the investigation, for such analyses. The database is called IDA (Integreret Database for Arbejdsmarkedsforskning; in English »integrated data base for labour market research«) and is documented (in Danish) in Emerek et al. Basically, it contains the same register variables following the same definitions as those used in the country-comparative study by Nås et al. for Norway, Sweden and Finland. Hence, our numbers for Denmark are comparable with their corresponding numbers for these three countries.[9]

9 Further information, such as innovation costs, number of researchers, patents, etc., may be added at the firm level. Unfortunately, such additional information is very costly and would not be complete. We have not analysed it further here.

IDA is ideal for mobility studies, since the most general data control has already been performed. As an example, the mobility data is corrected for mergers, new owners, bankruptcy, buyouts and take-overs, etc.

The register data covers the entire population and is quantitatively extremely large and costly to handle and access.[10] Thus, we have chosen a subsample consisting of the entire population of highly educated individuals (ISCED6+) and a random sample on 1% of the remaining part of the population. In the analysis the data is weighted accordingly to the sampling procedure.

10 IDA is physically located at Statistics Denmark, where all access and analyses must be done. The data cannot be taken out of their custody, and access is possible after application and approval. The cost of access consists of a basic price for the (subsample of the) data and a price for the time each researcher works on the data.

3. The stock of formal education in Denmark in 1995

The distribution and stock of knowledge in Denmark in 1995 are described in this section. Both total numbers and numbers split by gender, scientific fields, age and sectors are given. The numbers give the background for the study of mobility (flows) in Section 4 and 5. »In terms of the national innovation systems perspective, this (section) describes nodes in the system whereas (the next sections) addresses linkages in the system« (Nås et al., p. 17). The distribution and stock of knowledge will be related to the other Nordic countries where suitable.

First, Section 3.1, using empirical data for 1995, looks at the total stock (entire population) of formal knowledge by educational level, scientific field, gender and age, but not by sectors. Second, Section 3.2 gives the sector distribution for all employees and all highly educated employees by gender. Finally Section 3.2 gives the stock of all employees by educational level and sector and the distribution of highly educated employees by scientific field and sector.

In Section 3, we refer the results by an 11-sector aggregated distribution. Figures from a 42-sector aggregated distribution are found in the Appendix. We look at the total stock, the highly educated, group 3 below, and three scientific fields, namely 1) natural science and engineering, 2) medical and health-related fields, and 3) social sciences, humanities and other fields. For results presented in graphs, corresponding detailed tables are found in the Appendix.

The educational breakdown is based on the ISCED standard, which is available in the Danish register database as well. The educational levels are split into the following groups:

- Low and middle level of education:
  1. ISCED(4, secondary education or below, corresponding to max. 12 years of education.
- Higher level of education
  2. ISCED=5, corresponding to 12-15 years of education, including up to 3 years of higher education.
  3. Highly educated individuals
     3.a ISCED=6+, corresponding to 3 years or more of higher education (academics such as bachelors and graduates, but not PhDs and licentiates).
     3.b PhD, including licentiates.[11]

11 *There is no distinction between PhDs and licentiates in the Danish registers. As in Finland, PhDs and licentiates are both considered researcher educations in Denmark and are therefore both classified as PhDs. In contrast, Norway and Sweden use the name »licentiates« for »extended« Master degrees, even though they in some cases are almost similar to a PhD.*

The use of ISCED codes instead of the national education codes enhances the comparability of the results, although there still may be minor differences among countries. Such differences can be dealt with in a careful inclusion or exclusion of certain groups in the national registers following the spirit in the ISCED system. Even in the Nordic countries, it is difficult to translate the national education coding to the comparable ISCED code. Nås et al. translate the national code to the ISCED code, taking account of national differences and included and excluded groups of individuals in categories 2-4 above, for example individuals who did not fit the criteria of education length in the ISCED code, but instead the description of education type in the ISCED code. Since Statistics Denmark has already made this translation from national to ISCED code, it is directly accessible in the register data.

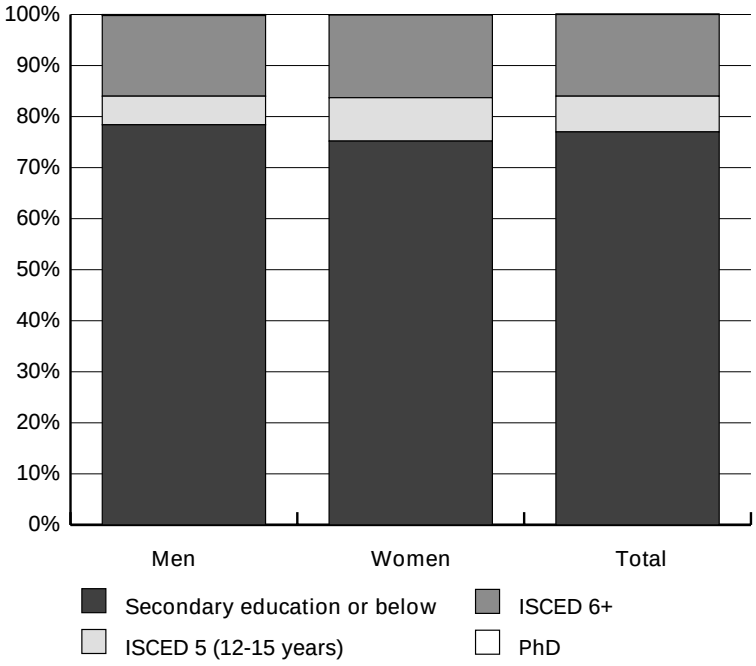
The following presentation focuses on individuals with a higher education, since they, on average, possess more innovative knowledge than individuals with low and middle level educations. This does not mean that the latter make an insignificant contribution to the national innovation; job-specific experience, tenure, vocational training and skills do matter and are naturally part of the NIS.[12]

3.1 The stock of formal education by level, scientific field and gender.

In 1995, the stock of employees in Denmark was approximately 2.2 million, which is 3-400,000 more than in Norway and Finland, but around 1.5 million less than in Sweden (cf. Nås et al.). The size of the work force corresponds proportionally well to the population sizes in the Nordic countries. In Denmark, 77% have maximum completed a secondary education, which is approximately equal to the other Nordic countries: 81% in Finland, 74% in Norway, and 73% in Sweden. Close to 16% of Danish employees have obtained the highest education (ISCED=6+), compared to 12% in Finland, 15% in Norway, and 13% in Sweden. Over time, the share of highly educated individuals has grown in all the Nordic countries (cf. ST≈), and this is expected to continue in the future. The share of short-time higher education (ISCED=5) is 7% in Denmark, compared to 7% in Finland, 11% in Norway, and 14% in Sweden. The relatively large variation between the Nordic countries for this group reflects differences in the educational system. Somewhat generalised, Sweden has the largest share of individuals with a higher education (ISCED=5+), Denmark the largest share of highly educated individuals, (ISCED=6+), followed closely by Norway, while Finland has the smallest share.

12 Whereas the distribution of knowledge in these dimensions can be analysed by IDA, this is not generally the case for other countries. Hence, in a country comparison, such a detailed analysis is not possible at the moment. It might be possible in future research.

Figure 3.1 Stock of employees by level of formal education and gender in Denmark. Percent. 1995.



Note: See the absolute numbers in Table A.1. ISCED 6+ is here exclusive PhDs.

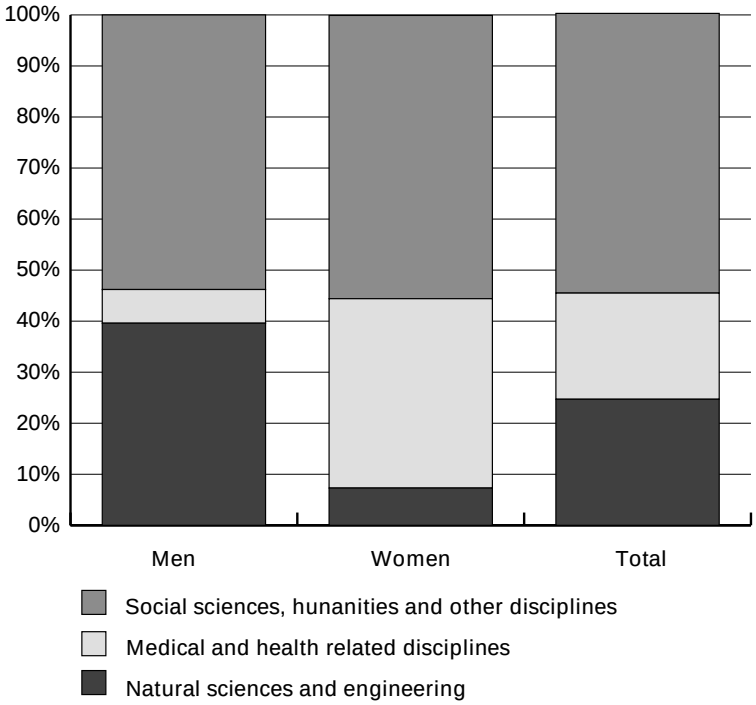
The share of employees with a PhD or equivalent is much smaller in Denmark than in the other Nordic countries. The share is very small and almost invisible in Figure 3.1. There is a statistical and an institutional explanation for this. First, some administrative units at the universities pool graduates, PhDs and licentiates as graduates in their reporting procedures. This seems to be a statistical problem concerning PhDs who concluded their studies before 1994. A qualified guess by experts at Statistics Denmark is that approximately 2,000 PhDs are misclassified as graduates in the stocks in 1995. Second, the Danish educational system has only recently (early 1990s) put resources into a systematic development of the PhD education.[13] The recent development is illustrated by the fact that the total number of employed PhDs in the register was around 2,200 in 1994; 2,670 in 1995; and 4,000 in 1996 (plus the misclassified 2,000).

13 Today, higher education institutes and R&D institutes require that new (and young) employees have a PhD or equivalent before long-term employment in a research job can be considered. Naturally, (older) well-estimated individuals in the fields are qualified through their earlier research if they do not have a PhD.

Looking for gender differences in Denmark, we find that the relative shares in the three educational groupings are more or less similar for men and women. However, the share of employees with short-term higher educations is larger for women, which reflects social and health-related jobs in the public sector. The overall participation rate on the Danish labour market is still higher for men than for women, resulting in 1.2 million men and 1.0 million women employed in Denmark in 1995. The share of men with a secondary education or below is 3.3 percentage points higher than for women. This difference is the opposite for employees with a short higher education (2.9 percentage points lower) and with a long higher education (0.3 percentage points lower). 0.18% of the men versus 0.05% of the women have a PhD, or, in absolute numbers, four times as many men as women.

The distribution of highly educated (ISCED=6+) employees by scientific field is of interest due to the large innovation power for the industry in the natural science and engineering group. As Figure 3.2 shows, social science, humanities and other fields is the largest group, consisting of around 55% of the highly educated employees in Denmark. The figures are around 61% for Finland, 63% for Norway, and 69% for Sweden. Natural science and engineering make up 25%, while medical and health-related education make up 20% of the highly educated in Denmark. The figures for natural science and engineering are around 28% for Finland, 22% for Norway and 18% for Sweden, and for medical and health-related educations around 11% for Finland, 15% for Norway, and 13% for Sweden. Compared to the other Nordic countries, Denmark generally has a high share in natural science and engineering education and the highest share in medical and health-related education. Denmark also has a long tradition for research in the medical industry.

Figure 3.2 Stock of highly educated employees by scientific field and gender in Denmark. Percent. 1995.



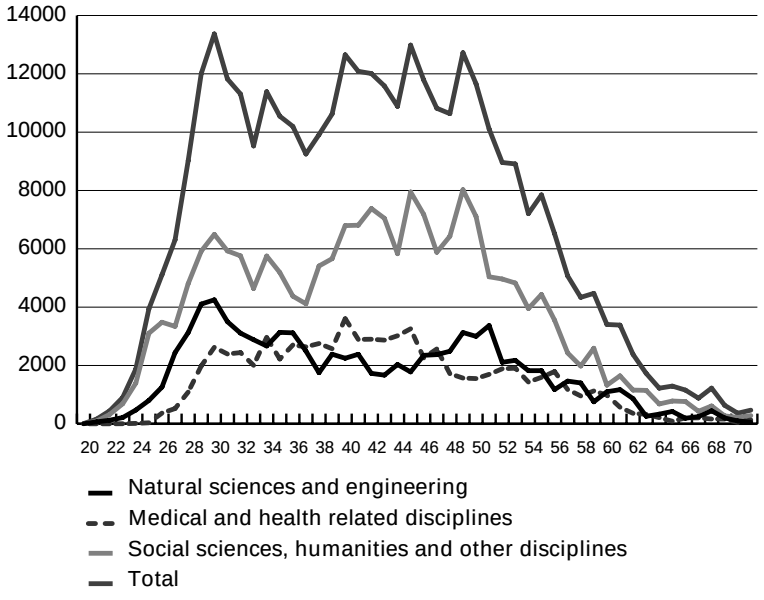
Whether these shares will change can be indicated by the composition of employees with degrees in the three scientific fields according to their age. The distribution over age also shows the size of each generation that has entered higher education and/or entered the active labour force, their educational choices, the duration of their education and the capacity of the education system (cf. Nås et al., pp. 22-23). Thus, it gives some information on the effects of previous educational policies and the need for replacements in the future. The retirement of certain skills is relatively easy to calculate, so new cohorts can be educated according to the short-term future demand in the market. Naturally, the composition of skills among employees will change since the demand for certain skills also changes, so the long-term future demand is difficult to predict.

Figure 3.3 shows the distribution of highly educated employees in 1995. Corresponding figures for men and women are given in Figure A.1 and A.2 in the Appendix. The stock of highly educated employees in Figure 3.3 seems fairly stable for the 30-50 age group. There are minor fluctuations around an inverse bell-shaped trend. The fact that future retirements must be replaced by new entrants indicates a need for an increasing inflow of highly educated

individuals just to replace future outflow. This, combined with the overall trend that highly educated individuals are more attractive than uneducated individuals for the employers, indicates a higher demand for highly educated people in the future. This is already recognised by public planners, who have increased inflow to universities considerably in recent years.

Naturally, the stock of highly educated employees in Figure 3.3 increases from zero to the flat level in the 20-30 age group. This reflects the year of graduation for these employees. Individuals in the medical and health-related disciplines seem, on average, to graduate older. The decreasing pattern for the 50-70 age group is more interesting. It may reflect a smaller stock of highly educated individuals some decades ago, but it may also reflect retirement from employment (these individuals have voluntarily or involuntarily chosen not to work or are unemployed). This group may constitute a flexible reserve. The total stock of highly educated individuals in the population must be known to distinguish between the two possibilities. The entire story probably lies in between the two interpretations. Hence, the distribution over age in Figure 3.3 cannot by itself tell whether an excess demand for highly educated individuals in the future is certain or not. Nås et al. found similar patterns in the other Nordic countries.

Figure 3.3 Distribution of highly educated employees by scientific field. Absolute numbers. 1995.



Note: Corresponding figures for men and women separately are given in the Appendix. The numbers are referred in Table A.4.

The distribution split by gender in the Appendix shows similar patterns. The overall inverse bell-shaped distribution by age is more pronounced because the »stable« age group only goes to the early 40s for women. Hence, Figure 3.3 hides an important aspect that can be explained by gender difference. Especially the natural science and engineering fields is expanding in numbers, while the two other fields are stable or decreasing for both gender.[14] The fluctuation in starting age for the different scientific fields is also interesting.

The development for each scientific field partly explains the overall pattern found in Figure 3.3. As the other Nordic countries, Denmark has a peak in the distribution among younger employees in the natural science and engineering field, almost double compared to middle-aged employees. Six times as many men as women are in this educational group, which reflects the recent priorities in the educational system combined with a higher labour demand in this scientific field compared to the others. The opposite is the case with the medical and health-related disciplines which also have the highest starting age on the labour market. The social sciences, humanities and other disciplines is clearly largest in absolute number of employees. They also seem to have the lowest starting age on the labour market. The patterns are similar in the other Nordic countries. Another common pattern among the Nordic countries, including Denmark, is that the inflow seems to be lower than the future outflow, partly because of a small number of children. This is most pronounced in Sweden. In Denmark, the inflow to the social science and humanities field is around 25% lower than the potential future outflow (comparing the level for the 30-35 age group with the 40-50 age). The result may be a reduction in the total number of highly educated employees in this field.

3.2 A sector breakdown of the stock of formal education by level, scientific field and gender

The distribution of employees by sectors is informative in the political planning of the educational resources. Especially the distribution of different levels of education by sector is useful. If the political system decides to give specific sectors (e.g., IT) high priority, it is important to know what kind of labour input the sectors use and how the input is composed. We use the NACE classification to create an 11-sector aggregate, nine broadly defined sectors and two research-oriented sectors, namely R&D institutes and higher education institutes. In the Appendix, a less aggregated distribution with 42 sectors is referred. The 11 sectors are defined in Table 3.1

14 Nås et al. do not split their distributions by gender.

Table 3.1. Definition of the sector breakdown by 11 sectors.

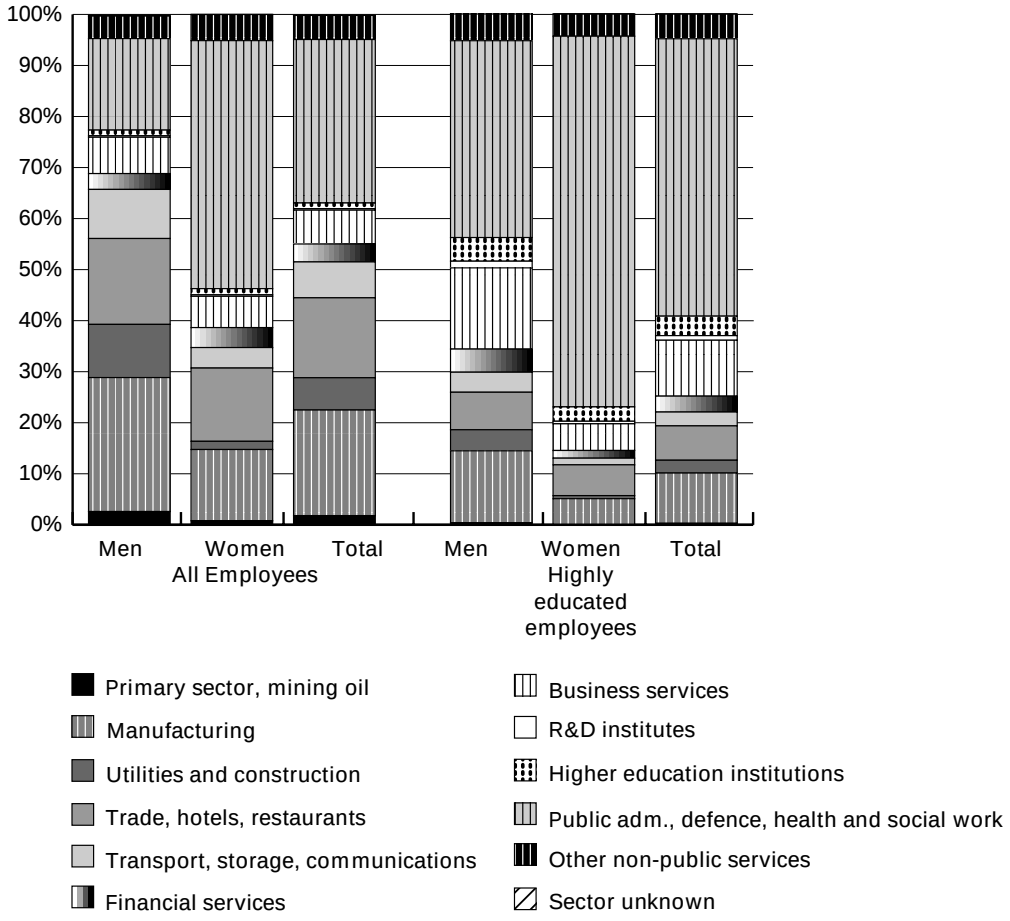
Sector	Includes the following sub-sectors	NACE code (2-digit)
1	Primary sectors, mining, oil	01-14
2	Manufacturing	15-37
3	Utilities and construction	40-45
4	Trade, hotels and restaurants	50-55
5	Transport, storage and communication	60-64
6	Financial services and real estate	65-67
7	Business services	70-72, 74
8	R&D services	73
9	Higher education institutes	80.3
10	Public administration, defence, health and social work	75-85 exclusive 80.3
11	Other non-public services	90-95, 99

The purpose of the 11-sector aggregate is twofold, namely to keep each category as homogeneous as possible and at the same time keep the number of categories so low that a graphical presentation is still meaningful. Naturally, the 42-sector aggregate (20 of them are subgroups of the manufacturing sector) shows larger differences between the sectors and between countries. At the same time, it also provides details which are meaningless in a country comparison, since they are caused by very specific country conditions, for example oil in Norway, telecommunication in Finland, etc., reflections of different industrial structures in the Nordic countries. Ideally, the construction of a common industrial structure would give a weight variable for the national distributions, allowing an easier comparison.[15]

Figure 3.4 gives the distribution of the total stock of employees by the 11-sector aggregate together with similar distribution for men and women separately, for all highly educated employees, and for highly educated men and women separately. The largest sector for women is the public administration, defence, health and social work sector (both if we look at all employed women or just highly educated women). This is also, to a lesser extent, the case for highly educated men. For all employed men, the manufacturing sector is largest. The R&D institute sector is only visible (significant) for highly educated men, while higher education institutes, HEI, are visible for both men and women, also in the distribution for all employees.

15 The construction of such a common structure can be a subject for future research discussion and negotiation in and among several participating countries, presumably under the auspices of OECD.

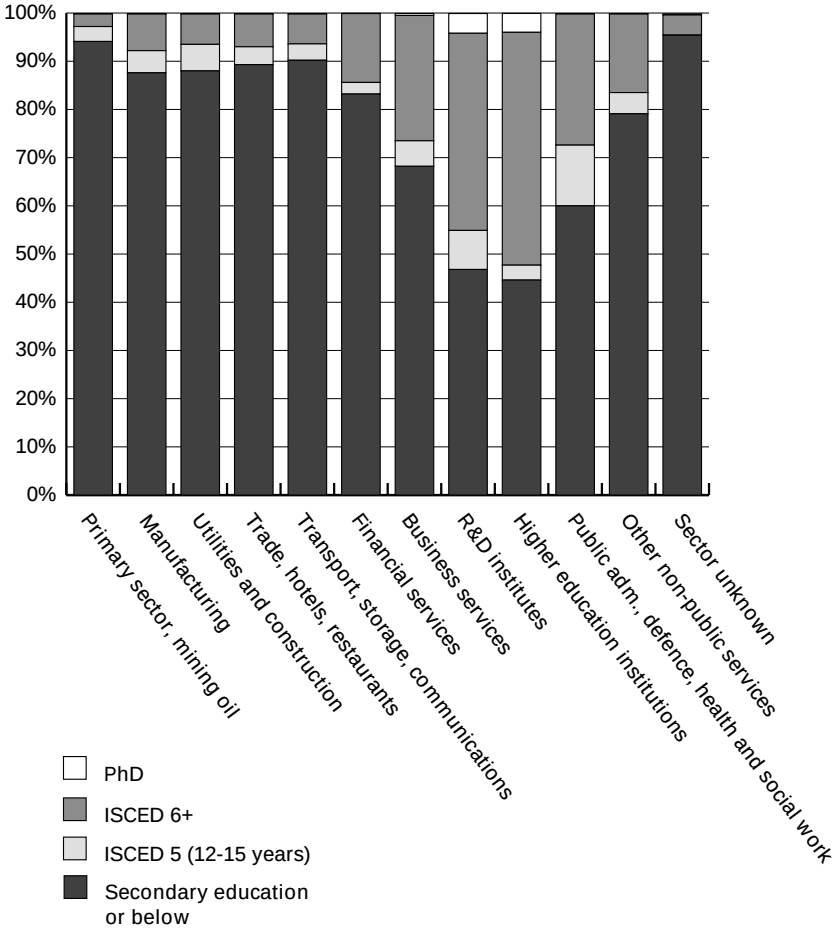
Figure 3.4. Sector distribution of employment in Denmark in 1995 by gender. All employees and highly educated employees.



The distribution of employees by educational level for the 11 sectors is given in Figure 3.5. The percentages are given together with the absolute numbers in Table A.6 in the Appendix. The actual number of heads in each sector varies considerably as Table A.6 shows. Figure 3.5 refers the relative share within each sector and not the share of all employees. As expected, there is a huge variation in the share of highly educated employees in the different sectors. Naturally, the two research sectors HEI and R&D institutes have the highest share of highly educated employees. Besides these, public administration, defence and health employ the highest share of highly educated individuals, followed closely by business services, financial services, and other non-public services. A ranking of the sectors according to the share of highly educated

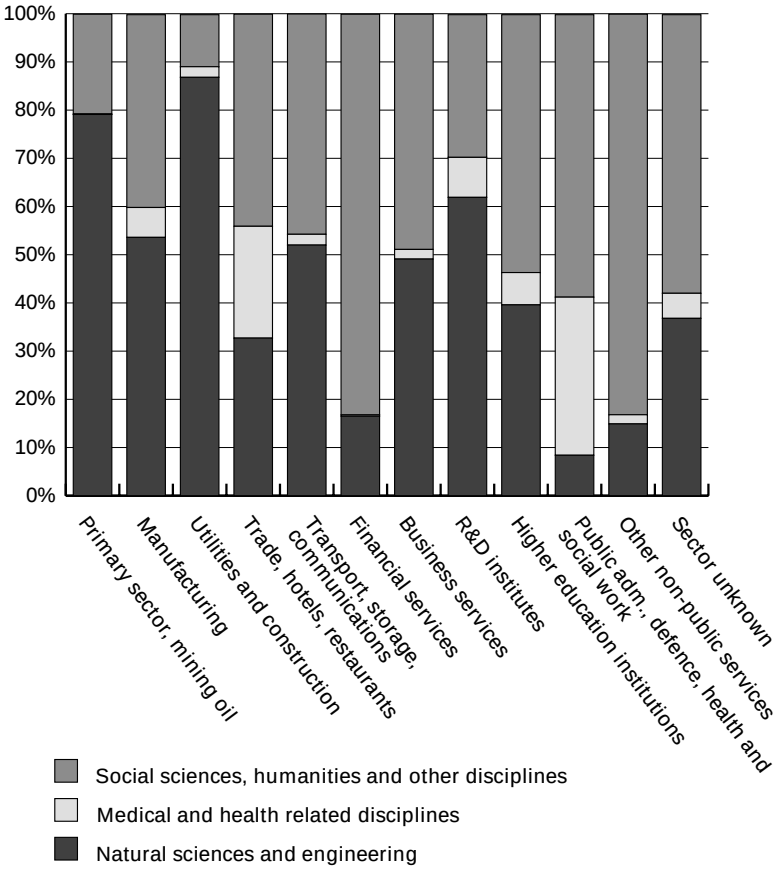
employees in the sector is almost identical to a similar ranking in the other Nordic countries. Although the ranking between the countries is similar, the shares of highly educated employees in the sectors vary between the countries. Thus, the variation between the sectors in the form of a ranking by share of highly educated employees seems to be coherent across the countries, i.e., determined by the kind of work performed in the sectors and not by national differences. The Danish evidence strongly supports the conclusion in Nås et al. (p. 29) that »the use of skills - defined by level of education - seems, therefore, to be an inherent property of the operations of the different sectors, and not a factor that is influenced strongly by the national system«.

Figure 3.5. Stock of employees by education and sector in Denmark in 1995. Percent.



Focusing again on the highly educated (ISCED=6+), Figure 3.6 gives the distribution of scientific fields by sector. Table A.8 in the Appendix shows the number of heads in each sector. Again, the distributions only show minor differences from the corresponding figures in Nås et al. These similarities among the Nordic countries confirm that sector activity, not country, determines the use of skills. Such a conclusion can only be reached from data in countries with similar institutional structures, since different institutional structures may create differences which could blur the clear conclusion found above.

Figure 3.6 Stock of highly educated employees by scientific field and sector in Denmark in 1995. Percent.



The distributions of highly educated employees by scientific field show huge variations in the share of employees in each sector. In the interpretation of the numbers in Figure 3.6, it is important to remember that the sectors have large variations in the absolute number of employees. Natural science and engineering has a share above 50% in five of the sectors. Among these are

utilities and construction, manufacturing and R&D. Social sciences, defence, health and social work dominate in 5 other sectors. Among those are naturally financial services, public administration, and other non-public services. The medical and health-related disciplines are by far the smallest group, concentrated in a few sectors. The public sector employs the largest share.
Of the three scientific fields, employees from the social sciences, humanities and other disciplines together with the natural science and engineering disciplines are employed in almost all 11 aggregate sectors, while employees educated in medical and health are employed in a few of the sectors. In the 42-sector aggregated distribution this is even clearer. Calculating inverted Herfindahl index on the 42-sector aggregated distribution give figures very similar to the other Nordic countries.

Next, three specialised sectors are chosen to represent different types of occupations. The three are used in the study by Nås et al, and for comparison their choice is followed here. First, the information and technology sector, IT, is chosen as the representative for a modern, high-tech and growing industry. Second, the pulp and paper sector is chosen as the traditional and process-intensive sector. Third, the public administration sector is chosen as the service sector outside ordinary market competition. The absolute numbers of employees by scientific field and gender in these sectors in 1995 are given in Table A.10, A.11 and A.12 in the Appendix. The absolute number of employees in the IT sector is 51,200; one third of them are women. The corresponding numbers are 10,300 employees, 25% women, in the pulp and paper sector, and 180,600 employees, 50% women, in the public administration sector. These gender differences are as expected. In the IT sector, 21% of the employees are highly educated, mainly in the natural science, engineering and social science fields. The pulp and paper sector employs the lowest share of highly educated employees: only 6%. In between, 18% of the public administration sector employees are highly educated, mainly from the social science and humanities fields.

Compared to the other Nordic countries, the Danish figures are almost identical for all three sectors. The IT sector has a smaller share of highly educated employees in this sector in Denmark, but the share from natural science and engineering is among the highest. The pulp and paper sector is small in Denmark, as in Norway, but the distribution by education resembles those of the other Nordic countries. Regarding the public administration sector, the share of highly educated employees is smaller than in the other three Nordic countries. As expected, the social science, humanities and other disciplines dominate among the highly educated in this sector. The conclusion must again be that the sectors are different in their use of knowledge, but the distribution by field of science and level of education is very similar in the countries.

4. Mobility of skilled labour as a measure of knowledge flows

Most interesting in relation to the national innovation system, NIS, is the flow of knowledge measured by labour mobility. The approach in which individual mobility is used as an approximation for exact knowledge circulation and transfers provides answers in two major areas of interest. First, are there significant differences in the patterns of knowledge circulation or general structural similarities among the countries, i.e., for cross-country comparisons? Second, are there asymmetries in the use of knowledge in the NIS, how it works, and how it is compounded?

There are many dimensions of analyses of knowledge circulation with the register data at hand. Family structures, geographical variations, urbanisation degrees, industrialisation levels, time variation, as well as other individual or country-specific characteristics could all be included in the analysis. However, since important lessons can be learned from a much simpler set-up, a more specialised and detailed analysis is postponed for future research. In this section, the fairly simple sector breakdown is presented in the text. A more detailed breakdown is given in the Appendix, although still at the sector level. A breakdown on more specialised innovation type firms is also a subject for future research, simply because they are very difficult to identify.[16]

The study of mobility rates consists of two parts. First, total mobility between 1995 and 1996 by education level, sectors, gender and age is given in this section. Second, the main delivering and receiving sectors are identified for the 11-sector aggregate by educational level in Section 5. It is analysed which sectors recruit broadly and which sectors recruit narrowly.

Mobility rates can be defined in various ways. As most of the empirical register data is measured annually, a year to year view is chosen.[17] The mobility rates are specified as both a »wide« mobility rate including new entrants and people leaving the labour force and a »narrow« mobility rate including only individuals working in both years of interest. The mobility rates will be presented by educational levels, scientific fields, age, sectors and stability in job (at least 3 years with the same employer).

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16 There is no »easy to access« information on R&D and R&D expenses in the registers. Survey information of the kind collected by the Danish Institute for Studies in Research and Research Policy could be merged by the data from Statistics Denmark. However, it will be a difficult task due to restrictions on data accessibility, merging criteria for the matches, as well as the overall financing of such a large project.

17 Month to month view, decade to decade view and so forth are also possible.

In the more static year to year analysis, the employees can be in one of three states:

1. Employees who work for the same employer both years.
2. Employees who work for different employers both years.
3. Employers who have left the active labour force the second year due to education, retirement, unemployment, etc.

In order to be included in any of these three states, the individual must be employed the first year. With the three-state definition, we do not know whether the employee is a newcomer or an experienced worker the first year. Therefore, we also use a three year mobility view with the following additional states:

a. Not employed last year, which means a newcomer from unemployment, education, another country or from another non-working state.
b. Employed by another employer last year.
c. Employed by the same employer last year.

Combined with states 1, 2 and 3 above, this gives nine states in 1995, the year of interest (see Figure 4.2 in Section 4.2).

4.1 Knowledge mobility measured as outflow by educational level

As Figure 4.1 shows, only 73% of the labour force are employed by the same employer the following year. As expected, the stability is higher for highly educated employees (ISCED=6+) with 78% stable compared to 72% for the rest of the employees on the labour market. The average rate is 73%. The difference is mainly caused by employees with low and middle-level education, who leave the active labour force more often. A split of the stability rate by men and women only shows a marginally lower stability rate for women. The corresponding numbers for all employees are 77% for Finland, 80% for Norway, and 77% for Sweden.[18] The highly educated group has a larger stability rate than the rest of the employees in both Sweden and Norway, but not in Finland. The difference is smaller than in Denmark (6 percentage points in Denmark compared to around 2 percentage points in the other Nordic countries). The major difference in relation to Denmark seems to be job stability for individuals with secondary and low education, who have lower job stability in Denmark than in the other Nordic countries. This may be explained by differences in the business cycle (unemployment rate) as well as by institutional differences in the social security systems and labour market laws and agreements between the countries.[19]

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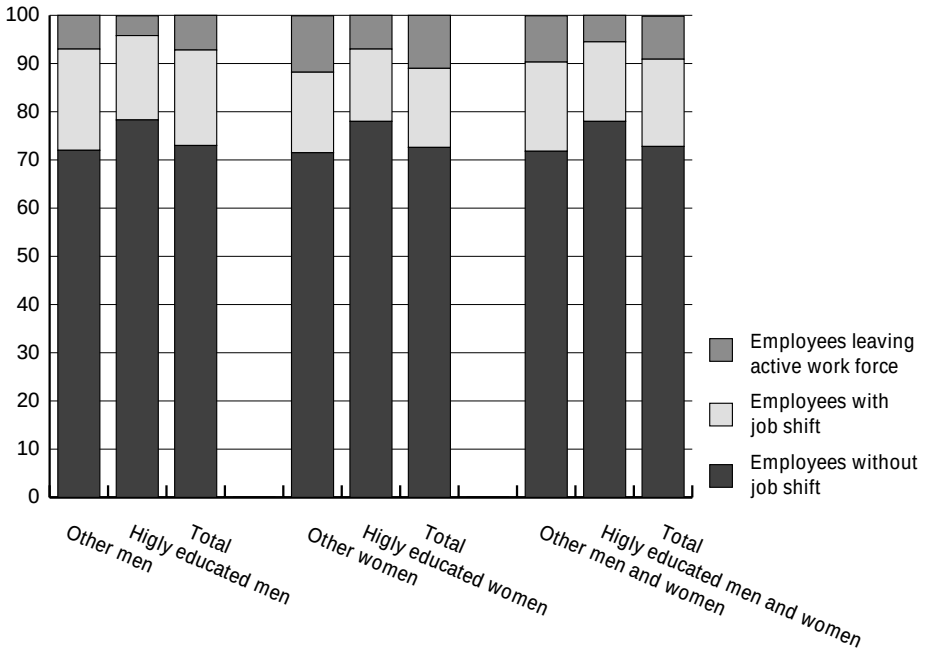
18 They also refer that only 30% of the employees in Norway in 1986 were employed by the same employer in 1994. Similarly, only 20% stayed with the same employer in Sweden between 1986 and 1993.

19 Such a »simple« matter as national rules for financing of firing costs or job security may influence the country-specific numbers heavily. Traditionally, Denmark has lower firing costs than comparable countries.

Figure 4.1 All employees and highly educated employees by type of forward job shift and gender. Percent. 1995.



There is a larger variation when we look at the mobility rate into a new job and out of the active labour force: 9% leave the active labour force, 18% find a new employer the following year, compared to 5% and 16% for highly educated employees and 10% and 19% for the other employees. Hence, we find a much more stable attachment to the labour market for the highly educated. A smaller share of men than women leaves the labour force and a larger share finds a new employer. In relation to the other Nordic countries, the Danish distribution lies somewhere in between the others. Among the highly educated, around 4% of the men and 7% of the women leave the labour force in the following year, 18% of the men and 15% of the women find a new employer. The figures are 8% and 20% for all other employed men and 12% and 17% for all other employed women.

As for whether the knowledge mobility is acceptable, the lower circulation or mobility rates for the highly educated (more innovative) employees in Denmark could be seen as a problem. On the other hand, learning and exchange of knowledge are time consuming, so the mobility rate should not be excessive.

At the same time, some of the individuals who move are from a core group of short-time employed, meaning that they often switch jobs, have a lot of experience, but not much innovative knowledge. It is important to point out that mobility of individuals both represents knowledge circulation and the employers' »right to manage« due to business cycle fluctuations as well as age profiles in the labour force. Hence, the average mobility rate over several years will be a better measure of the usual mobility rate.[20]

In Table 4.1, we use a »wide« and a »narrow« definition of mobility where we include and exclude individuals leaving the labour force. The same trend is evident no matter which definition we use. The mobility rates are considerably lower for highly educated employees compared to the entire group of employees. Focusing on the highly educated, splitting them into three scientific fields, medical science has a marginally higher »wide« mobility rate than the other groups, which is primarily caused by a high male mobility rate. Natural science and engineering has a marginally higher »narrow« mobility rate than the others, which is caused by a high female mobility rate. Social science, humanities and other fields of science have the lowest mobility rate no matter which definition we use. This holds for both men and women separately.

Table 4.1 Mobility rates for all employees, highly educated employees, and highly educated employees by scientific field. Percent of employment in 1995.

Type of employees	Type of mobility rate	Men	Women	Total
All employees	Wide	26.9	27.4	27.2
	Narrow	19.7	16.4	18.2
Highly educated	Wide	21.6	22.0	21.8
	Narrow	17.5	15.0	16.4
Natural science and engineering	Wide	21.5	26.7	22.2
	Narrow	17.0	19.4	17.4
Medical fields of science	Wide	27.6	21.9	22.9
	Narrow	24.2	15.2	16.8
Social sciences, humanities and other sciences	Wide	21.0	21.5	21.2
	Narrow	17.6	14.4	15.8

Note: »Wide« type of mobility: Including employees leaving the active labour force the following year. »Narrow« type of mobility: Excluding those leaving the active labour force the following year.

20 Holding the average mobility rate against the overall performance of the economy or the sector of interest is the best way to judge whether the mobility rate is to low, high enough or maybe to high. This is not the purpose of the presented analysis and it is postponed to another study where more years of data should be included.

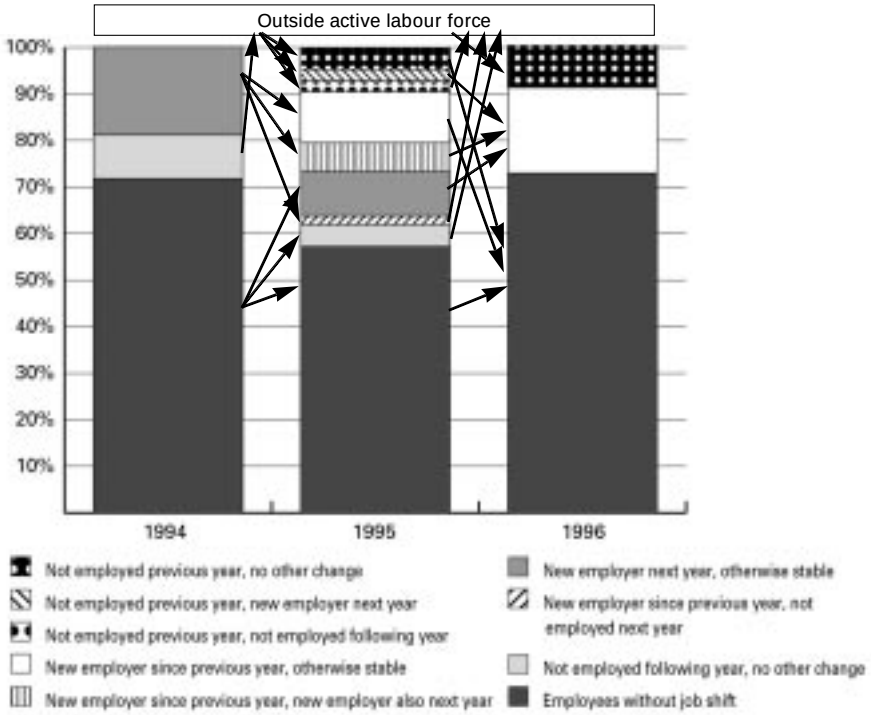
The overall mobility rate in Denmark is higher than in the other Nordic countries (4 percentage points for Sweden and Finland and 7 percentage points for Norway in the »wide« version, 2 percentage points for Sweden and 6 percentage points for Finland and Norway in the »narrow« version). For highly educated employees, the Danish figures are lower than the figures for Sweden and Finland and higher than the figures for Norway in both versions of the mobility rate, also when we split the mobility rates for highly educated employees by scientific fields.

4.2 Knowledge mobility measured by inflow and outflow by educational level

Expanding the definition of mobility with information from the year previous to the year of interest allows a further decomposition of mobility. The use of information on inflow, outflow and job stability gives nine categories. This reveals further information on the share of, for example, »stable« workers employed by the same employer all three years, »shifters« or »nomads« moving every year, or »pop ups« who are inactive both the year before and after the year of interest. The Danish mobility rates are given in Figure 4.2 (and Table A.15 in the Appendix) where the year of interest is 1995.

Using the broader definition of mobility naturally gives a lower rate of »stable« employees. Only 57% have the same employer in all three years, compared to 62% for Norway and Finland. Hence, the residual mobility rate in Denmark of 43% is larger than in these two Nordic countries. There are no figures for Sweden.

Figure 4.2 Permanent and mobile employees by type of mobility 1994-1996. Percent.

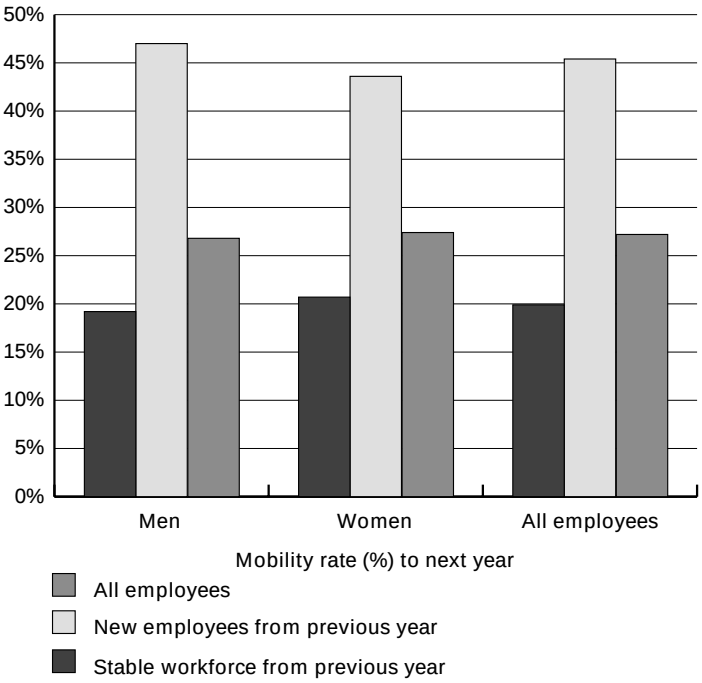


The major part of the three kinds of inflow from either »out of the labour force«, »new employer« or »same employer« stays with the same employer the following year (category 3, 6 and 8). They can be characterised as being or becoming job stable and encompass the most valuable group due to their accumulated experience, not only for the present employer but also for subsequent employers. The 57% in category 6 are the most stable employees, staying with the same employer all three years. A small part of the inflow from all three groups leaves the labour force the following year (category 4, 7 and 9). Category 1 has the same employer as last year, but a new next year. The employees in this category have accumulated at least two years of experience in their earlier job and must therefore be more valuable than, for example, category 2 employees, who do not have experience from the previous year. There are 11% of the employees in category 1 in Denmark compared to 7-8% in Norway and Finland. The 2% in category 2 come from outside the labour force and shift employer again next year. Finally, the 6% »nomads« in category 5 shift employer each year.

4.2.1 Aggregated mobility rates for »stable« and »new« employees

The aggregated mobility rates are 20% for »semi-stable« employees (employed by the same employer last year) and 45% for »new« employees (not employed by the same employer last year), a significant difference. The weighted average is 27% as referred in Table 4.1. The difference in mobility rates reveals that the loss of experienced employees is more serious and worth preventing by wage increases, improved work conditions, etc., and that the high mobility rate for »new« employees represent a »trial and error« process for both employee and employer. The »trial and error« argument is supported by the fact that »new« employees, on average, are younger than »semi-stable« employees are. Table A.16 in the Appendix refers the mobility rates split by employee type and gender. The gender differences are small, as Figure 4.3 shows.

Figure 4.3 Mobility rates for »semi-stable« and »new« employees by gender. 1995.



Compared to Norway and Finland, the shares for Denmark in Figure 4.2 are broadly similar. All in all, the variations between the Danish and the Norwegian and Finnish figures are small in magnitude, although still important. The tendencies are very similar.

4.3 Outflow by age for the active labour force

Returning to the year to year definition of mobility based on outflows alone, Figure 4.4 shows the age distribution in absolute numbers of all employees in Denmark in 1995 by their mobility type. Figure 4.5 shows the similar relative age distribution for all employees and for men and women separately. The age distribution is important in relation to the »stable« versus »new« employee discussion above. A country or a sector with unusually many elders is forced to have a high mobility rate for the »stable« (and probably older) employees who leave the labour force. At the same time, the mobility rate could be either lower or higher for the »new« employees, since their employers have a higher interest in keeping them (lower mobility rate), and since they receive more job offers from other employers (higher mobility rate). As many other countries, Denmark also has an unevenly distributed population (WW-2 generation etc.)

Figure 4.4 Age distribution of all employees by type of mobility. Absolute numbers. 1995.

Figure 4.5 Relative age distribution of all employees by type of mobility and gender. 1995.

5. Overall mobility by delivering and receiving sectors

In Section 4, we found that mobility involves a large part of the labour force and that the mobility rates varied by educational level, scientific fields, gender and age. This section analyses whether the mobility rates vary by sectors, by educational level and sectors, and how the inflow and outflow to the different sectors are composed, i.e., the major delivering and receiving sectors. The last part can answer, for example, whether there are knowledge transfers in and out of the publicly financed research institutes. In order to simplify the presentation later in Section 5, an 11-sector aggregate breakdown is used (see Section 3 for the definition). When suitable, as in Section 5.1, we use a more detailed 42-sector aggregate.

5.1 Mobility rates for all employees by sector and educational level

To analyse which sectors may have a higher mobility rate than others, the mobility rates for the 42 sectors are referred in Table 5.1. The mobility rates are measured as the outflow in each sector from 1995 to 1996. Both the »wide« mobility rates, including job to job mobility as well as leaving the active labour force, and the »narrow« mobility rates, only including job to job mobility, are given.

In general, we find huge sector variations in the mobility rates no matter which definition we use. The standard deviation of the mobility rates is 7.7 for the »wide« and 7.1 for the »narrow« definition. Hence, an average mobility rate for the entire economy may be quite misleading for policy recommendations and for a precise analysis of the NIS. The large variation in the mobility rates would decrease with the degree of sector aggregation, but the variation is still present within the sectors as well. Over time, the mobility rates within the sectors may vary, but presumably less than between the sectors. However, we expect the differences in the mobility rates between the sectors to be relatively persistent over the years. Naturally, with a time span of a decade or two this does not hold.

Table 5.1 Mobility rates for all employees by 42 sectors.
Percent of employees. 1995.

Sector	All employees		Highly educated	
	Wide	Narrow	Wide	Narrow
Agriculture, hunting and related service activities	44.2	31.7	40.5	26.2
Forestry, logging and related service activities	31.9	28.5	8.4	5.9
Fishing, operation of fish hatcheries and fish farms	46.6	26.7	33.3	27.8
Mining and quarrying	20.0	13.2	8.6	4.8
Food products; beverages and tobacco	26.4	14.9	26.8	16.2
Textiles and textile products	26.9	17.3	22.9	21.4
Wood and of products of wood	29.7	23.2	31.1	29.4
Pulp and paper products	18.6	6.0	23.8	3.6
Publishing, printing and reproduct. of recorded media	25.2	17.6	24,6	19.1
Coke, refined petroleum products, nuclear fuel	19.4	9.5	10.2	2.9
Chemicals and chemical products	16.0	10.6	5.1	3.1
Basic chemicals	40.9	38.6	41.4	36.8
Pharmaceutical preparations	38.7	32.3	35.8	30.2
Rubber and plastic products	18.7	8.8	7.1	5.7
Non-metallic mineral products	18.0	12.9	31.9	30.5
Basic metals	15.1	10.1	4.9	4.0
Fabricated metal products	25.3	17.1	18.8	13.0
Machinery and equipment n.e.c.	22.1	15.4	21.6	17.2
Office machinery and computers	36.2	19.7	21.3	18.7
Electrical machinery and apparatus n.e.c.	22.8	15.1	17.3	15.5
Radio, television and communication equipment	17.6	10.7	14.5	13.4
Medical, precision and optical instruments	25.1	18.2	35.2	28.8
Transport equipment	22.9	13.9	37.1	21.2
Manufacturing n.e.c.	29.7	18.7	21.9	20.5
Electricity, gas and water supply	18.3	11.9	16.3	15.0
Construction	30.4	22.8	21.5	14.6
Wholesale and retail trade	23.9	17.1	21.1	17.2
Wholesale of machinery and equipment	39.6	26.4	27.0	17.2
Transport and storage	28.1	19.9	26.8	20.2
Post and telecommunications	38.3	29.9	59.9	52.1
Financial intermediation	23.8	18.8	27.7	24.5
Other, mainly private services	31.9	21.7	32.8	28.3
Computer and related services	28.5	24.5	25.3	23.7
Research institutes, technology	23.9	14.6	24.2	20.2
Research institutes, social sciences	25.7	22.1	21.5	16.5
Other business activities	27.9	19.4	24.2	18.6
Architectural and engineering activities	20.7	15.5	17.0	14.1
Technical testing and analysis	15.4	14.1	24.6	20.6
Public administration	25.3	15.6	19.8	14.0
Higher education institutes	32.6	22.0	28.0	21.6
Other non-public services	25.8	15.5	20.4	15.6
Total	27.2	18.2	21.8	16.4

Note: »Wide« type of mobility: Including employees leaving the active labour force the following year. »Narrow« type of mobility: Excluding those leaving the active labour force the following year.

If the Danish mobility rates are compared to the corresponding mobility rates for the other Nordic countries, there are many deviations. This is also the case in a comparison between the other Nordic countries. Nås et al. refer a simple correlation coefficient for the mobility rates by sectors between Norway and Finland of 0.54 in the »wide« and 0.31 in the »narrow« definition. With the »wide« definition, we find simple correlation coefficients of 0.39, 0.35 and 0.16 between Denmark and Sweden, Norway and Finland respectively. With the »narrow« definition, the corresponding correlations are 0.22, 0.14 and 0.05. Thus, even with a relatively broad breakdown on 42 sectors, the national labour market structures generally dominate the mobility rates more than the specific sector characteristics. Hence, a cross-country comparison based on mobility rates for 42 »comparable« sectors is not generally possible, not even between similar countries as the Nordic countries, and a comparison based on such a breakdown requires much more control for national institutional differences among the countries. However, the 42-sector breakdown is still quite suitable for a single country study.

Given the large deviations in the results concerning all employees, we now look at the highly educated employees (ISCED=6+). Two questions are now of major interest: First, whether the mobility rates for highly educated employees deviate compared to the mobility rates for all employees. Second, whether the mobility rates for highly educated employees more similar across countries.

A breakdown of the mobility rates for highly educated employees by 42 sectors also gives considerable variations in the rates, no matter whether we use the »wide« or the »narrow« definition. Table 5.1 refers the mobility rates by sectors. The average values are smaller as found in Table 4.1, although the variability in the mobility rates are similar to the variability found in Table 5.1 for all employees. Hence, there does not seem to be less variability in mobility rates for highly educated employees between the sectors. Comparing the mobility rates for Denmark with the corresponding figures for the Nordic countries disappoints again. There are some similarities, but no clear tendency. Thus, we must conclude that national variation in the labour market matters more for the mobility rates than the skills defining the 42 sectors.

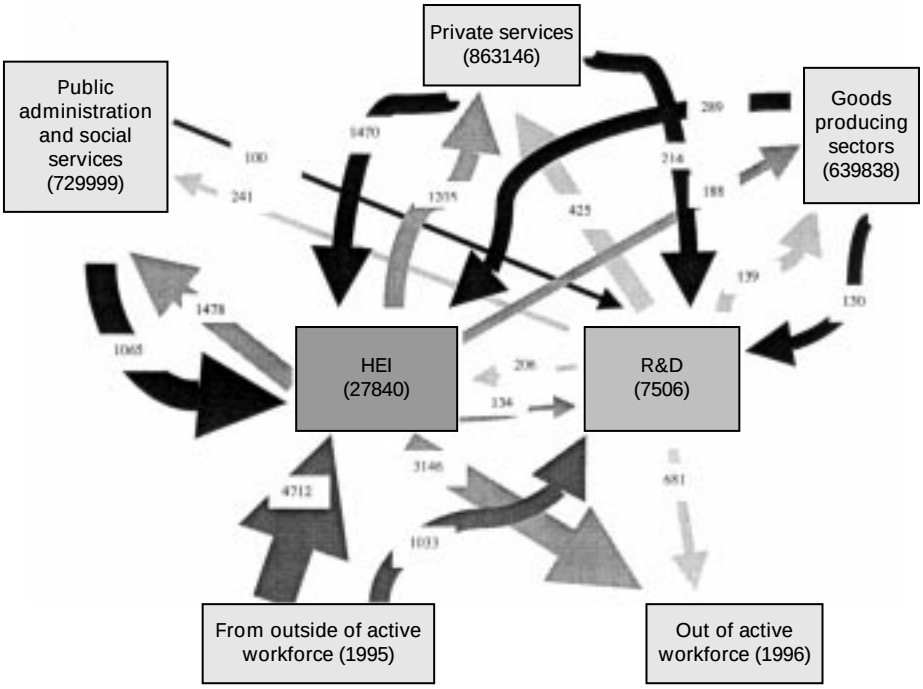
5.2 Mobility rates for all employees by delivering and receiving sectors

Instead of the diffusing pictures drawn on the basis of outflow mobility in the 42 sectors, we will now focus on flows between the 11 sectors defined in Section 3. This means less information on the national level, but higher comparability among the countries. Table 5.2 gives the outflow mobility rates by delivering sector in 1995 against the inflow mobility rates by receiving sector in 1996. Hence, the total number of employees is expanded with individuals who are not employed in 1995, but employed in 1996. This means an extra »out of the labour force sector« in both years. The referred mobility rates include both job to job mobility as well as out of the active labour force in 1995 and into the active labour force in 1996, i.e., »wide« mobility rates as defined in Section 4.1. The absolute numbers are referred in Table A.18 in the Appendix. The purpose of this input-output table is to find the main delivering and receiving sectors relative to the two innovative or dominating sectors in the NIS, namely HEI and R&D institutes. The flowchart in Figure 5.1 concentrates on these two sectors and shows the mobility into and out of these two. Hence, the flows between the other sectors are not illustrated in Figure 5.1. To simplify the figure, the other sectors are aggregated into three groups: Public administration and social services, private services, and the goods producing sectors.[21] Attached to the arrows in the flowchart is the number of individuals moving (the flow between 1995 and 1996), and for each box the number of individuals in this sector (the stock in 1995) is stated.

Figure 5.1 illustrates the main flows between the NIS sectors and the rest of the economy. The flow between the HEI and R&D sectors is small in absolute numbers, but relatively as large as to the other sectors. The net flow goes from the R&D sector to the HEI sector. There are large differences in the net flow from these two NIS sectors. There is a net outflow from the R&D sector to all other sectors, but only to the public sector from the HEI sector. The dominating flow is in and out of the active labour force, but the public sector and private services comes next. The HEI sector is larger than the R&D sector which results in larger absolute flows. Relatively, the flow from the R&D sector is sometimes larger and sometimes smaller than the flows from the HEI sector. For the HEI sector, the knowledge circulation goes to and from public and private services. For the R&D sector, the knowledge circulation goes to and from private services. The exchange to and from the goods producing sector is small for both NIS sectors.

21 »Private services« are trade, transport, finance, business and other non-public services, while the »goods producing« sectors are primary sectors, manufacturing, utilities and construction.

Figure 5.1 Mobility for all employees by delivering and receiving sectors. Absolute numbers. 1995.



Note: »Private services« are trade, transport, finance, business and other non-public services, while the »goods producing« sectors are primary sectors, manufacturing, utilities and construction.

Table 5.2 shows, on a more detailed level than Figure 5.1, that for most sectors internal mobility dominates together with movements in and out of the active labour force. Hence, the most common type of mobility is to a new employer inside the same sector. For the two NIS sectors in particular, self-recruitment seems to be somewhat smaller compared to the other sectors, a result that is partly dictated by the choice of sectors. 28% of the movers in the HEI sector move to another HEI workplace. 17% of the movers move to the public sector (this is partly explained by the large public sector group), while 8% move to business services, and 4% to other non-public services. Only a small fraction moves to the R&D sector or to the private production sectors. Hence, it seems like the movers from the HEI sector mainly move to sectors with services, and mainly public services (including HEI itself). The R&D sector has the smallest self-recruitment, 7%, of all sectors. The movers from this sector go to private as well as public sectors: 11% to the HEI sector, 13% to the public sector, and around 7% to each of the business, trade, transport, and manufacturing sectors. The largest receiving sector of personnel from the NIS sectors is the public sector. The largest delivering sectors of personnel to the NIS sectors are the

HEI and R&D sectors themselves. The large delivering rate from R&D and the other sectors indicates a large amount of knowledge flows. Unfortunately, R&D is the smallest group of all in absolute numbers. The internal flow in the NIS sectors goes clearly from R&D to HEI. Taking the absolute numbers in the sectors into consideration gives a more equal flow between the two sectors, although still in the same net direction.

Compared to the findings for Sweden, Norway and Finland, the numbers in Table 5.2 illustrate several similarities. Although self-recruitment and the large fraction leaving the active labour force are common for all the countries, the net flow from R&D to HEI is opposite the Swedish experiences, but similar to the Norwegian and Finnish experiences.

Table 5.2 Mobility rates of all employees by delivering and receiving sectors. Percent. 1995-96.

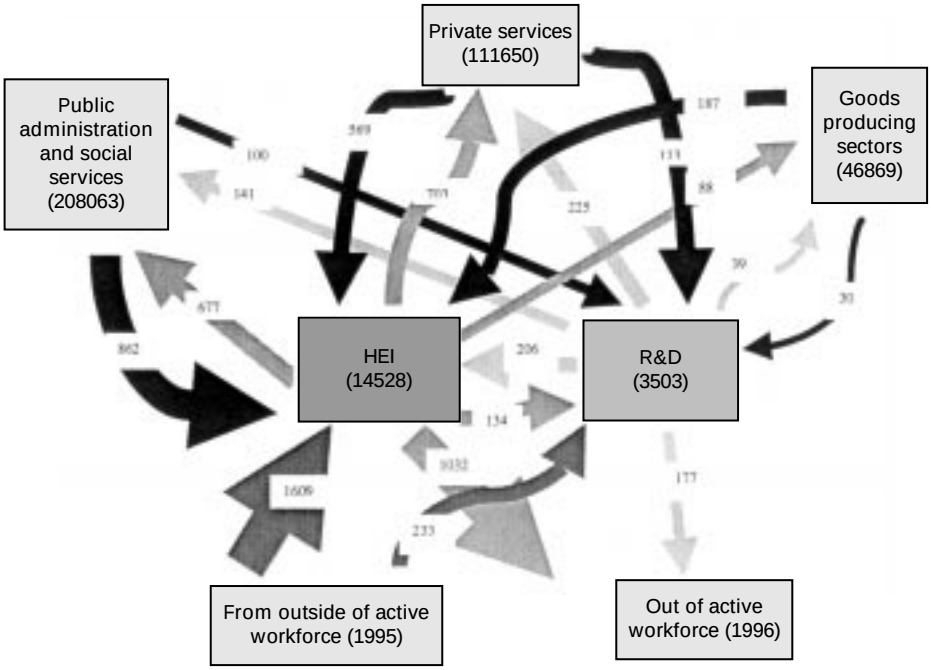
Delivering sector (1995) ➜ ↓ Receiving sector (1996)	Primary sectors, mining, oil	Manufacturing	Utilities and construction	Trade, hotels, restaurants	Transport, storage, communication	Financial services, real estate	Business services	R&D institutes	Higher education institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	Mobility rate in
Primary sectors, mining, oil	29.7	1.5	1.5	0.4	0.4	0.6	0.8	0.2	0.1	0.2	1.1	0.2	2.3	14770	40818	36.2
Manufacturing	7.9	35.1	7.8	6.8	5.2	0.7	5.2	7.3	1.9	2.1	5.8	0.0	16.1	103361	460164	22.5
Utilities and construction	3.6	3.8	42.8	1.3	1.7	1.7	3.6	0.2	0.1	0.8	1.9	24.4	5.3	42136	142610	29.5
Trade, hotels, restaurants	6.7	7.1	3.2	36.1	5.8	1.8	10.1	6.5	0.6	3.0	5.0	24.6	17.2	108177	349380	31.0
Transport, storage, communication	3.1	2.0	2.2	5.4	47.7	1.7	4.7	8.3	0.3	0.8	1.2	0.0	6.0	52686	158116	33.3
Financial services, real estate	0.0	0.5	0.3	0.1	0.5	55.4	1.5	0.2	1.4	0.2	0.8	0.2	1.6	16727	78880	21.2
Business services	2.5	2.9	3.8	3.0	2.3	7.1	26.1	7.5	7.7	1.6	2.7	0.0	7.5	45068	149183	30.2
R&D institutes	0.0	0.1	0.0	0.1	0.0	0.0	0.1	6.6	1.6	0.1	0.1	0.0	0.4	1730	7503	23.1
Higher education institutes	0.0	0.2	0.3	0.5	0.3	0.6	0.4	11.4	28.4	0.6	1.7	0.0	1.8	10184	26346	38.7
Public adm., defence, health and social work	3.8	4.6	3.7	6.4	3.5	5.2	8.6	13.3	17.2	42.6	11.8	0.2	36.1	194735	712589	27.3
Other non-public services	3.6	1.6	2.0	2.0	1.7	0.7	3.5	1.1	4.1	1.9	20.2	0.0	5.7	31892	105710	30.2
NACE Unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6	6	100
Out of active labour force	39.1	40.7	32.5	37.8	30.9	24.6	35.3	37.6	36.6	46.1	47.6	50.2	0.0	241090	241090	100
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	862562	2472395	34.9[1]
N persons moving (=100%)	16580	112860	41357	108964	48989	18749	40266	1811	8593	180205	27286	410	256492			
N persons employed	39296	455710	144832	357893	162785	76856	155485	7506	27840	729999	110127	410	256492			
Mobility rate out	42.2	24.8	28.6	30.4	30.1	24.4	25.9	24.1	30.9	24.7	24.8	100	100			

Note 1) If the category »out of active labour force« is excluded, the mobility rate in is 27.9%.

5.2.1 Mobility rates for highly educated employees by delivering and receiving sectors

This subsection gives an input-output table (Table 5.3) and a flowchart (Figure 5.2) for highly educated employees (ISCED=6+) similar to the table and chart in the section above. As in Table 4.1, the flows (mobility rates) for highly educated employees are, on average, smaller than the flows for all employees. Table A.19 in the Appendix gives the absolute numbers.

Figure 5.2 Mobility of all highly educated employees by delivering and receiving sectors. Absolute numbers. 1995.



Note: »Private services« are trade, transport, finance, business and other non-public services, while the »goods producing« sectors are primary sectors, manufacturing, utilities and construction.

The basic pattern for the highly educated is quite similar to the pattern for all employees: The absolute numbers are smaller, but the relative numbers in Table 5.3 are not much smaller. The self-recruitment rates are slightly higher, so internal flow of highly educated employees is more dominant for all sectors. Again, we see a flow from the HEI sector to the public and the business sectors, but now there also seems to be a significant flow to the manufacturing sector. Dominant flows from R&D are again to the HEI, public and transport sectors.

The other dominant sectors that emerge from the view on all employees are now less dominant. The main delivering sectors to the HEI sector are R&D, public and non-public services. The main delivering sector to the R&D sector is HEI. Again, the flow goes mainly from R&D to HEI, although the absolute numbers are more equal. All in all, there is a net flow into the NIS sector which is driven by a net inflow to the HEI sector.

Compared to the other Nordic countries, most of the findings are similar. Again there is a large dominating flow into and out of the active labour force; again the net flow goes from R&D to HEI, opposite of the Swedish experience, but similar to the Norwegian and Finnish experience. This cannot be explained by a much larger HEI sector in Sweden as the distribution 5:1 is similar to the proportion in Denmark, and the high internal mobility is also a common feature. As in Denmark, the overall similarities in the country-specific patterns for all employees and for highly educated employees are valid for the other three Nordic countries.

Table 5.3 Mobility rates of highly educated employees by delivering and receiving sectors. Percent. 1995-96.

Delivering sector (1995) ➜ / ↓ Receiving sector (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 institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	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	10.0	0.6	470	1632	28.8
Manufacturing	31.5	44.9	6.6	11.1	6.1	0.9	7.3	3.6	4.3	1.1	4.7	0.0	7.4	9341	34301	27.2
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	0.0	1.9	1731	8654	20.0
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	10.0	6.6	6553	24819	26.4
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	0.0	4.1	4479	9750	45.9
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	10.0	2.1	3319	11246	29.5
Business services	16.5	9.1	4.4	13.0	7.6	12.6	34.1	3.9	9.2	2.4	3.5	0.0	12.3	11251	39658	28.4
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	0.0	0.8	729	3420	21.3
Higher education institutes	0.6	0.9	0.3	1.3	0.8	0.5	1.7	22.7	29.5	2.0	6.6	0.0	5.4	4475	12886	34.7
Public adm., defence, health and social work	3.8	7.0	12.2	12.1	10.4	11.4	10.9	15.6	17.5	55.6	23.5	10.0	52.6	45371	191373	23.7
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	0.0	6.2	5372	16968	31.7
NACE unknown	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6	6	100
Out of active labour force	11.7	27.7	33.0	22.5	18.1	12.0	19.5	19.5	26.6	34.4	27.1	60.0	0.0	25287	25287	100
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	118384	380000	31.2
N persons moving (=100%)	677	9329	1950	7019	4069	3340	9728	907	3874	43804	3957	10	29720			
N persons employed	1493	36653	8723	26041	11071	11629	43328	3503	14524	208063	19581	10	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	100			

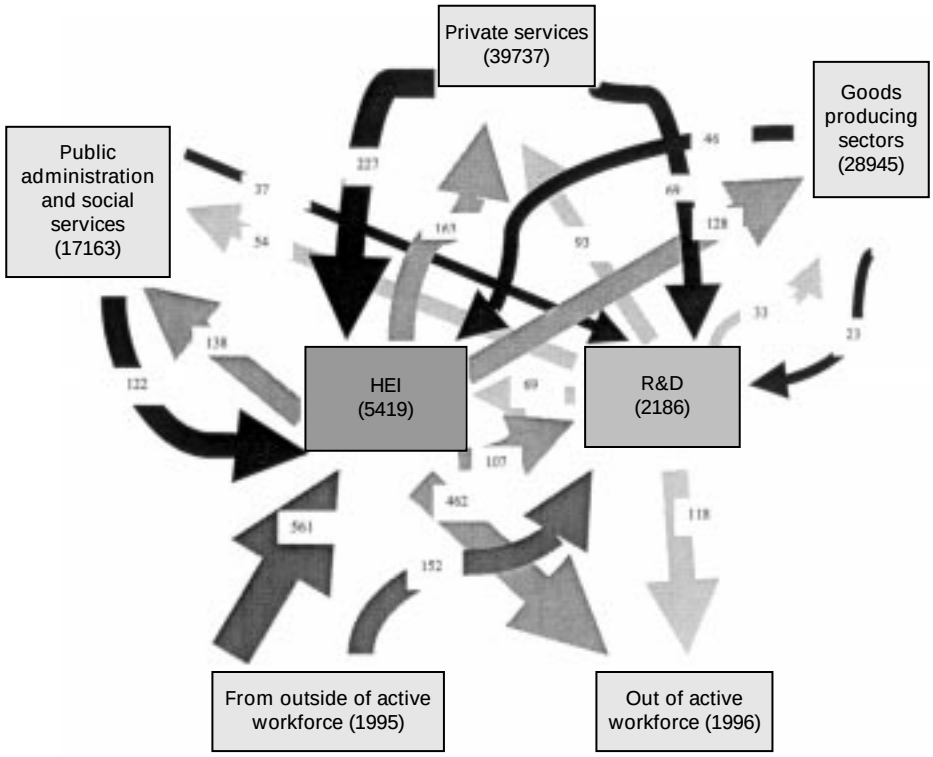
5.2.2 Mobility rates for highly educated employees within the natural science and engineering field by delivering and receiving sectors

An interesting subsample of the highly educated is employees in the natural science and engineering field. The subsample is the major contributor to the Human Resources for Science and Technology group, HRST. The HRST group is defined by OECD and Eurostat as the ideal for an analysis of the national innovation system, NIS. This section follows the methodology used above, presenting a flowchart in Figure 5.3 and an input-output table in Table 5.4. The absolute numbers are given in Table A.20 in the Appendix.

The overall flow patterns for employees in the natural science and engineering group are similar to what we have seen so far for all employees and for all highly educated employees. However, the flow from R&D to HEI is relatively smaller, which means that the absolute flow now goes from HEI to R&D for this subgroup of the highly educated. There is also a significant net inflow for both NIS sectors. Opposite the other Nordic countries, it also seems like the link to the public sector is of significant importance for the two NIS sectors. Individuals leaving HEI go mainly to all three large sectors in Figure 5.3, but also to the R&D sector. Movers from R&D go mainly to HEI, public and private services (transport sector). As in the earlier figures, there is also a significant flow from the public sector to the HEI (and a minor to R&D) sector. Unlike the other Nordic countries, the manufacturing sector receives a fair, but small share of employees from the NIS sectors.

In contrast to the Swedish case, there seems to be larger knowledge circulation in Denmark, since the employees in the natural science and engineering group are much more spread out between the other sectors. The Danish pattern looks more like the Norwegian and Finnish findings.

Figure 5.3 Mobility of all highly educated employees within natural science and engineering by delivering and receiving sectors. Absolute numbers. 1995.



Note: »Private services« are trade, transport, finance, business and other non-public services, while the »goods producing« sectors are primary sectors, manufacturing, utilities and construction.

Table 5.4 Mobility rates of highly educated employees in natural science and engineering by delivering and receiving sectors. Percent. 1995-96.

Delivering sector (1995) ➜ / ↓ Receiving sector (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 institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	Mobility rate in
Primary sectors, mining, oil	37.7	0.1	0.1	0.3	5.9	0.2	0.1	0.7	0.7	0.3	0.2	33.3	0.7	315	1123	28.0
Manufacturing	33.6	51.7	8.5	17.4	7.1	1.2	10.6	5.8	8.0	4.8	4.9	0.0	20.6	5545	18480	30.0
Utilities and construction	0.6	0.4	32.8	4.7	0.5	0.7	5.9	0.7	0.5	3.6	0.6	0.0	4.5	1290	7805	16.5
Trade, hotels, restaurants	2.2	8.3	1.1	31.1	1.3	1.2	7.4	3.5	1.4	1.3	2.7	33.3	8.4	2190	7771	28.2
Transport, storage, communication	1.3	0.6	8.2	5.9	61.1	0.7	2.1	8.6	1.2	0.8	1.6	0.0	7.5	2043	5136	39.8
Financial services, real estate	0.0	0.2	0.2	0.2	0.1	49.5	3.1	0.2	0.4	0.2	0.6	0.0	3.5	698	1939	36.0
Business services	1.9	6.1	4.7	15.6	3.0	35.5	35.6	6.0	11.3	5.4	9.1	0.0	22.4	4471	19047	23.5
R&D institutes	0.3	0.4	0.1	0.4	0.2	0.5	0.9	20.9	7.7	1.1	3.3	0.0	2.2	485	1987	24.4
Higher education institutes	0.0	0.8	0.3	1.8	1.2	0.5	1.9	14.8	23.8	3.8	3.3	0.0	8.0	1292	5060	25.5
Public adm., defence, health and social work	4.4	5.0	8.7	2.5	1.6	2.2	9.3	11.6	9.9	37.1	11.7	0.0	18.6	3630	15475	23.5
Other non-public services	0.3	0.2	14.8	0.6	0.4	0.0	1.0	1.7	1.9	1.9	16.1	0.0	3.7	719	2462	29.2
NACE unknown	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	4	100
Out of active labour force	17.8	26.3	20.5	19.6	17.7	7.9	22.2	25.4	33.2	39.7	46.0	33.3	0.0	5496	5496	100
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	28178	91785	30.7
N persons moving (=100%)	321	4976	1397	2368	1708	592	4153	464	1393	3250	515	3	7038			
N persons employed	1169	20122	7654	8263	5722	2085	20762	2186	5419	17168	2905	3	7038			
Mobility rate out	27.5	24.7	18.3	28.7	29.8	28.4	20.0	21.2	25.7	18.9	17.7	100	100			

5.3 Identification of effective receiving sectors by delivering sectors

Section 5.1 and 5.2 have shown complex but comparable mobility patterns. In this section, we use the inverted Herfindahl statistics to determine the number of effective or important sectors that the sectors deliver employees to. By this measure, we identify preferences among employees who shift from a specific sector based on their move to all the other sectors or just to a few selective sectors. The size of such an indicator is important if the number of receiving sectors indicates whether the skills embodied in the movers are of general (all-around experience) or specific (job or skill-specific experience) use in the receiving sector. Thus, the number of receiving sectors measured by the indicator should be lower for highly educated employees compared to all employees on the labour market, since highly educated employees are specialists rather than generalists.

In the comparison of the Nordic countries, the number of receiving sectors could be used to pinpoint similarities or differences in the behaviour by movers from the different sectors. The interpretation in the cross-country comparison is easiest if the patterns are similar, and becomes very complicated if the patterns are different. In the latter case, it could mean that national differences in the institutional structures on the labour market dominate and offset the effects we would like to compare, but it could also mean that our measure is useless.

We calculate the Herfindahl index from the relative distribution of outflow in 1995 on receiving sectors in 1996 and use the 42-sector aggregate described earlier. The inverse of the Herfindahl index can be interpreted as the number of effective receiving sectors. The value lies between 1 and 42. The results are referred in Table 5.5 for all employees and for highly educated employees.

Table 5.5 Number of effective receiving sectors by delivering sector for all employees and for highly educated employees. 1995. Inverted Herfindahl indexes based on a 42*42 sector input-output matrix.

Delivering sectors	All employees	Highly educated
Agriculture, hunting and related service activities	4.1	5.6
Forestry, logging and related service activities	4.6	1.5
Fishing, operation of fish hatcheries and fish farms	2.3	3.0
Mining and quarrying	5.4	4.1
Food products; beverages and tobacco	3.2	3.5
Textiles and textile products	4.6	2.1
Wood and of products of wood	6.3	1.7
Pulp and paper products	1.6	1.4
Publishing, printing and reproduction of recorded media	4.3	3.5
Coke, refined petroleum products, nuclear fuel	2.0	1.8
Chemicals and chemical products	4.8	4.6
Basic chemicals	2.5	2.2
Pharmaceutical preparations	3.4	3.6
Rubber and plastic products	3.3	3.2
Non-metallic mineral products	4.3	2.5
Basic metals	4.3	8.5
Fabricated metal products	4.5	2.4
Machinery and equipment n.e.c.	5.6	5.5
Office machinery and computers	3.6	8.0
Electrical machinery and apparatus n.e.c.	4.5	2.4
Radio, television and communication equipment	4.2	4.5
Medical, precision and optical instruments	5.3	4.1
Transport equipment	4.0	2.8
Manufacturing n.e.c.	4.4	3.3
Electricity, gas and water supply	3.0	3.5
Construction	3.5	4.9
Wholesale and retail trade	4.7	9.0
Wholesale of machinery and equipment	3.6	6.3
Transport and storage	3.3	4.0
Post and telecommunications	2.7	4.8
Financial intermediation	2.7	2.8
Other, mainly private services	4.9	5.8
Computer and related services	4.9	5.0
Research institutes, technology	4.8	7.4
Research institutes, social sciences	2.9	2.9
Other business activities	4.3	5.8
Architectural and engineering activities	4.7	5.0
Technical testing and analysis	5.2	4.6
Public administration	2.5	2.3
Higher education institutes	4.0	5.1
Other non-public services	3.5	4.4
Sector unknown	6.3	3.4

First of all, Table 5.5 shows large variations in the number of user sectors for the different delivering sectors, from less than two up to nine. The two NIS sectors are in no way special compared to the other sectors. However, internally the tendency is that the technological research institutes deliver more broadly than social research institutes, with the higher education sector in between. This picture was also present in the analysis in Section 5.2, and Table 5.5 more or less confirms those findings. There does not seems to be any systematic pattern in the numbers. The number of receiving sectors is neither smaller nor larger for highly educated employees compared to all employees. The conclusion is similar for shrinking and expanding sectors, for male and female-dominated sectors, etc. Hence, the numbers are illustrative for the sectors themselves, but there seems to be no systematic and easily explainable pattern in the numbers by sectors.

Compared to the other Nordic countries, the number of user sectors in Table 5.5 are generally equal or smaller. The number of user sectors vary considerably in these countries as well. The number of user sectors is higher on average in Sweden compared to Norway and Finland. Neither we nor Nås et al. find any systematic pattern between sectors that scores high and low numbers, neither internally in the countries nor among the other Nordic countries. Nås et al conclude that the numbers generally is neither higher nor lower for sectors with high shares of highly educated employees. They finally conclude that a cross-country comparison using these Herfindahl indexes is not possible. We end up with the same conclusion, since the Danish numbers seem to fit in anywhere and nowhere in the patterns of the other Nordic countries. At best, the Danish numbers are closest to the Finnish findings, followed by the Norwegian findings. The Swedish numbers are generally, but not always, higher than the Danish ones.

The hypothesis set up at the beginning of Section 5.3 does not seem to be confirmed. This may indicate important differences in the way the labour markets work. Hence, the national institutional structure seems to be the main determinant of the mobility patterns across sectors on the 42-sector aggregated level. In general, the differences across the countries in their labour market composition and labour market rules may explain the large variations. Such a detailed investigation is postponed to future research since the present report is an initial analysis of common trends in Denmark and the other Nordic countries. However, the number of receiving sectors still tells part of a story on the NIS system, for example, that the Swedish number of receiving sectors generally seems to be larger than in the other Nordic countries. This indicates a weaker sector segregation in Sweden, perhaps caused

by the effective labour market programmes and the historically low unemployment rate in Sweden. Norway and Finland are, on average, more equal. With respect to Denmark, the findings in Table 5.5 indicate a quite narrow recruiting pattern, since the sectors seem only to deliver employees to themselves and a few other sectors.

Focusing on the two NIS sectors, we calculate around 5 receiving sectors. This corresponds best to the Norwegian and Finnish findings (around 4), but less than in Sweden (around 10). In the long run, such differences in the number of receiving sectors influence knowledge distribution among the countries. A low number says that research knowledge is kept within the research environment. If research knowledge is transferred to the surrounding environment through other channels than human capital mobility, this does not cause trouble. However, if everything else is equal, a high number of receiving sectors is better as long as it is not too high, since a very high number would indicate that high level research is performed at many small workplaces or research units. Basically, a certain degree of centralisation or critical mass in the research environments is necessary in order to increase the synergy effects.

6. Conclusion and projects for future work

The present report is the Danish description of the innovation system in terms of stocks and flows of human resources. The stock and flow of employees in the economy are chosen as indicators of knowledge circulation. A large part of the groupings and definitions in this report were chosen to make the outcome comparable with the findings for Sweden, Norway and Finland. However, there are many possible pitfalls in a cross-country comparison, and differences and similarities are described and commented in the report given this in mind.

The analysis focuses especially on highly educated employees and the two NIS sectors, R&D institutes and HEI, higher education institutes. Human resources are divided by several broad categories, such as level of formal education, scientific fields, sectors, age and gender as well as combinations of these categories. An attractive element in the analysis of the national innovation system is the use of register data where information on the entire population is available. The human resource indicator measured by formal education is one out of many possibilities for an analysis of the NIS. Due to the register data stored in all the Nordic countries, it is one of the most promising in a cross-country study. Change of workplace is then used as an indicator for knowledge mobility and circulation.

Even though indicators based on human resources are an easy approach, they also have some pitfalls. We can only measure volume and not quality, although the breakdown by formal education is an attempt to indicate the quality of the employees. Another problem with our mobility indicator is that knowledge transfers that do not include a job shift are not measured. A more detailed breakdown of the mobility rates by tenure and experience, firm performance, R&D expenses, etc., could improve the outcome of the analysis. However, this is not directly possible with the register data at hand. At the same time, this report intends to relate Danish results to the other Nordic countries as well as illustrate possibilities for future research areas. Therefore, a fairly simple approach is used throughout the report.

6.1 Main findings

Section 3 gives the basic stocks of employees in 1995 by educational level, gender, scientific field, age and sector. The focus is on the general knowledge flow measured by job mobility by educational level, gender and age in Section 4 and the knowledge flow measured by individual mobility between sectors in Section 5. Both outflows from the delivering sectors as well as the inflow to the receiving sectors are analysed.

The stock of employees in Denmark in 1995 was 2.2 million (1.2 million men and 1.0 million women). The educational level is fairly equal for men and women, but there are gender differences in the choice of employment in various scientific fields, an equal share in the social science and humanities fields, a larger share of men in natural science and engineering fields and the opposite in the medical field. This tendency is confirmed in the 11-sector breakdown of all employees.

The analysis in Section 4 uses primarily a year to year outflow mobility measure. In a subsection, the outflow mobility rate is combined with the corresponding inflow mobility rate, all in all defining nine types of employees, among these newcomers, nomads, stable workers, etc. The study revealed relatively stable pattern of different mobility rates between education types, between sectors and between the Nordic countries. The mobility rate of all employees is rather high, 27%, and somewhat lower, 21%, for highly educated employees (ISCED=6+). Newcomers are much more mobile at 45% than stable employees at 20%. In a three-year period where the middle year is the one of interest, 43% entered the workplace since the previous year or left it the following year. Only 57% were employed by the same employer all three years, 1994-96. Job stability increases with age for both genders. Similarly, there is a clear difference in the mobility rates between the educational levels. Compared to the other Nordic countries, the tendencies in and levels of mobility rates in the Danish findings are very similar.

Section 5 analyses the determining receiving and delivering sectors, especially in relation to HEI and R&D institutes. Relatively, the R&D sector interacts more with the other sectors than the HEI sector does. However, there seems to be a strong link between HEI and the public sector. In general, the net flow goes from the HEI sector to the public sector, although the opposite is the case for the natural science and engineering field. The net flow is from the two NIS sectors to both the goods producing and the private service sectors. The links between the HEI and the R&D sectors are, in general, relatively weak. These Danish findings match the Norwegian and Finnish findings well. The opposite is the case compared to the Swedish findings.

Using the inverted Herfindahl index to measure the number of effective receiving sectors for individuals moving to another job gives a varied and incomparable picture. Although it seems consistent with theoretical explanations on a national level, the comparison to the other Nordic countries showed few or no similarities. Most similarities are found between the Danish and Norwegian results, and fewer between the Danish and the Swedish results. Hence, institu-

tional variation among the countries seems to be the only explanations for these differences.

The overall impression is that Denmark is quite similar to the other Nordic countries measured in stocks and flows of human resources. However, there are large but mostly explainable differences, such as national impact of economic recessions in the world economy, how industrial research is organised in relation to the two public research sectors, HEI and R&D, historical differences in the higher education systems in terms of academic priorities and education length. In recent years, the education systems are becoming more international and therefore more equal.

The Danish economy has, until recently, behaved differently than the economies in the other Nordic countries. For example, there has been a higher unemployment rate in Denmark, which could explain the larger mobility rates as a forced consequence, i.e., lower firing and hiring costs, high unemployment benefits, publicly provided job training which gives many short-term jobs, etc. In 1995, the business cycle pointed weakly upwards in Denmark after a low point was reached around 1993. New optimism in the economy also raises mobility rates, since more job openings exist. This can also be seen in the inflow and outflow from the active labour force, where the net inflow is positive. Regarding research, the Danish research infrastructure looks like the structure in all the other Nordic countries. Industrial research is concentrated around research parks close to the universities and the public research institutes in natural science and engineering. It is comparable to the Swedish system, but not identical. It also looks like the Norwegian and Finnish system with large industrial research institutes.

The industrial structure in Denmark is most similar to the structure in Sweden and Finland regarding the manufacturing sector, and in Sweden and Norway regarding the large public sector. The Danish higher education and R&D sectors are relatively similar to those of the other Nordic countries, and the distribution of employees by sector and educational levels is very similar to that of the other countries. The number of PhDs in Denmark is much lower than in the other countries. This is caused by a measuring problem with the Danish PhDs resulting in an underestimate of around 2,000. At the same time, the Danish policy has earlier given low priority to the PhD education. The latter has changed today. Hence, especially the distribution of educational level for the two NIS sectors varies considerably from the other Nordic countries with respect to the share of PhDs. There is a larger fraction of employees with low or middle education in these two sectors, perhaps because foreigners working in Denmark are registered as hav-

ing no education until otherwise documented. Hence, the overall picture is a quite similar use of shares of the different educational levels across the Nordic countries.

A look at three subsectors, (the IT sector, the pulp and paper sector, and the public administration sector) gives the same results. A similar, although less clear, conclusion is reached when we look at the share of highly educated employees from three different scientific fields in each of the three subsectors.

In Denmark, around 27% of the employees change job from year to year, a higher share than in the other Nordic countries. The gender differences in mobility rates are small in Denmark. A more striking result is a lower mobility rate for highly educated employees, also found in Norway and Sweden, but not in Finland. Over a three-year period, only 57% of the employees are employed by the same employer all three years. This is lower than in the other Nordic countries. Newcomers not employed the previous year have a mobility rate above 45% to the following year. Employees employed by the same employer as last year only have a mobility rate of 20% in Denmark. These figures are again higher than the figures in Finland and Norway.

As in the other Nordic countries, delivering and receiving sector give large internal variations in the Danish mobility rates. There are some similarities in the figures across the Nordic countries, but it is somewhat diffused by national sector differences. Although the numbers are basically similar across the countries, the national variations in the way the labour market functions and the way the industries are combined dominate the systematic pattern in the figures.

Studying the HEI and R&D sectors reveals larger similarities between Denmark and Norway and Finland than between Denmark and Sweden. The R&D sector is relatively small in Denmark, but it co-operates with more sectors than the HEI sector. The technology subgroup of the R&D sector has the highest number, 8, of receiving sectors for employees leaving the sector. The HEI sector delivers, on average, to 4 other sectors. Hence, the co-operation counted in sectors is on the same level as in Norway and Finland, but considerably lower than in Sweden. The HEI sector is around five times larger than the R&D sector in Denmark. The net flow from the HEI sector is approximately balanced, although in from the public and goods producing sectors and out to the private sector for the highly educated. The net flow from the R&D sector goes out to all the other sectors for the highly educated. The opposite is the case for the subgroup of highly educated in the natural science and engineering field. The size of the interactions between the NIS sectors and the other sectors does not seem to be weaker in Denmark than in the other Nordic countries.

6.2 Mapping the national innovation system

The use of individuals as an indicator for knowledge resources and knowledge circulation is a fruitful approach. Measures aggregated by sectors, educational levels or other characteristics describe important aspects of the national innovation system. However, the results in this report are not meant to stand alone, but should ideally be merged with other indicators of knowledge and competence in the economy. A more detailed categorisation of the research-oriented items is possible with the data in hand, but it has not been the purpose of the present report. However, it would be natural to pursue a more detailed and analytical approach in future research based on the register data. Similarly, an approach where register data is merged with survey data will be able to answer more specific questions. Here, the trade-off is between the entire population in the registers and the normally much smaller survey populations.

The register data on labour market attachments is unique for the Nordic countries. However, the major part of the analysis can be done with smaller administrative or survey-based data sets. Unfortunately, it is very difficult to get a common structure on such data sampling procedures. The register data have all the information from public data sampling. Thus, the registers contain all the information that is used for public administration and statistics. The bug is, of course, that the registers have neither behavioural information nor other kinds of additional information which we may find relevant, such as firm organisation, research priorities, or firm-specific future plans. Therefore, we must conclude that register data does contribute to the knowledge of the NIS, but additional data is required to tell the entire story.

The present analysis is based on stock and flows of individuals. The composition of flows by firms and organisations is a project for future work. Similarly, a more detailed description of inflow and outflow to the active labour force is postponed. The return mobility split by causes is interesting, i.e., whether the leave is caused by work abroad (country mobility), unemployment, disability, retirement, etc. A more detailed identification of the research-oriented firms across institutions and sectors is also a subject for future research.

The present analysis is the first attempt to compare the knowledge stocks and flows in Denmark with the corresponding figures in the other Nordic countries. The findings confirm the similarities among the countries and prove the strong relevance of cross-country studies based on register data. The present study has concluded the basic analysis. More focused and detailed analyses can be initiated in later reports.

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Appendix

Table A.1 Number of employees in Denmark in 1995 by educational level.

Educational level	Men	Women	Total
Secondary education or below	946414	770472	1716886
ISCED 5 (12-15 years)	68260	87456	155716
ISCED 6+ (exclusive PhDs)	190241	166209	356450
PhD	2119	547	2666
Total	1207034	1024684	2231718

Note: A qualified guess from Statistic Denmark claims that around 2,000 PhDs are misclassified as candidates (ISCED=6+).

Table A.2 Number of highly educated employees in Denmark in 1995 by scientific field.

Scientific field	Men	Women	Total
Natural sciences and engineering	76303	12257	88560
Medical and health-related disciplines	12617	61935	74552
Social sciences, humanities and other disciplines	103440	92564	196004
Total	192360	166756	359116

Table A.3 Number of PhD employees in Denmark in 1995 by scientific field.

Scientific field	Men	Women	Total
Natural sciences and engineering	1723	303	2026
Medical and health-related disciplines	186	164	350
Social sciences, humanities and other disciplines	210	80	290
Total number of PhDs	2119	547	2666
Education less than PhD	190241	166209	356450
Total number of highly educated	192360	166756	359116

Note: A qualified guess from Statistic Denmark claims that around 2,000 PhDs are misclassified as candidates (ISCED=6+).

Table A.4 Highly educated employees in Denmark by age, scientific field and gender.

	Men				Women				Total			
Age	Natural sciences and engineering	Medical and health-related disciplines	Social sciences, humanities and other disciplines	Total	Natural sciences and engineering	Medical and health-related disciplines	Social sciences, humanities and other disciplines	Total	Natural sciences and engineering	Medical and health-related disciplines	Social sciences, humanities and other disciplines	Total
20	43	0	42	85	23	0	52	75	66	0	94	160
21	89	0	117	206	34	0	204	238	123	0	321	444
22	149	1	344	494	66	2	343	411	215	3	687	905
23	340	6	440	786	131	8	954	1093	471	14	1394	1879
24	648	4	1185	1837	153	31	1921	2105	801	35	3106	3942
25	737	17	1607	2361	523	350	1876	2749	1260	367	3483	5110
26	1743	27	1586	3356	698	497	1754	2949	2441	524	3340	6305
27	2625	249	2265	5139	501	838	2539	3878	3126	1087	4804	9017
28	2768	102	2735	5605	1337	1882	3185	6404	4105	1984	5920	12009
29	3166	223	3249	6638	1085	2399	3247	6731	4251	2622	6496	13369
30	2595	578	3332	6505	907	1816	2596	5319	3502	2394	5928	11824
31	2645	202	2967	5814	463	2239	2792	5494	3108	2441	5759	11308
32	2338	452	2397	5187	545	1553	2241	4339	2883	2005	4638	9526
33	2177	208	3473	5858	491	2759	2280	5530	2668	2967	5753	11388
34	2561	583	2784	5928	574	1639	2407	4620	3135	2222	5191	10548
35	2686	341	1804	4831	433	2361	2573	5367	3119	2702	4377	10198
36	2170	615	2419	5204	324	2025	1696	4045	2494	2640	4115	9249
37	1354	338	2503	4195	397	2415	2908	5720	1751	2753	5411	9915
38	2099	457	2719	5275	287	2117	2942	5346	2386	2574	5661	10621
39	1871	698	3925	6494	377	2911	2871	6159	2248	3609	6796	12653
40	2039	490	3908	6437	345	2403	2901	5649	2384	2893	6809	12086
41	1500	684	4292	6476	228	2216	3090	5534	1728	2900	7382	12010
42	1492	760	3102	5354	177	2109	3944	6230	1669	2869	7046	11584
43	1830	363	2929	5122	204	2656	2902	5762	2034	3019	5831	10884
44	1576	377	4223	6176	203	2881	3726	6810	1779	3258	7949	12986
45	2165	328	4195	6688	183	1931	2986	5100	2348	2259	7181	11788
46	2116	355	2935	5406	256	2211	2946	5413	2372	2566	5881	10819
47	2337	319	2947	5603	150	1399	3482	5031	2487	1718	6429	10634
48	2971	334	3798	7103	158	1234	4230	5622	3129	1568	8028	12725
49	2756	447	4067	7270	243	1104	3040	4387	2999	1551	7107	11657
50	3244	293	2405	5942	125	1403	2636	4164	3369	1696	5041	10106
51	1999	245	3119	5363	110	1641	1846	3597	2109	1886	4965	8960
52	2083	373	2821	5277	94	1534	2006	3634	2177	1907	4827	8911
53	1745	191	2166	4102	77	1242	1784	3103	1822	1433	3950	7205
54	1750	295	2240	4285	72	1298	2195	3565	1822	1593	4435	7850
55	1128	185	1903	3216	45	1607	1651	3303	1173	1792	3554	6519
56	1421	185	1369	2975	43	991	1061	2095	1464	1176	2430	5070
57	1368	160	1066	2594	33	795	914	1742	1401	955	1980	4336
58	729	147	1502	2378	25	980	1090	2095	754	1127	2592	4473
59	1077	143	955	2175	22	840	369	1231	1099	983	1324	3406
60	1152	127	894	2173	19	442	751	1212	1171	569	1645	3385
61	841	121	868	1830	23	237	288	548	864	358	1156	2378
62	244	96	757	1097	14	230	389	633	258	326	1146	1730
63	315	88	498	901	16	123	182	321	331	211	680	1222
64	415	76	615	1106	8	13	166	187	423	89	781	1293
65	178	78	613	869	13	123	151	287	191	201	764	1156
66	240	89	286	615	7	114	143	264	247	203	429	879
67	440	52	472	964	7	113	140	260	447	165	612	1224
68	197	51	139	387	3	111	133	247	200	162	272	634
69	95	37	197	329	4	7	23	34	99	44	220	363
70	55	27	264	346	0	105	17	122	55	132	281	468
Total	76303	12617	103440	192360	12257	61935	92564	166756	88560	74552	196004	359116

Table A.5 Number of employees in Denmark by sector and gender. 1995.

	All employees			Highly educated employees		
Sector	Men	Women	Total	Men	Women	Total
Primary sector, mining, oil	32299 (2.7)	8519 (0.8)	40818 (1.8)	885 (0.5)	214 (0.1)	1099 (0.3)
Manufacturing	317089 (26.3)	143075 (14.0)	460164 (20.6)	27110 (14.1)	8422 (5.1)	35532 (9.9)
Utilities and construction	126112 (10.4)	16498 (1.6)	142610 (6.4)	7987 (4.2)	1094 (0.7)	9081 (2.5)
Trade, hotels, restaurants	202788 (16.8)	146592 (14.3)	349380 (15.7)	14103 (7.3)	10021 (6.0)	24124 (6.7)
Transport, storage, communication	116905 (9.7)	41211 (4.0)	158116 (7.1)	7574 (3.9)	2286 (1.4)	9860 (2.7)
Financial services	38133 (3.2)	40747 (4.0)	78880 (3.5)	8798 (4.6)	2525 (1.5)	11323 (3.2)
Business services	85906 (7.1)	63277 (6.1)	149183 (6.7)	30578 (15.9)	8693 (5.2)	39271 (10.9)
R&D institutes	4132 (0.3)	3371 (0.3)	7503 (0.3)	2523 (1.3)	860 (0.5)	3383 (0.9)
Higher education institutes	13760 (1.1)	12586 (1.2)	26346 (1.2)	9024 (4.7)	4740 (2.8)	13764 (3.8)
Public adm., defence, health and social work	216286 (17.9)	496303 (48.4)	712589 (31.9)	73709 (38.3)	120649 (72.4)	194358 (54.1)
Other non-public services	53310 (4.4)	52400 (5.1)	105710 (4.7)	10055 (5.2)	7247 (4.3)	17302 (4.8)
Sector unknown	314 (0.0)	105 (0.0)	419 (0.0)	14 (0.0)	5 (0.0)	19 (0.0)
Total	1207034 (100)	1024684 (100)	2231718 (100)	192360 (100)	166756 (100)	359116 (100)

Note: Column percentages in parentheses.

Table A.6 Number of employees in Denmark by sector and educational level. 1995.

Sector	Secondary education or below	ISCED 5	ISCED 6+	PhD	Total
Primary sector, mining, oil	38416 (94.1)	1303 (3.2)	1080 (2.6)	19 (0.0)	40818 (100)
Manufacturing	403193 (87.6)	21439 (4.7)	35103 (7.6)	429 (0.1)	460164 (100)
Utilities and construction	125623 (88.1)	7906 (5.5)	9060 (6.4)	21 (0.0)	142610 (100)
Trade, hotels, restaurants	312229 (89.4)	13027 (3.7)	24055 (6.9)	69 (0.0)	349380 (100)
Transport, storage, communication	142750 (90.3)	5506 (3.5)	9838 (6.2)	22 (0.0)	158116 (100)
Financial services	65649 (83.2)	1908 (2.4)	11307 (14.3)	16 (0.0)	78880 (100)
Business services	101862 (68.3)	8050 (5.4)	38927 (26.1)	344 (0.2)	149183 (100)
R&D institutes	3512 (46.8)	608 (8.1)	3075 (41.0)	308 (4.1)	7503 (100)
Higher education institutes	11758 (44.6)	824 (3.1)	12730 (48.3)	1034 (3.9)	26346 (100)
Public adm., defence, health and social work	427824 (60.0)	90407 (12.7)	194006 (27.2)	352 (0.0)	712589 (100)
Other non-public services	83670 (79.2)	4738 (4.5)	17251 (16.3)	51 (0.0)	105710 (100)
Sector unknown	400 (95.5)	0 (0.0)	18 (4.3)	1 (0.2)	419 (100)
Total	1716886 (76.9)	155716 (7.0)	356450 (16.0)	2666 (0.1)	2231718 (100)

Note: Row percentages in parentheses.
A qualified guess from Statistic Denmark claims that around 2,000 PhDs are misclassified as candidates (ISCED=6+).

Table A.7 Number of employees in Denmark by 42 sectors and educational level. 1995.

Sector	Secondary education or below	ISCED 5	ISCED 6+	PhD	Total
Agriculture, hunting and related service activities	28813	802	230	7	29852
Forestry, logging and related service activities	2902	0	318	3	3223
Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing	3000	1	18	0	3019
Mining and quarrying	3701	500	514	9	4724
Food products; beverages and tobacco	74621	2703	3662	47	81033
Textiles and textile products	18501	701	646	0	19848
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	12801	700	424	1	13926
Pulp and paper products	9500	300	528	2	10330
Publishing, printing and reproduction of recorded media	30225	1005	5999	8	37237
Coke, refined petroleum, nuclear fuel, chemicals and chemical products	1000	0	66	3	1069
Chemicals and chemical products	8202	302	1265	22	9791
Basic chemicals	4301	601	492	54	5448
Pharmaceutical preparations	9206	1409	3299	163	14077
Rubber and plastic products	20204	902	1264	9	22379
Other non-metallic mineral products	21501	1002	1153	3	23659
Manufacture of basic metals	7300	300	525	2	8127
Fabricated metal products, except machinery and equipment	37705	1601	2166	5	41477
Machinery and equipment n.e.c.	62309	4703	6319	43	73374
Office machinery and computers	1201	300	377	3	1881
Electrical machinery and apparatus n.e.c.	11902	1403	1128	8	14441
Radio, tv and communication equipment and apparatus	8402	402	1652	18	10474
Medical, precision and optical instruments, watches an clocks	11401	1402	2107	33	14943
Transport equipment	20801	1100	726	4	22631
Manufacturing n.e.c.	32110	603	1305	1	34019
Electricity, gas and water supply	12302	1702	2141	13	16158
Construction	113321	6204	6919	8	126452
Wholesale on a fee or contract basis, wholesale of machinery, equipment and supplies	160955	9910	15593	61	186519
Wholesale and retail trade; repairs	151274	3117	8462	8	162861
Transport and storage	101525	5005	6792	12	113334
Post and telecommunications	41225	501	3046	10	44782
Financial intermediation	65649	1908	11307	16	78880
Real estate, renting and business activities	25517	606	2208	2	28333
Computer and related activities	14546	1607	6914	46	23113
Research and development	3208	607	2498	286	6599
Research institutes, social sciences	304	1	577	22	904
Other business activities	48474	2516	14495	26	65511
Architectural and engineering activities and related technical consultancy	10317	2719	13791	202	27029
Technical testing and analysis	3008	602	1519	68	5197
Public adm. and defence; compulsory social security	427824	90407	194006	352	712589
Higher education institutes	11758	824	12730	1034	26346
Other community, social and personal services	83670	4738	17251	51	105710
Unknown	400	0	18	1	419
Total	1716886	155716	356450	2666	2231718

Note: A qualified guess from Statistic Denmark claims that around 2,000 PhDs are misclassified as ISCED 6+.

Table A.8 Number of highly educated employees by sector, scientific field and gender.

Sector	Men				Women				All employees			
	Natural sciences and engineering	Medical and healthrelated disciplines	Social sciences, humanities and other disciplines	Total	Natural sciences and engineering	Medical and healthrelated disciplines	Social sciences, humanities and other disciplines	Total	Natural sciences and engineering	Medical and healthrelated disciplines	Social sciences, humanities and other disciplines	Total
Primary sectors, mining, oil	802	0	83	885	68	1	145	214	870	1	228	1099
Manufacturing	16912	443	9755	27110	2159	1771	4492	8422	19071	2214	14247	35532
Utilities and construction	7428	6	553	7987	459	202	433	1094	7887	208	986	9081
Trade, hotels, restaurants	7131	391	6581	14103	763	5224	4034	10021	7894	5615	10615	24124
Transport, storage, communication	4838	19	2717	7574	293	202	1791	2286	5131	221	4508	9860
Financial services	1761	14	7023	8798	113	19	2393	2525	1874	33	9416	11323
Business services	16869	189	13520	30578	2434	603	5656	8693	19303	792	19176	39271
R&D institutes	1677	141	705	2523	418	143	299	860	2095	284	1004	3383
Higher education institutes	4326	496	4202	9024	1135	430	3175	4740	5461	926	7377	13764
Public adm., defence, health and social work	12482	10865	50362	73709	3902	53061	63686	120649	16384	63926	114048	194358
Other non-public services	2071	52	7932	10055	512	279	6456	7247	2583	331	14388	17302
Sector unknown	6	1	7	14	1	0	4	5	7	1	11	19
Total	76303	12617	103440	192360	12257	61935	92564	166756	88560	74552	196004	359116

Table A.9 Number of highly educated employees by 42 sectors and scientific field.

Sector	Natural sciences and engineering	Medical and health-related disciplines	Social sciences, humanities and other disciplines	Total
Agriculture, hunting and related service activities	162	1	74	237
Forestry, logging and related service activities	305	0	16	321
Fishing, operation of fish hatcheries and fish farms	12	0	6	18
Mining and quarrying	391	0	132	523
Food products; beverages and tobacco	1232	143	2334	3709
Textiles and textile products	444	1	201	646
Wood and of products of wood	187	0	238	425
Pulp and paper products	263	0	267	530
Publishing, printing and reproduction of recorded media	888	220	4899	6007
Coke, refined petroleum products, nuclear fuel	64	0	5	69
Chemicals and chemical products	566	19	702	1287
Basic chemicals	473	26	47	546
Pharmaceutical preparations	996	1741	725	3462
Rubber and plastic products	819	21	433	1273
Other non-metallic mineral products	947	1	208	1156
Basic metals	394	0	133	527
Fabricated metal products	1464	9	698	2171
Machinery and equipment n.e.c.	5138	5	1219	6362
Office machinery and computers	330	0	50	380
Electrical machinery and apparatus n.e.c.	759	0	377	1136
Radio, tv and communication equipment	1275	1	394	1670
Medical, precision and optical instruments	1628	27	485	2140
Transport equipment	667	0	63	730
Manufacturing n.e.c.	537	0	769	1306
Electricity, gas and water supply	1756	4	394	2154
Construction	6131	204	592	6927
Wholesale and retail trade	7063	1024	7567	15654
Wholesale of machinery and equipment	831	4591	3048	8470
Transport and storage	4126	115	2563	6804
Post and telecommunications	1005	106	1945	3056
Financial intermediation	1874	33	9416	11323
Real estate, renting and business activities	567	217	1426	2210
Computer and related activities	3188	134	3638	6960
Research institutes, technology	2007	252	525	2784
Research institutes, social sciences	88	32	479	599
Other business activities	1959	332	12230	14521
Architectural and engineering activities	12273	45	1675	13993
Technical testing and analysis	1316	64	207	1587
Public administration	16384	63926	114048	194358
Higher education institutes	5461	926	7377	13764
Other community, social and personal services activities	2583	331	14388	17302
NACE unknown	7	1	11	19
Total	88560	74552	196004	359116

Table A.10 Number of highly educated employees by scientific field and gender. Information and communication technology sector (NACE 30 + 32 + 64.2 + 72).

	Men		Women		Total	
Education less than ISCED=6	25038	74%	15517	89%	40555	79%
Natural sciences and engineering	4940	15%	395	2%	5335	10%
Medical and health-related disciplines	13	0%	123	1%	136	0%
Social sciences, humanities and other disciplines	3752	11%	1439	8%	5191	10%
Total	33743	100%	17474	100%	51217	99%

Table A.11 Number of highly educated employees by scientific field and gender. Pulp and paper sector (NACE 21).

	Men		Women		Total	
Education less than ISCED=6	7300	93%	2500	99%	9800	95%
Natural sciences and engineering	259	3%	4	0%	263	3%
Medical and health-related disciplines	0	0%	0	0%	0	0%
Social sciences, humanities and other disciplines	253	3%	14	1%	267	3%
Total	7812	99%	2518	100%	10330	101%

Table A.12 Number of highly educated employees by scientific field and gender. Public administration sector (NACE 75).

	Men		Women		Total	
Education less than ISCED=6	72558	79%	75448	84%	148006	82%
Natural sciences and engineering	5828	6%	1864	2%	7692	4%
Medical and health-related disciplines	605	1%	1693	2%	2298	1%
Social sciences, humanities and other disciplines	12313	13%	10289	12%	22602	13%
Total	91304	99%	89294	100%	180598	100%

Table A.13 Share of employees with and without job shift between two years by educational level and gender. Absolute numbers.

	Men			Women			All employees		
	Others	Highly educated	Total	Others	Highly educated	Total	Others	Highly educated	Total
Employees leaving active work force	79380	7916	87296	101190	11621	112811	180570	19537	200107
Employees without job shift	731075	150770	881845	613744	130059	743803	1344819	280829	1625648
Employees with job shift	204219	33674	237893	142994	25076	168070	347213	58750	405963
Total	1014674	192360	1207034	857928	166756	1024684	1872602	359116	2231718

Table A.14 Share of employees with and without job shift between two years by educational level and gender. Percent.

	Men			Women			All employees		
	Others	Highly educated	Total	Others	Highly educated	Total	Others	Highly educated	Total
Employees leaving active work force	7.8	4.1	7.2	11.8	7.0	11.0	9.6	5.4	9.0
Employees without job shift	72.1	78.4	73.1	71.5	78.0	72.6	71.8	78.2	72.8
Employees with job shift	20.1	17.5	19.7	16.7	15.0	16.4	18.5	16.4	18.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0

Table A.15 Number of employees with and without job shift between three years by type of job shift.

Employment state	1994	1995	1996
Not employed previous year, no other change	0	103549	203001
Not employed previous year, new employer next year	0	55190	0
Not employed previous year, not employed following year	0	52395	0
New employer since previous year, otherwise stable	0	244441	418471
New employer since previous year, new employer also next year	0	139675	0
New employer next year, otherwise stable	412616	211098	0
New employer since previous year, not employed next year	0	42003	0
Not employed following year, no other change	204998	105709	0
Employees without job shift	1571050	1277658	1646864
Total number of employees	2188664	2231718	2268336

A.16 Mobility rates for »stable« and »new« employees by gender. Absolute numbers and percent. 1995.

	Men			Women			All employees		
	Number of employees	Employees having left next year	Mobility rate (%) to next year	Number of employees	Employees having left next year	Mobility rate (%) to next year	Number of employees	Employees having left next year	Mobility rate (%) to next year
Stable workforce from previous year	871086	167160	19.2	723379	147647	20.7	1594465	316807	19.9
New employees from previous year	335948	158029	47.0	301305	131234	43.6	637253	289263	45.4
All employees	1207034	325189	26.9	1024684	280831	27.4	2231718	606070	27.2

Table A.17. Number of employees by type of job shift, age and gender. 1995.

Age	Men				Women				All employees			
	Employees leaving active work force	Employees without job shift	Employees with job shift	Total	Employees leaving active work force	Employees without job shift	Employees with job shift	Total	Employees leaving active work force	Employees without job shift	Employees with job shift	Total
20	3024	16843	10738	30605	5116	10534	9127	24777	8140	27377	19865	55382
21	3846	12901	9773	26520	3141	8900	7607	19648	6987	21801	17380	46168
22	2877	15079	9853	27809	3073	12583	8361	24017	5950	27662	18214	51826
23	2802	15864	12143	30809	3640	15096	8873	27609	6442	30960	21016	58418
24	3922	17790	9162	30874	4373	14450	8124	26947	8295	32240	17286	57821
25	3846	16606	7747	28199	3100	13303	6592	22995	6946	29909	14339	51194
26	2158	20440	8295	30893	4104	12908	5367	22379	6262	33348	13662	53272
27	3158	22215	8706	34079	4305	16218	6695	27218	7463	38433	15401	61297
28	2781	22348	10629	35758	4316	19097	6234	29647	7097	41445	16863	65405
29	2379	28155	9855	40389	4009	18922	6243	29174	6388	47077	16098	69563
30	2075	24982	7195	34252	3593	20164	5684	29441	5668	45146	12879	63693
31	1377	22444	6945	30766	4465	16831	5429	26725	5842	39275	12374	57491
32	1740	21793	7693	31226	2948	18239	4186	25373	4688	40032	11879	56599
33	1329	25121	7742	34192	3703	18194	3750	25647	5032	43315	11492	59839
34	2027	22723	5904	30654	2623	19642	4374	26639	4650	42365	10278	57293
35	2297	21191	7467	30955	2709	20357	3520	26586	5006	41548	10987	57541
36	1491	22301	6229	30021	3378	18515	3870	25763	4869	40816	10099	55784
37	1692	20141	5377	27210	1788	17513	4235	23536	3480	37654	9612	50746
38	1268	22207	6013	29488	1971	20677	3912	26560	3239	42884	9925	56048
39	1070	24932	6805	32807	3374	22477	5023	30874	4444	47409	11828	63681
40	1576	25698	5172	32446	2363	21006	4090	27459	3939	46704	9262	59905
41	867	27061	5555	33483	2054	23934	2862	28850	2921	50995	8417	62333
42	775	23888	4401	29064	2351	22930	2357	27638	3126	46818	6758	56702
43	980	21883	4167	27030	2154	22493	3227	27874	3134	44376	7394	54904
44	871	25286	4022	30179	2757	21266	2598	26621	3628	46552	6620	56800
45	1578	24812	4803	31193	1842	20368	4303	26513	3420	45180	9106	57706
46	1267	21760	3881	26908	1731	25826	3561	31118	2998	47586	7442	58026
47	1369	23571	2964	27904	1146	25245	3547	29938	2515	48816	6511	57842
48	1966	26993	4547	33506	1239	26040	3554	30833	3205	53033	8101	64339
49	968	30366	3943	35277	1448	26222	2027	29697	2416	56588	5970	64974
50	1255	25516	3972	30743	1040	22209	3019	26268	2295	47725	6991	57011
51	1255	23784	2629	27668	1432	23666	1607	26705	2687	47450	4236	54373
52	865	24575	2938	28378	1226	20221	1791	23238	2091	44796	4729	51616
53	1555	20849	2898	25302	1923	16513	1475	19911	3478	37362	4373	45213
54	1538	16585	2763	20886	1217	15094	1560	17871	2755	31679	4323	38757
55	1327	15732	2857	19916	1307	14345	2054	17706	2634	30077	4911	37622
56	632	15925	1719	18276	1521	12430	1045	14996	2153	28355	2764	33272
57	1134	14255	1705	17094	1107	11402	1134	13643	2241	25657	2839	30737
58	1045	13345	888	15278	808	10360	728	11896	1853	23705	1616	27174
59	4582	9883	611	15076	4138	5976	520	10634	8720	15859	1131	25710
60	2671	7402	1300	11373	1631	5265	617	7513	4302	12667	1917	18886
61	1755	5791	484	8030	916	4022	510	5448	2671	9813	994	13478
62	1868	3858	372	6098	1215	2003	216	3434	3083	5861	588	9532
63	1053	2687	261	4001	617	1789	315	2721	1670	4476	576	6722
64	1164	2487	355	4006	612	1068	107	1787	1776	3555	462	5793
65	269	1840	160	2269	418	1861	108	2387	687	3701	268	4656
66	688	1365	462	2515	515	1541	108	2164	1203	2906	570	4679
67	784	1919	561	3264	516	736	8	1260	1300	2655	569	4524
68	562	1688	137	2387	312	932	3	1247	874	2620	140	3634
69	669	592	268	1529	314	112	8	434	983	704	276	1963
70	148	1173	125	1446	211	306	5	522	359	1479	130	1968
Total	87296	881845	237893	1207034	112811	743803	168070	1024684	200107	1625648	405963	2231718

Table A.18 Overall mobility independent of education by delivering and receiving sectors. Absolute numbers. 1995.

Delivering sector (1995) ➜ ↓ Receiving sector (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 institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	Mobility rate in
Primary sectors, mining, oil	4924	1706	601	411	202	103	310	3	12	418	303	1	5776	14770	40818	36.2
Manufacturing	1313	39591	3229	7383	2548	129	2110	133	166	3769	1586	0	41404	103361	460164	22.5
Utilities and construction	602	4328	17685	1421	813	309	1466	3	10	1428	505	100	13466	42136	142610	29.5
Trade, hotels, restaurants	1110	8052	1325	39365	2854	339	4061	118	51	5475	1370	101	43956	108177	349380	31.0
Transport, storage, communication	505	2269	920	5868	23384	323	1881	150	29	1506	330	0	15521	52686	158116	33.3
Financial services, real estate	0	530	106	132	223	10381	604	3	116	372	226	1	4033	16727	78880	21.2
Business services	412	3247	1585	3309	1111	1324	10522	135	658	2852	738	0	19175	45068	149183	30.2
R&D institutes	1	127	2	120	4	4	48	119	134	100	38	0	1033	1730	7503	23.1
Higher education institutes	4	179	106	592	134	116	166	206	2442	1065	462	0	4712	10184	26346	38.7
Public adm., defence, health and social work	626	5155	1537	6954	1725	979	3459	241	1478	76696	3230	1	92654	194735	712589	27.3
Other non-public services	601	1769	814	2197	838	138	1422	19	351	3484	5501	0	14758	31892	105710	30.2
NACE unknown	0	0	1	1	0	0	0	0	0	0	0	0	4	6	6	100
Out of active labour force	6482	45907	13446	41211	15153	4604	14217	681	3146	83040	12997	206	0	241090	241090	100
N persons moving	16580	112860	41357	108964	48989	18749	40266	1811	8593	180205	27286	410	256902			
N persons employed	39296	455710	144832	357893	162785	76856	155485	7506	27840	729999	110127	410	256902			
Mobility rate out	42.2	24.8	28.6	30.4	30.1	24.4	25.9	24.1	30.9	24.7	24.8	100	100			

Table A.19 Mobility of highly educated employees by delivering and receiving sectors. Absolute numbers. 1995.

Delivering sector (1995) ➜ ↓ Receiving sector (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 institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	Mobility rate in
Primary sectors, mining, oil	124	6	1	11	102	3	10	3	12	18	3	1	176	470	1632	28.8
Manufacturing	213	4185	129	782	248	29	709	33	165	468	186	0	2194	9341	34301	27.2
Utilities and construction	2	28	482	121	13	9	366	3	10	128	5	0	564	1731	8654	20.0
Trade, hotels, restaurants	110	751	25	1861	252	139	958	18	50	371	68	1	1949	6553	24819	26.4
Transport, storage, communication	5	69	120	368	1783	23	479	150	29	206	30	0	1217	4479	9750	45.9
Financial services, real estate	0	29	6	132	22	1878	403	3	16	172	26	1	631	3319	11246	29.5
Business services	112	846	85	909	310	422	3318	35	357	1051	138	0	3668	11251	39658	28.4
R&D institutes	1	27	2	20	4	4	47	119	134	100	38	0	233	729	3420	21.3
Higher education institutes	4	79	5	92	34	15	166	206	1141	862	262	0	1609	4475	12886	34.7
Public adm., defence, health and social work	26	654	237	852	425	379	1057	141	677	24367	930	1	15625	45371	191373	23.7
Other non-public services	1	67	214	294	138	37	322	19	251	982	1197	0	1850	5372	16968	31.7
NACE unknown	0	0	1	1	0	0	0	0	0	0	0	0	4	6	6	100
Out of active labour force	79	2588	643	1576	738	402	1893	177	1032	15079	1074	6	0	25287	25287	100
N persons moving	677	9329	1950	7019	4069	3340	9728	907	3874	43804	3957	10	29720			
N persons employed	1493	36653	8723	26041	11071	11629	43328	3503	14524	208063	19581	10	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	100			

Table A.20 Mobility of highly educated employees within natural science and engineering by delivering and receiving sectors. Absolute numbers. 1995.

Delivering sector (1995) ➜ ↓ Receiving sector (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 institutes	Public adm., defence, health and social work	Other non-public services	NACE unknown	Out of active labour force	Number of persons moving	Number of persons employed	Mobility rate in
Primary sectors, mining, oil	121	5	1	8	101	1	4	3	9	10	1	1	50	315	1123	28.0
Manufacturing	108	2570	119	411	121	7	441	27	112	155	25	0	1449	5545	18480	30.0
Utilities and construction	2	18	458	110	8	4	244	3	7	118	3	0	315	1290	7805	16.5
Trade, hotels, restaurants	7	413	15	736	22	7	308	16	19	42	14	1	590	2190	7771	28.2
Transport, storage, communication	4	32	114	140	1043	4	86	40	17	26	8	0	529	2043	5136	39.8
Financial services, real estate	0	8	3	5	1	293	127	1	6	7	3	0	244	698	1939	36.0
Business services	6	301	66	370	52	210	1479	28	158	175	47	0	1579	4471	19047	23.5
R&D institutes	1	21	1	9	3	3	37	97	107	37	17	0	152	485	1987	24.4
Higher education institutes	0	42	4	43	20	3	80	69	331	122	17	0	561	1292	5060	25.5
Public adm., defence, health and social work	14	249	121	58	28	13	384	54	138	1204	60	0	1307	3630	15475	23.5
Other non-public services	1	11	207	13	6	0	40	8	27	63	83	0	260	719	2462	29.2
NACE unknown	0	0	1	1	0	0	0	0	0	0	0	0	2	4	4	100
Out of active labour force	57	1306	287	464	303	47	923	118	462	1291	237	1	0	5496	5496	100
N persons moving	321	4976	1397	2368	1708	592	4153	464	1393	3250	515	3	7038			
N persons employed	1169	20122	7654	8263	5722	2085	20762	2186	5419	17168	2905	3	7038			
Mobility rate out	27.5	24.7	18.3	28.7	29.8	28.4	20.0	21.2	25.7	18.9	17.7	100	100			

Figure A.1 Distribution of highly educated male employees by scientific fields. Absolute numbers. 1995.

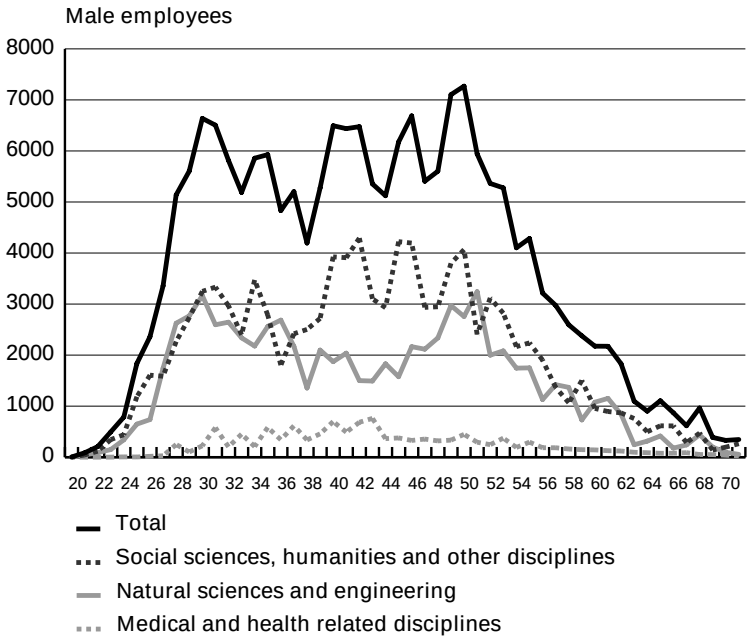

Figure A.2 Distribution of highly educated female employees by scientific fields. Absolute numbers. 1995.