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Job mobility among researchers in Denmark

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by

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1. Introduction

In the era of the knowledge-based economy, the capability to learn has become more important than ever for the economic success of individuals, firms and regions.

(Foray and Lundvall, 1996)

Indicators that measure human innovation resources are an important addition to traditional R&D-statistics on R&D-costs and R&D performed. Job mobility among highly educated employees or among employees with a large innovative potential is a vital part of the less visible knowledge circulation between innovative work places; private as well as public firms and research institutions.¹ Indicators on the knowledge exchange and the knowledge stock among the work places map the innovation and research based links in the national innovation system; links that correspondingly can be used to evaluate the effect of R&D policies or to prioritise the R&D policy by areas such as education, R&D, R&D absorption capacity, R&D cooperation, productivity, competitiveness and regional as well as national growth potential. Recognizing, that the industrial economy more and more is replaced by the knowledge economy with life-long learning, makes the management of the individual specific knowledge to a fundamental functional link in a community where possession or admittance to knowledge has become a parameter for survival among firms as well as public research institutions.

Knowledge is created on several levels in the community. The entire formal education system is the first measurable step in human's acquisition of knowledge. This knowledge is typically formal meaning that it is visible, reproducible, sharable, but still basic for the human's possibilities to absorb and develop new knowledge in the second step of their acquisition of knowledge; namely the informal or tacit personal and person specific knowledge. The level of formal education is typically highly correlated with the ability to acquire tacit knowledge, i.e. how effective, creative and innovative the humans are. Employees at work places acquire tacit firm specific knowledge through their experience, work and innovation on the work place. It is the innovation related part of the tacit knowledge that is especially individual specific, since it typically neither is visible nor shareable and since it is difficult to reproduce by others.

On the firm level it is important to know what knowledge and other competences the firm have at disposal through its employees. A full mapping of the existing knowledge stock gives the firms a management tool to provide, protect or replace lost knowledge in an effective, efficient and cost minimizing way. Many firms use large resources on identify and render visible what knowledge they have at disposal cf. "Guidelines for knowledge accounts" (MVTU, 2000).

¹ In the following firm is used for as a synonym for private as well as public work places and research institutions unless other things stated.

A specific account of the existing formal as well as tacit knowledge, can also help the firms to target their need for procurement of external knowledge in connection with its innovation activities.² The firm can choose to develop new products or new knowledge through R&D or through collecting and formalising firm specific experience and knowledge among its employees. It can also choose to buy or in other ways getting access to the missing exact knowledge from an external source. The external knowledge can for example be procured through hires of new employees, cooperation and networks, consultants, temporary exchange of employees, education etc. No matter which form the external knowledge source has, the new knowledge should correspondingly be collected internally and transformed to formal firm specific knowledge.³ Hence, other indicators on knowledge circulation in and between firms than just job mobility can be all form for indicators that measure any of the activities mentioned.

This report analyses only results for the permanent physical mobility of employed researchers in such a way that they reasonable well can be identified in an empirical context. Therefore, the revealed knowledge circulation is a conservative minimum measure for the amount of knowledge circulation, exchange and accumulation in the firms. Job mobility is only one among many part that together maps the complex net of connections in the Danish innovation system as it is defined in for example Lundvall (1992) or Nelson (1993), where the theory on the national innovation system builds on the assumption that the innovation ability in the system depends on the links between different organisations and units in the system. Therefore, researcher mobility indicators shall be hold together with other indicators on knowledge generation and use of knowledge such as R&D and innovation statistics, investments in ICT, machines or equipments, as well as regional or national labour market barriers and other structural conditions for sufficient set of indicators usable for research policy recommendations.

Nonetheless has knowledge links as part of the national innovation systems been intensely analysed in the last decade by OECD, EU, national organisations and others in recognizing that knowledge on knowledge links is an important part in the understanding of the shift from industrial economies to knowledge economies and

² The need for external knowledge allows the firm to target its search for the competences it needs, such that the firm does not loose resources by providing and hiring competences that already exists internally. Public research institutions in Denmark is highly criticised for this targeting in job openings, although its justification can be defended by these institutions' need for these exact competences and although private companies always have searched very narrow and specialised competences when they hire core specific employees such as researchers or managers.

³ Analyses of Danish firms' use of external consultants, for example the Danish GTS-institutes, show that a large share of the firms chooses this solution instead of building the competence stock them selves. These firms have typically so seldom a need for the competence that it becomes cheaper to buy them instead of possessing them internally in the firm. Doing it this ways allow the firms to share some of the costs to upgrade the needed competences with other firms that uses the same consultants, cf. for example Lundvall (1999) or Madsen (1999).

learning economies. A long row of analysis' that builds on the assumption that links between organisations influence the innovation ability, is published in the recent years, see for example OECD (1999a, 1999b, 2000, 2001a, 2001b, 2002), Scott et al (2001), The Research Commission (2001), Graversen et al (2002) among others.

The present report gives a summary of Danish results on researcher mobility in Denmark. The report covers results from work performed by AFSK in several projects; specifically on job mobility as well as other analyses of research environments. Similarly, are included results from external analyses that we are aware of. The term researcher mobility is usually assigned to the physical shift of job between two research environments, since a real job shift is a unique act that can be measured and accounted for. Other definitions on researcher mobility is also used in the paper, since these indicators also reveals new information on the knowledge mobility in the national innovation system. These indicators on the mobility act are therefore approximate measures for the knowledge imbedded in persons that is exchanged between work places. The real knowledge exchange between firms or research environments is very difficult to quantify since it happens on all levels; from formal sources such as written documents over cooperation and consultantcies to more or less permanent job shifts. It can similarly be argued that a researcher's physical mobility between two work places not always is giving for the surrendering firm, if it has not collected and formalised the knowledge lost through the leaving researcher, see Langberg and Graversen (2001).

Especially in the private sector is it difficult to precisely identify the researchers. A person that research but also have other tasks like administration or planning is at the same time both-and but also neither-nor. There exists no stringent definition for when a researcher that shifts job is a real (full time) researcher. The number of researchers at a work place can be summarised in full time equivalents but the same is much more difficult regarding job mobility. How much shall a job shift count in a statistic if the researcher is not a full time researcher?

In the public sector, especially at universities and sector research institutions, is the identification of researchers somewhat easier without being unproblematic. The number of public research institutions is much smaller than the number of private firms. Similarly, it is easier to identify the public employed researchers since the public research institutions typically are more open and informing regarding their employees compared to private firms. It is also easier through common titles in the public employment system, to define, limit, identify and classify public employed researchers. However, the public employed researchers at universities etc. do also use a large fraction of their work time on teaching, administration etc. Hence, neither here the employees perform research in all their work time.

The term researchers in studies of researcher mobility covers mostly employees that perform research in a significant part of their work time; more precisely it is difficult to measure for the researchers. This naturally also influences the degree of comparability of the researcher mobility indicators over sectors, time, geographical areas etc. According to the R&D Statistic from The Danish Institute for Studies in Research and Research Policy (Analyseinstitut for Forskning 2001a, 2001b), the private sector has 28688 R&D-employees performing 21022 full time equivalent R&D man-years. Therefore the average R&D time per R&D-employee is in average 0.73, giving that the R&D personnel do other things than R&D in 27 percent of their work time. The corresponding numbers for the public sector research institutions are 25289 R&D-employees and 14629 full time equivalent R&D man-years, which only give a ratio between R&D-employees and R&D time on 0.58. Public employees R&D personnel uses 42 percent of their work time on other things than R&D. Hence R&D personnel in the private firms perform research in a larger fraction of their work time than R&D personnel in the public sector research institutions.

Country comparable studies on job mobility are often done on Eurostats' Labour Force Survey, LFS, data with its common structure and definitions, see for example Laafia and Stimpson (2001). Numbers from these studies give varying job mobility rates around 10 percent in the most countries that calculate and publish these. The common definition on data as well as job mobility does not work in practice according to Laafia and Stimpson (2001). Furthermore is the subsample of researchers in the LFS typically too small for small countries like Denmark etc. to be used to calculate valid and trustful researcher job mobility rates. In the Danish LFS is the survey sample approximately 10000 employed persons, cf. Graversen (2002).

Alternatively, Denmark and the other Nordic countries⁴, plus a few other countries like Belgium and Holland instead build register databases on the entire or parts of the population. These registers give opposite to the relatively small surveys in the LFS possibilities for analyses of even very narrowly defined subsamples of the population, since there are no sample errors in the data on the entire population. The sample is the entire population, so even subgroups on for example 10 persons give exact mobility rates without sample errors. Furthermore, the data is collected independent of the population, such that there is no individual determined non-response or missing information. The Danish studies as well as studies from the other Nordic countries based on register data find considerably higher job mobility rates, 20-35 percent, than found on the basis of Eurostats' LFS data.

⁴ Iceland has not yet a fully deployed register based database.

Section 2 goes further in details with the results from Danish mobility studies based on register as well as survey data.

Register data has the disadvantage that it just like the LFS data is collected for other purposes than mobility studies. A long list of emotional factors that is included in the LFS cannot be analysed in the register data. In relation to researcher mobility is the missing emotional data especially relevant for analyses of reasons for job shifts, i.e. whether it is caused by quitting, firing, carrier jumps or other reasons in connection to transnational mobility where there is a high focus on barriers for mobility. In the registers it is not possible to distinguish between immigrating researchers from other immigrants because the registers only have information collected in other procedures; for example in the national population register where everybody has to be registered. The information here includes typically age, gender, and country of origin, but not education level, work experience, job function in new job etc. which would be more interesting in an analyse of researcher, knowledge or competence mobility.

Internationally researcher mobility has been brought to top actuality by the recommendations and wishes from the European Commission on researcher mobility for and in the development of the European research area, ERA, cf. European Commission (2000a, 2000b). The Commission's wishes are mostly pointing at an optimisation of the transnational researcher mobility in EU and between EU and the most usual cooperation countries like the EAC-countries, Eastern Europe and USA. The national researcher mobility is assumed to be a mirror of the transnational, just with considerably fewer mobility barriers. The Commission writes in their paper on the creation of the European research area that: *"More use should be made....[of] mobility as an instrument of information and technology transfer. The mobility of researchers between the academic world and the business world, in different forms that this might take, should also be readily encouraged and developed"*. The communiqué caused the creation of a *"high-level Expert Group"* which should come with suggestions to improve the researcher mobility in EU. Their final report points at ways in which researcher mobility can be made more efficient in the EU countries, cf. Commission (2001). Section 3 sum up on a list of recommendations on what to do in order better to measure and analyse researcher mobility nationally as well as internationally with the Danish conditions as a starting point.

1.1 Theoretical aspects of researcher mobility

...three hypotheses have been tested separately and regarded as alternatives to one another. It is more plausible that they interact in their impact on jobs.

(Foray and Lundvall, 1996)

In a labour market economic perspective job mobility among researchers do not differ from job mobility among other workers. Job mobility is controlled by supply and demand in the labour market combined with different barriers like social relations, ownership of steady property, and geographical limitations among others. With all this in mind the individuals react rational; they switch jobs whenever it is beneficial and possible. They optimise their utility due to the specific barriers, which they find constraining. Hence, job mobility is determined by several factors; better offers and conditions elsewhere, bad environment at the present company etc., i.e. the possibility of being fired or literally being sacked or to see whether other work environments are better. The rationale in switching job is determined within the individual solely and is a complex function of the already mentioned factors including the barriers of the employee but also within the employer.

In an industrial economic perspective or in a national or international macro perspectives the quality, speed, content and reason of job mobility are determining whether job mobility is either good or inferior to the company or the society. It is possible for the individual to act against the best interests of both the company and the society, due to the fact that the individual's self-seeking interests do not necessarily equal the interests of either the company or the society. This potential micro, meso and macro level divergence in interests may imply serious amounts of negative externalities in the society and these externalities legalize the creation of incentives by the society to eliminate these externalities or even making them positive. These incentives and other public regulations may unfortunately imply other barriers and other negative externalities. Public regulations, e.g. firm and employee job deduction, indirect support due to public R&D, regulations and proclamations, should smoothen the drawbacks in the society. Negative public actions for job mobility include refugee regulations, which obstruct the mobility among researcher in an out of Denmark, or high tax levels that lower the activity and the competitiveness among foreign as well as Danish researchers.

In a knowledge economic perspective the visibility and the amount of knowledge imbedded within the individual is extremely important. Contrary to a mass production view it is important to realise the capacity and competence of the employee in the knowledge economy. This is particularly important if the production within the company depends on the employee's innovative capacity. From this point of view employment, educating and upgrading employees are an investment rather than a

cost for the company and the employee. Through an investment related point of view the return of the investment, i.e. competence upgrading, is of crucial matter. To determine whether an investment should be carried out, it is crucial to take stock of the full size of the company's competences. Knowledge calculations and competence catalogues are evidence of this view. It enables the company to control, reward and develop the competences, which it is missing, or is already possessing, i.e. increasing the salary of core competences, innovative or creative employees. In the view of the company job mobility among competent employees is a knowledge diffusion mechanism as well as a potential negative externality.

No matter what economical approach that is used to analyse and relate the results of job mobility and especially job mobility among researchers, it is not possible to determine the best size of job mobility. Job mobility needs to attend a large size to secure a firm and flexible labour market, so implies the theory, but it cannot grow to big, due to the fact that the companies will loose their ability to have a continual and efficient flow. What is left is to empirically determining the benchmark level of job mobility, and what statistically is determining the mobility reflecting the theories. Job mobility is determined from the components of all mentioned economical approaches; this means that job mobility is determined by time and place more than anything else. Chapter 2 shows a variety of Danish empirical results of job mobility among researchers, which can be used to put up numerous benchmarks for actual job mobility among research at various times, places and researcher populations. These different benchmarks can be used as guidelines for different political regulations, reducing lack of functionality in the Danish innovation system.

2. Researcher mobility indicators

...it was found that net job creation was predominantly taking place in the knowledge intensive parts of the economy. This tendency was significant across regions, across firm sizes and in services as well as in manufacturing. (Canada in the 1980s.)

(Foray og Lundvall, 1996)

Job mobility in general is easy to define contrary to job mobility among researchers. Job mobility among researchers is being analysed in chapter 2.1. In an analysis of researchers mobility other definitions than the narrow definition of job mobility can be very interesting. Some of these alternative researcher mobility definitions includes research environmental mobility, mobility between educational camp and existing research environment, cross disciplinary mobility, staying abroad, educational stays and exchange stays, regarding whether or not it has taken place and how often and how many times through a career. These measures are being dealt with in chapter 2.2. These measures of mobility are, like job mobility, depending on individualized characteristics like age, educational level, sector, family relations among others as

well as time dependent differences in the marked conditions cf. Graversen (2000) and Langberg and Graversen (2001).

2.1 Research mobility as job mobility

...Mobility of employees, especially the innovative HRST employees, is a significant building stone in the National Innovation System.

(Graversen og Friis-Jensen, 2001)

It is somewhat more difficult to measure and limit job mobility in practice than it is in theory. The limitations of working place, the period of time before the researchers job mobility is permanent, the problems measuring data among others create huge empirical problems and therefore the choice of a practical implementable definition has to be made. A commonly used definition is given in box 1, although others are mentioned in the following when they are being used. Mobility when it is measured as a change of job between two moments of time, typically between two continuous years, is historically based, because it can be used generally, as it rely on clear definitions and are easily compared across time, place and population.

Box 1 outlines these general job mobility definitions. In relation to mobility among researchers both gross mobility and net mobility are of interest. Net mobility concerns the turnover of employed researchers with research experience. Gross mobility concerns the recruitment of researchers without previous experience or those with experience from abroad or those who become unemployed, retired or going abroad.

Job mobility can be divided into gross and net mobility.

- **Gross job mobility** is defined as the total transfer of mobility in and out of the workplace.
- **Net job mobility** is defined as a employment change between two workplaces from one period time to another. Net job mobility is a subset of gross mobility.

Job mobility can be measured relatively to the previous period as (in-to-job mobility) as well as relatively to the next period (out-of-job mobility). The rate of gross job mobility depends on which of the two that is used, while net in-to-job mobility will be the same as the net out-of-job mobility. Workplaces are typically limited legal units or geographically limited subsets of this, but it may also include concerns or national parts of this. The mobility is typically measured from one year to another, but it can be measured over longer time periods.

Box 1. Job mobility among researchers. Definition

2.1.1 Job mobility of high educated in and out of the public research sector

The job mobility rate among high educated employees between public research sectors and the surrounding society gives the rate of research competent persons that move within public research sectors and other work places. Table 1 shows these rates for the year 1995. There is no reason to believe that the rates have changed significant since.

The figures in table 1 shows that approximately 30 percent of the high-educated persons employed in the public research sector change workplace each year. An inflow of 5204 persons and an outflow counting 4781 persons indicates that the sector was expanding in 1995. This expansion is most likely no longer present. Approximately 30 percent of the newly appointed arrives from other public research sectors, while 35 percent leave to join these. Likewise, one fourth of the employees leave the active part of the Danish labour market. 35 percent are coming into the sector. This category contains new educated, persons employed abroad, pensioners and unemployed. Between the remaining high educated only a small part move in and out of the private manufacturing sector. The figures are larger, 7 and 14 percent, but they are still small compared to the private counselling sector, and the product oriented service sector. The main mobility in and out of the surrounding Danish society concerns the human oriented service sector, primarily the public sector.

As table 1 indicates there is high job mobility among high-educated employees at public research institutions i Denmark, but a relatively small mobility between this sector and the private manufacturing sector. This pattern in mobility raises obvious research policy priorities that shall support or even increase the mobility between the private and public research establishment; this aspect will be further discussed in chapter 3.

Table 1 Gross job mobility in and out of present jobs among high-educated persons in Denmark distributed by receiving and delivering sector in 1995

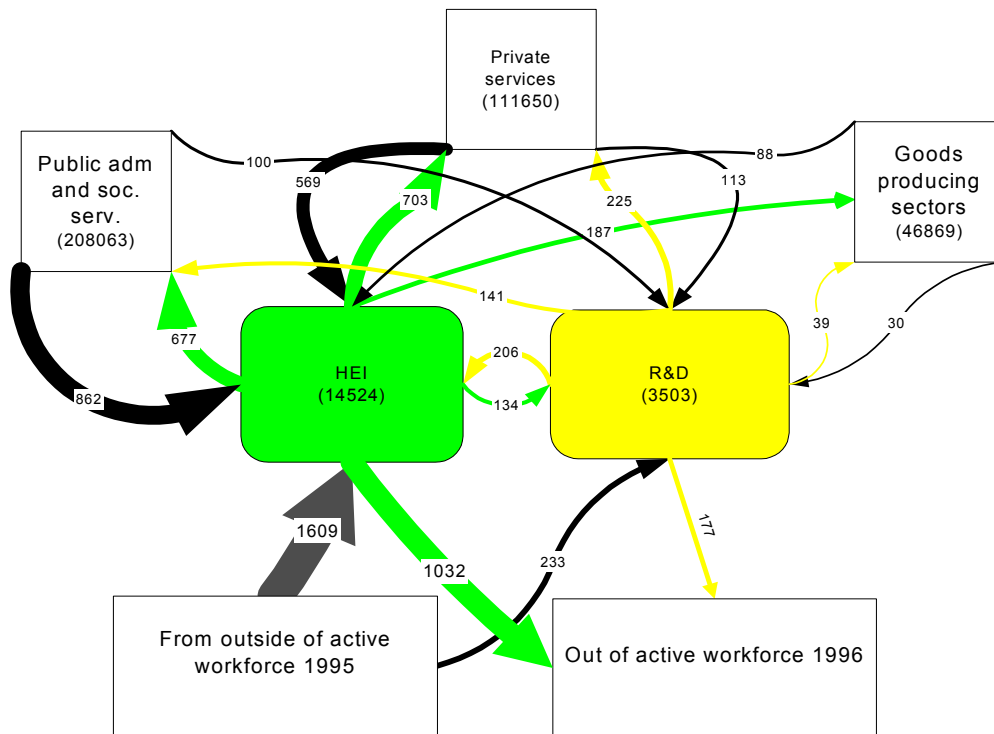
1995	Public research institutions	Universities	Private manufacturing sector	Manufacturing oriented service sector ²⁾	Humanity service sector	Foreign, education, pension, unemployed	Total	Number of persons moving	Number of persons employed	Average mobility rate
⇓ Receiving sector	Delivering sector, 1994									Into job
	----- Mobility rate, percent -----							Num-ber	Num-ber	Percent
Research institutions	16	18	4	10	19	32	100	729	3420	21
Universities	5	26	2	7	25	36	100	4475	12886	35
Total	7	25	2	7	24	35	100	5204	16306	32
⇓ Delivering sector	Receiving sector, 1996									Out of job
	----- Mobility rate, percent -----							Num-ber	Num-ber	Percent
Research institutions	13	23	4	23	18	20	100	907	3505	26
Universities	4	30	5	12	24	27	100	3874	14524	27
Total	6	29	5	14	23	24	100	4781	18029	27

Note: ¹⁾ Manufacturing industry ²⁾ Trade, finance, knowledge and consulting. ³⁾ Private and public health related activities, public administration and other human related private and public services.

Source: Graversen (1999)

The conclusion from table 1 can be illustrated even more clearly. Figure 1 shows that even though research institutions within the public sector relatively exchange a larger part of the employees with the private manufacturing sector, the exchange between the universities and the private sector in absolutely figures is twice this figure among high-educated.

Figure 1 Mobility among high-educated employed distributed by sender and receiving sector in Denmark 1995-96. Absolute number



Source: Graversen (1999).

2.1.2 Job mobility among high educated between private firms.

If the figures in table 1 are supplemented with corresponding figures from the private manufacturing sector, it shows again significant sector stability. It shows that high-educated mainly stays inside their sector area when they switch job. This tendency is rather natural and the share of employees, which shifts job internally in the sector is proportionally increasing with the absolute number of employees within the sector and the broader the sector is defined. A smaller sector in turn provides fewer opportunities internally within the sector and logically it is easier to find jobs outside the sector. 45 percent of the job mobile within the manufacturing sector shifts to new work places within the sector. The manufacturing sector holds three times the number of high-educated compared to the university sector, i.e. 37000. This tendency is by no means general. A small sector like the financial sector containing 11000 employees have a mobility rate of 56 percent within the sector. The sector extern mobility among high-educated within a sector is to a large extend determined by the employees level of specialisation. This statement is confirmed by the results in section 2.2.2, which shows what type of research educations the private business sector demand.

2.1.3 Job mobility among research competent employees

Due to the fact that it can be rather difficult to define researchers the definition from the Canberra Manual can be used as an alternative, c.f. OECD (1995). The definition for researchers is named HRST "Human Resources in Sciences and Technology". The HRST-population is either high educated or employees in a job with innovation potential, c.f. Graversen and Friis-Jensen (2001). The HRST-population includes approximately 35-40 percent of the Danish work force. A particularly interesting sub group of this is the research competent employees working within technology and natural science, i.e. the S&E-population that can be defined as core group of researchers or a core group of research competent employees. This sub unit includes approximately 10 percent of the HRST-population.

The job mobility concerning the HRST-population is 25 percent or one out of four employees. Hence, with equal mobility every employee will be switching job every fourth year. The mobility rate increases to 26 percent if the HRST-population is limited to academics solely, also known as the HRSTE-population, while it drops to 23 percent if the population is limited to those who fulfil the occupational definitions, also known as the HRSTO-population. The S&E-population, which is a sub unit of the HRSTO, have an even higher mobility rate of 26.1 percent. In general it can be concluded that a higher educational level increases the job mobility rate and that core research competences also increases the job mobility. The job mobility rate among all high educated employees in 1995 is approximately 22 percent.

2.2 Job mobility among researchers measured in other terms

...Any analysis of economic systems and labour markets that focuses only on high-skilled labour is going to be weaklow-skilled labour mobility may be just as important.

(Tomlinson in OECD, 2001a)

The work place mobility definition used in chapter 2.1 is not the only way to analyse or define researcher mobility. Other measures of mobility includes change in research environment since graduation, change between research environments, experience from abroad or changes in professional skills between first education and research job or just changes throughout the carrier may all explain other aspects of the contents and consequences of mobility among researchers. Box 2 shows some of these alternative specifications and definitions of mobility among researchers.

- a) At least one year of working experience somewhere else than the current work place.
- b) At least one year of research employment somewhere else than the current.
- c) Changes between current educational environment and current research work place.
 - Changes between the graduation university and the university, which is the current employer.
- d) Cross-disciplinary mobility throughout the carrier.
 - Profession change between education and employment.
- e) Geographical mobility among researchers.
 - Simultaneous job and residential changes.
 - Inclusive change in employment due to moving distance.

Box 2. Alternative mobility measures. Definitions

2.2.1 Job mobility among researchers employed either as university researchers or researchers in the public sector.

Short time job mobility from one year to another seems to decline as the employed researcher grow older, likewise does the short time job mobility for the HRST-population in general. The level of job mobility does not seem to be significantly different compared to other high educated. Likewise older public employed researchers accumulate a significant working experience from different working places. Two analyses from The Danish Institute for Studies in Research and Research Policy has gathered information concerning public employed researchers working life, c.f. Langberg and Graversen (2001).

The analysis shows that 65 percent of the researchers who are employed at the university and who are older than 35 years have working experience, with duration of more than one year, from other working places, and 32 percent for those who are younger than 35.⁵ Half the university employed researchers who posses working experience from other working places obtain this experience on an early stage of their working lives. 10 percent of the younger researchers bring on experience from

⁵ The group concerning researchers younger than 35 years can be divided into those who are younger than 30, in which 20 percent have working experience from another working place, and into those who are in the age from 30 to 34, where 45 percent have working experience from another working place. The group concerning researchers older than 35 years is quite stable with 65 percent who have working experience from another working place. This figure does tend to rise as the level of employment rises, hence 80 percent of the professors have gained working experience elsewhere, 50 percent of the adjuncts professors and 65 percent of the associate professors, c.f. Langberg and Graversen (2001).

the private sector against “only” 15 percent of the older researchers. Among older researchers 21 percent have experience from foreign universities compared to 8 percent of the younger researchers.

Another kind of job mobility is change between educational place and the present research environment. This kind of mobility illustrates the dissemination and exchange of competences and research traditions between research environments. This way a best practise should appear and improve the effectiveness and functional capacity of the national innovation system. Langberg and Graversen (2001) show that 38 percent of the PhD-educated university researchers have completed their PhD somewhere else than where they have completed their master. A larger share of these researchers has also working experience from elsewhere along their working career. Hence, they are generally more mobile.

Kallehauge and Langberg (1999) state that 60 percent of the researchers from the public research sector have been employed elsewhere throughout their career. Compared to the university researchers there are no significant differences in this particularly type of mobility. 33 percent of the researchers have job experience from universities in Denmark, 8 percent from foreign universities, 6 percent from other foreign research institutions, 10 percent from Danish research institutions within the public sector. Researchers from public sector research institutions are therefore equally as mobile throughout their research career as university employed researchers are.

2.2.2 The Mobility among newly graduated PhDs.⁶

The Danish Research Agency (2001) analysed a major part of the the Danish PhDs graduated within the fields of chemistry, physics and mathematics during the 1990's. The study covers what sectors the PhDs are working in and what functions the PhDs have at present. The study provides a picture of which sectors that are successfully demanding highly educated employees. Hereby the study concludes on who is getting the benefits from the large public investments in educating PhDs. The study builds on 465 answers from a population of 673.

The main focus in the study from The Danish Research Agency is the PhDs' first and present working place. There is not collected to information about mobility between these two. The study shows that approximately 30 percent of the PhDs are employed in the private sector. Thus the universities still employs the largest share, 60 percent of the first employment of the PhDs, including 18 percent at foreign universities. In their present job, 45 percent of the PhDs are employed at universities, including 14

⁶ Only PhDs from natural science at five Danish universities are included in the analysis (AU, AAU, KU, RUC and SDU) in the analysis. PhDs from three others (KVL, DTU and DFH) are not included.

percent at foreign universities. Hence, there is general job mobility from the universities to the private sector, to the public sector and to the research institutions within the public sector in this succession. The study further shows that with the ageing of the PhDs degree the possibility of working in the private sector increases. Moreover, the study finds that the possibility that research is the PhDs principal function is 90 percent the first year, and drops to 40 percent after 10 years.

Previous figures from 1987 to 1995 shows that 23 percent of the PhDs were employed in the private sector, compared to 30 percent of the 238 graduated PhDs in 1997 to 1998. Here, 62 percent employed at universities including 13 percent abroad.

The PhDs included in the studies from The Danish Research Agency shows that among temporary stays in other environments or mobility, throughout the PhD education it is shorter and longer stays abroad that have the largest effect on the further career. Approximately 55 percent of the PhDs have been abroad during their PhD. This part is probably higher today. Of the 673 PhDs close to 30 percent have been abroad some time of the study. Among the respondents, 26 percent named their first working place to be foreign. As the PhD degree gets older the probability of both working abroad and have been working abroad seem to drop. Approximately 30 percent of the PhDs have never been abroad during their PhD career, neither in their first nor their present job; however a small number may have had experiences abroad due to jobs in between.

2.2.2.1 Mobility among new educated PhDs in 1997-1998

Compared to the figures on the natural science field from The Danish Research Agency, The Research Academy (1999) provides figures from 1998-1999. These figures cover practically all PhD gradulators in Denmark from that period. Among all the figures in the rapport there is an overview over the PhDs present employment category. These figures are collected and restated in the following table 2.

Table 2 PhDs from year 1998-99 and their labour market position

Sector	Humanities	Social science	Natural science	Medical science	Agriculture /veterinary science	Technical science	Total
Public sector sum	88	76	49	83	64	37	62
Universities	65	62	29	12	33	28	30
Public research institutions	2	7	12	4	25	5	8
Hospitals	-	-	2	62	2	-	17
Others	21	7	6	5	4	4	7
Private sector sum	9	16	29	14	27	53	27
Manufacturing	2	3	16	10	18	24	14
Service firms	6	13	13	4	9	27	12
Building and construction	1	-	-	-	-	2	1
Abroad sum	1	7	19	2	5	9	9
Others	2	1	3	1	4	1	2
Sum	100	100	100	100	100	100	100
Total numbers	83	71	238	249	81	219	941

Source: Research Academy (1999).

As the figures in table 2 shows, one third of the PhDs are employed in the public sector, including 30 percent at universities. A corresponding part, 27 percent, is employed in the private sector, while 10 percent is employed abroad. Thus, there are a rather large mobility among new PhDs. Table 2 also shows large differences between the different fields, the technological and scientific fields have the largest mobility rate among PhDs towards the private sector⁷. The natural science field have by far the largest job mobility rate going abroad.

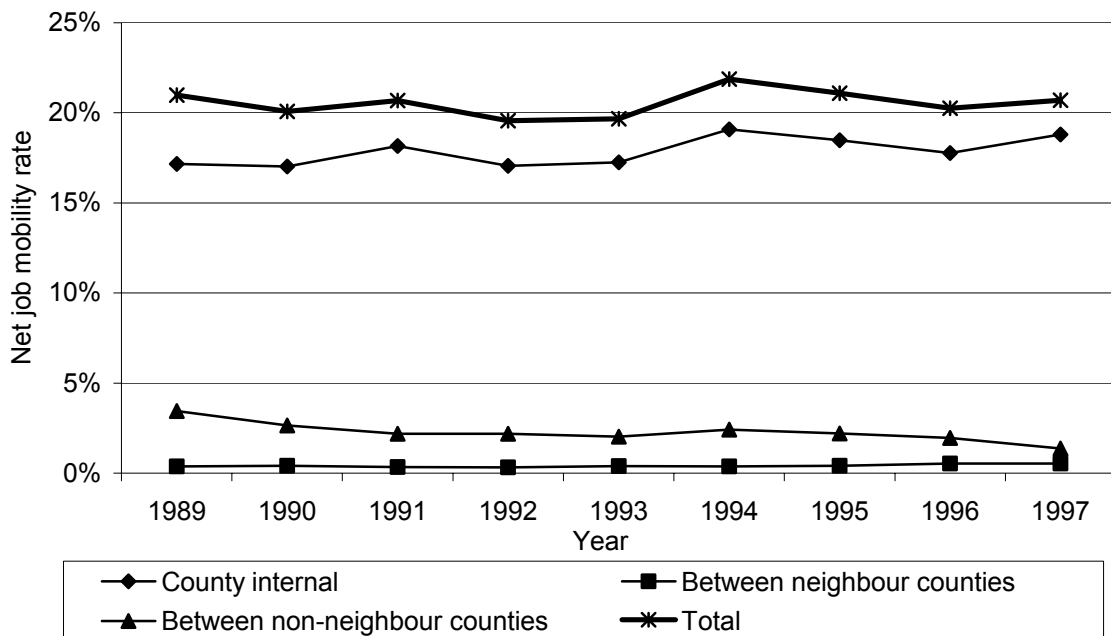
2.2.3 Geographical Mobility

Numerous studies like, Graversen (2001b), Graversen and Friis-Jensen (2001) and Graversen et al. (2001), find high national net job mobility rates; approximately 20 percent for those with high educations. The same studies find low job mobility rates at merely 1 percent when looking at cross bordering mobility. Graversen (2001c) therefore divides the national job mobility into whether the mobility involves a significant change in home addresses defined as a change between counties. Likewise the job mobility is divided into the distance between the home address and the employment the year before the job change.

⁷ The PhD register from the Research Academy estimates the population of PhDs (graduated within 1976 – 2000) to be nearly 9750. 1050 are PhDs in humanities, 950 in social science, 2600 in (natural) science, 1725 in medical science, 850 in agriculture/veterinary science and 2550 within technological science.

The job shift probability is highly positive correlated with the distance between the place of living and the left working place. The majority, 90 percent, of the job mobility is taking place between working places close to the home address and does not involve a change of address. Less than two percent moves between two counties as a consequence of switching jobs and eight percent moves even further away than the neighbour county when switching jobs, mainly a move to the capital, Copenhagen, from other places round the country. Job mobility within the county is therefore highly dominating as showed in figure 2.

Figure 2 Net job mobility rate distributed after private address; 1989-97



Source: Graversen (2001c)

Further Graversen (2001c) finds a family dependency in the mobility rates. Single people as well as cohabiting non-married are significantly more mobile than married couples.

The results found in connection with the geographical mobility are probably less noticeable for high educated and other research competent employees, since these groups are generally paid higher wages, and as a consequence longer distance mobility will be more profitable, and the groups are more specialised and therefore the number of job possibilities will be less, longer away and more selective.

3. Job Mobility Among Researchers and Research Policies

Lower levels of Industry-Science Relations can be attributed mainly to a lack in demand on the enterprise side – a specialisation in innovation paths which do not require scientific knowledge or expertise (i.e. knowledge market is demand-driven) and to a lack of incentive structures and institutional factors on the science side. Typically, they do not reflect a lack in supply of scientific knowledge nor willingness or readiness to co-operate on the science side.

(Polt et al (2001))

The employee's physical mobility between firms is very important for the firms way of acting and their performance both in an intermediate and long perspective. If the mobility of researchers is too big firms may be experience difficulties in keeping up a high level of research competence, while researchers, as a rule of thump, do not create any positive return before their third year of employment. On the other hand if the mobility is too small the firm will experience a lack of dynamics, innovation and further development. R&D cooperation, informal contact and networks make it very hard to define the perfect mobility level among researchers. Contrary one should keep in mind that job mobility alone is not enough to create innovation; it provides potential of innovation and as such economic growth.

Physical job mobility among research competent and high-educated employees is a visible and measurable indicator of knowledge diffusion, -circulation and accumulation of informal knowledge throughout the national innovation system. Knowledge accumulation and diffusion are fundamental inputs in newer models of economic growth. The physical mobility among research competent employees seems to have an immediate influence on the economy. When the level of knowledge in the economy is high, its ability to innovate and implement innovations is better. Significant mobility among high-educated employees ensures the firms the best competences, which at the right time and place ensures growth and better economic performance for the firm.

Furthermore, continual stabile knowledge mobility such as job mobility between firms and knowledge institutions creates both diffusion of new knowledge and increases productivity and efficiency among the employees, which in turn creates potential for increased economic growth among the firms. 26 percent of the employed high-educated Danes are new comers at the working places compared to the year before. 20 percent of the employees come from another job; hence 54 percent are already employed at the work place. The mobility share among the population, inclusive research competent employees, is nearly at the same level. The mobility among public employed researchers is a few percent larger, while the mobility between private firms and public research institutions are very low although significantly larger than zero.

This relatively high job mobility rate in Denmark indicates large and significant knowledge diffusion, which in turn supports the huge innovation potential embedded in a well-functioning national innovation system, where the system is built on a well-functioning knowledge based infra structure.

3.1 Research Policy in the Light of Existing Job Mobility

...The policy challenge is to facilitate the circulation of highly skilled workers across frontiers while generating benefits....

(Guellec and Cervantes in OECD, 2001b)

...it seems likely that the magnitude of various positive or negative effects are likely to be significantly affected by aspects of a country's immigration, education and technology policies.

(Regets in OECD, 2001a)

A general opinion that mobility among researchers is good does not provide a useable goal to reach by research policy actions. In stead there must be a more subtle approach to improve the use of research policy actions in connection with mobility among researchers. There does not seem to be anything that empirically should indicate that mobility among researchers in Denmark, neither nationally nor internationally, is too low compared to other communities. Still, the Danish mobility among researchers does not seem to be optimal related to the functionality of the national innovation system. There are visible slackness' within the cross sectoral mobility among researchers. The missing field crossing mobility between private sectors is probably not so difficult to increase. However the small mobility between the cross-disciplinary public research sectors and the remaining private sectors and public sectors is illustrating a too low diffusion of new and innovative knowledge from the innovation producing public sector to the surrounding society. Research employees in the public sector rarely switch to other sectors and the same group of private employees stays in their sectors respectively. There is only a very limited physical knowledge exchange, competence gaining and professional improvement due to this kind of job mobility.

Thus there is a need for research policy initiative, which in turn will fill in the lack of knowledge diffusion in the current national innovation system. The firms emphasis on development oriented research and innovation compared to, among others, the basic research approach at the universities is just one of the huge barriers to an increased mobility among researchers between these sectors. Another problem is the lack of merits of employments outside the narrowly defined research environments. Research results that is being published, as an example, is the measuring unit within the universities, while research experience, patents and/or product development is the most important factors to most innovative firms. In

principle it is a problem like the Gordian knot, but this can, of course, be cut. In practice this is a rational externalities, which may be optimal to the firms as well as the research institutions, but far from optimal for the society as a whole. Hence, there seems to be place for an active public policy that removes the community externalities in this area.

To recommend useable research policy instruments it is necessary to define the aims of the policy. A typical aim is a better positive influence and scientific stimuli on a high quality level affecting the national innovation system. This indirect sector satisfaction, as can be concluded on basis of the low cross-sector mobility rate, is not proving an efficiently executed research policy. Making the changing of job easier in general in the economy is not enough to get rid of the externalities that are connected with researcher mobility between the public research sector and the surrounding society. Instead, there must be used applied research policies that have one primary aim; to remove the explicit barriers. Therefore research policy initiatives aimed directly at the problem must be used; the problem here is research mobility between sectors with different R&D-profiles. Then it can be determined whether the used initiatives are effective and sufficient enough.

The overall aim of the research policy must without question be to strengthen the national research competence both at firms, research institutes and researchers in the national innovation system. The contribution that originates from the job mobility among employed, and in particular researchers, is the target of the research policy instruments in this analysis. There are two particular problems to mobility among researchers when focusing on the low researcher mobility between the public research sector and the surrounding society. One leads to non-optimal national knowledge diffusion, another leads to a lack of renewal and dynamic within the research environments. The cause is a consistent though laterally reversed cause and consequence pattern inside and outside the public research sector, caused by an extensive mismatch between the researchers research, and employment and work conditions throughout the public and private research sectors.

The mismatch is bound within a lack of bridges between the two sectors. Public employed researchers have difficulties trying to match their research with the demands from the firms, likewise the private employed researchers have difficulties in getting their research acknowledged in the public system. The barriers for the firms and research institutions lie within the time horizon of the performed research, the application aspects, the societal utility and the short-term economic horizon in most firms. The two sectors only have mutual force of attraction within areas where both the public research sector and the private sector conduct comparable basic research, which in particular is the case within the natural science and technology. Other fields tend to have much lower cross-sector force of attraction. Securing both

basic research and more application oriented research room in the public sector as well as in the surrounding sectors may increase the cross-sector mobility among researchers. Through this a larger force of attraction and demand between the two sectors is ensured.

At the same time, an increased supply effect from the researchers may be obtained through an approval mechanism that merits application oriented research equal to basic research. By this, the researchers can secure that changing sectors does not spoil their future research career. Several studies have shown that a salary incitement is just minor factor among those who are able to increase the cross-sector mobility. Most researchers feel a dedication to their research and seek to the places where they obtain the best space and room to carry out their research. The working environment in the broadest sense is by all means the most significant barrier to cross-sector research mobility. Hereby one of the biggest schism can be illustrated: A researcher from a private firm is not able to obtain merits enough to get employment at a university and is in that sense blocked in the private sector. At the same time the only opportunity for a researcher from a public research institution to collect a higher salary is in the private sector through a change to this sector; a change from the basic research to the application oriented research, which at the same time makes return mobility impossible. The Gordian knot once again.

There seem to be a need for research policy instruments, which can lower the mobility barriers between the public research sector and the surrounding sectors. These instruments could be differencing salaries, new measures of merits, more open career paths, subsidies to particular kinds of mobility, rewarding research delivering working places, increased external financing of researchers employed in the public research sector, among others. Alternatively an increase of the knowledge circulation in general and not necessarily increasing the physical mobility of researchers may be a solution; through as an example the formal as well as informal research cooperation between research institutions and the surrounding sectors in the national innovation system.

Knowledge diffusion through mobile researchers between different research environments is one but many ways to exchange, disseminate and collect research competence in firms. To determine whether the low mobility between public research institutions and the surrounding sectors is problematic, and not just indicating a problem, it will be necessary to compare and estimate the sectors aggregated knowledge exchange and not just the part that is included in the personal mobility. Knowledge exchange between the public research sector and the surrounding sectors may be significantly different from the knowledge exchange in other sectors. This may be the foundation of a study of the knowledge diffusion within the national

innovation system and not just the part carried in personal mobility between working places.

References

- Commission. 2000a. *Meddelelse fra kommissionen til Rådet og Europa-parlamentet. En mobilitetsstrategi for det europæiske forskningsrum*. Kommissionen KOM(2001) 331 endelig udgave.
- Commission. 2000b. *Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. Making a reality of the European Research Area: Guidelines for the EU research activities (2002-2006)*. COM(2000) 612 final.
- Commission. 2001. *High-Level Expert Group on Improving Mobility of Researchers. Final Report*. DG-Research 2001.
- Foray D. og B Lundvall. 1996. The Knowledge-based economy: From the economics of knowledge to the learning economy. I D. Foray og B. Lundvall (eds.) *Employment and Growth in the Knowledge Economy*. Pp. 11-32. OECD.
- Graversen E. 1999. *Formal Competencies in the Danish National Innovation System*. Analyseinstitut for Forskning. Report 1999/4.
- Graversen E. 2000. *Cyclical Mobility Rates on Human Capital – Evidence from Danish register data, 1988-97*. Analyseinstitut for Forskning. Working Paper 2000/5.
- Graversen E. 2001a. *Human Capital Mobility – A Comparable Knowledge Indicator*. Chapter 4 in K. Wille Maus (ed.). *Science and Technology Indicators for the Nordic Countries 2000*. TemaNord 2001:539.
- Graversen E. 2001b. *Human Capital Mobility into and out of Research Sectors in the Nordic Countries*. Chapter 8 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.
- Graversen E. 2001c. *The influence of moving distance on the job mobility rates in Denmark*. Upubliceret note.
- Graversen E. 2002. *Data Sources on Human Capital Mobility – The Danish case*. Workshop paper, the 1st ENMOB Workshop, Leuven, Belgien.
- Graversen E. og K. Friis-Jensen. 2001. *Job Mobility Implications of the HRST Definition: Illustrated by Empirical Numbers from Register Data*. Chapter 4 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.
- Graversen E., M. Lemming, M. Åkerblom og M. Virtaharju. 2001. *Migration between the Nordic Countries: What Do Register Data Tell Us about the Knowledge Flow?* Chapter 18 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.

- Graversen E., A. Ekeland, S. O. Nås, M. Åkerblom, M. Virtaharju, A. Ratkic og C. Svanfeldt. 2001. *Job-to-job Mobility Rates in the Nordic Countries, 1988-98*. Chapter 7 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.
- Graversen E., S. O. Nås A. Ekeland, M. Bugge, C. Svanfeldt og M. Åkerblom. 2002. *Knowledge transfer by labour mobility in the Nordic countries*. Analyseinstitut for Forskning. Working Paper 2002/1.
- Hansen J. V. og J. Krog Søbysgaard. 2001. *Farvel og på gensyn*. Kronik i Jyllandsposten d. 4.10.2001.
- Hauknes J. og A. Ekeland. 2002. *Mobility of Researchers – policy, models and data*. STEP working paper. STEP-group, Oslo.
- Kallehauge P. og K. Langberg. 1999. *Forskere på sektorforskningsinstitutioner. Arbejdsvilkår og holdninger til arbejdet*. AFSK Rapport 1999/6.
- Laafia I. og A. Stimpson. 2001. *Using the Community Labour Force Survey to Develop Mobility Rates on Human Resources in Science and Technology*. Chapter 9 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.
- Langberg K. og E. Graversen. 2001. *Mobility among Researchers*. Analyseinstitut for Forskning. Working Paper 2001/7.
- Lundvall B. 1999. *Det danske innovationssystem – et forskningsbaseret debatoplæg om innovationspolitiske udfordringer og handlemuligheder. DISKO-projektet: Sammenfattende rapport*. DISKO-rapport nr. 9. Erhvervsudviklingsrådet. Erhvervsfremmestyrelsen.
- Mahroum S. 2001. *Foreign Scientific Researchers in Selected OECD EU Countries: Data Sources and Analysis*. Chapter 15 in OECD (ed.). *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings.
- Miller R. 1996. Towards the knowledge economy: New institutions for human capital accounting. I D. Foray og B. Lundvall (eds.). *Employment and Growth in the Knowledge Economy* Pp.69-80. OECD.
- Nerdrum L. 2001. *International Research Mobility into the Nordic Countries. Contextual background, statistics, and policy measures. A pilot study*. TemaNord 2001:561.
- Nielsen P. 1999. *Personale og fornyelse*. DISKO-rapport nr. 7. Erhvervsudviklingsrådet. Erhvervsfremmestyrelsen.
- OECD. 1995. *Canberra Manual. The Measurement of Scientific and Technological Activities – Manual on the Measurement of Human Resources devoted to Science and Technology*. OECD/GD(95)77.
- OECD. 1999a. *Boosting Innovation. The Cluster Approach*. OECD Proceedings.
- OECD. 1999b. *Managing National Innovation Systems*.
- OECD. 2000. *Innovative Clusters. Drivers of National Innovation Systems*. OECD Proceedings. Science and Innovation.

- OECD. 2001a. *Innovative People. Mobility of Skilled Personnel in National Innovation Systems*. OECD Proceedings. Science and Innovation.
- OECD. 2001b. *Innovative Networks. Cooperation in National Innovation Systems*. OECD Proceedings. Science and Innovation.
- OECD. 2002. *International Mobility of the Highly Skilled*. OECD Proceedings.
- Pedersen P. (ed.). 1996. *Scandinavians without Borders – Skill Migration and the European Integration Process*. I E. Wadensjö (ed.) *The Nordic Labour Markets in the 1990's*. Vol. II. Elsevier Science B.V.
- Polt W., H. Gassler, A. Schibany, C. Rammer, N. Valentinelli og D. Schartinger. 2001. *Benchmarking Industry-Science Relations – The Role of Framework Conditions*. Final Report, European Commission, Enterprise DG.
- Scott A., G. Steyn, A. Genua, S. Brusoni og E. Steinmueller. 2001. *The Economic Return to Basic Research and the Benefits of University-Industry Relationships. A literature review and update of findings*. Report prepared for the Office of Science and Technology, November 2001. SPRU
- The Economic Council. 2001. *Migration*. Afsnit 5 i kapitel 2: 'Udfordringer for skattesystemet' i vismandsrapporten: 'Dansk Økonomi, forår 2001'. Det Økonomiske Råd, 2001.
- The Danish Research Agency. 2001. *Naturvidenskabelige ph.d.er. Ph.d.er i matematik-, fysik- og kemifagene: Karriereundersøgelse årgangene 1990-1999*. Ministry of Education, 2001.
- The Research Academy. 1999. *De ph.d.-uddannede 1997 og 1998*. Forskeruddannelsesrådet: <http://www.forsk.dk/fur/publ/eval/phduddannede/>