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The Mobility from the Research Sector – the Norwegian Case 1987 - 2000

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Introduction

This report is part of the FAKTA programe of the Norwegian Research Council, more specifically the project "Competences, mobility and value creation". Together with other reports from this project on ICT personel, on technologist it tries to look at stocks and flows of knowledge in the economy.

This report builds upon another report of a more theoretical nature, Hauknes and Ekeland "The mobility of researchers - data, models and policy", 2001. We deepen the theoretical discussion of that report by starting out discussion the relationship between two aspects of knowledge, tacit and codified.

Then we go on to a detailed discussion on how the concept of a research sector is made operational in the Norwegian statistical system. This discussion also includes some discussion on the problems with the register data that we use as the empirical basis for this report. There has been a change of industrial classification, of firm ID numbers, and since these registerdata is still very little used relative to their potential there are some unhappy consequences of these changes that we only can point to, not having the ressources needed to remedy those weaknesses.

Given the overall and explorative character of this report, these problems should not give the impression that the data is not reliable on a general level. And in the last part of the report we use descriptive statistics to give a picture of the stocks and flows of researchers in order to get a better picture and understanding of the knowledge flows from and to the research producing sector.

Human mobility and the relation between tacit and codified knowledge

In one of the other reports from this project "Researcher mobility, data, models and policy" we have at length dealt with the question of the positive and negative aspects of mobility seen from the point of view of each organisation/firm. The "downside" is that too much mobility means that teamwork is disrupted, key-persons leave projects before they are finished, you get "too" high training costs etc. The "upside" is that getting in new people with new ideas is generally beneficial for your innovative capacity. The problem is to find a optimum between the various negative and positive aspects of mobility. And that is not a single number but an optimal range.

In the following we shall discuss another aspect of knowledge that influences the mobility rates - the relation between the tacit and codified dimension of knowledge. One of the reasons why human mobility occur is certainly that there is a tacit dimension to knowledge. This is of course not an absolute "tacitness", but is clearly given by the context. Some types of knowledge are tacit to some people, but not to others. Knowledge that was not codified can be so if there is sufficient demand for it.

Cowan, David and Foray discusses this at length in "The Explicit Economics of Knowledge Codification and Tacitness" (1999). It would be temping to go into this very interesting discussion, but that is beyond the scope of this paper. But the authors touch upon the relation between tacitness and codification and human mobility and its implication for policy.

The authors claim that with the notion of tacit knowledge the traditional Arrowian appropriability argument is less valid, if not outright misleading when an important part of the innovative knowledge is de facto tacit in the given context. Consequently the authors argue that "the traditional economic case for subsidizing science and research in general collapses, as there is little or no basis for a presumption of market failure."

Consequently the rationale for subsidies of science as part of a strategic innovation policy in national systems of innovation is raised. A standard argument against public subsidy has been that other nations' researchers could free-ride by using the results of the research of our researchers, given of course that the result of such research has public good characteristics. Cowan, David and Foray write:

> A corollary of this class of arguments is that the case for granting public subsidies and tax concessions to private companies that invest in R&D would seem to be much weakened, were it not for the difficulties caused these firms by the circulation of their scientific research personnel. Scientific and engineering staff is able to carry critical tacit knowledge off to potential rival firms that offer them better terms of employment, including equity ownership in "start ups" of their own. In the logic of this approach, recognition of the criticality of tacit knowledge argues for further strengthening of trade secrecy protections, to block those "leakages" and altogether eliminate the market failure rationale for governmental support for the performance of R&D by the private sector.

The authors add in a footnote that:

> Acknowledging the importance of tacit knowledge, and thus at the initial problem [of appropriability] may not be so severe, we face a "new problem" stemming from the fact that a firm's *knowledge workers* are easily appropriated by other firms. In both cases the general issue remains however - fluidity of knowledge or information (whether transmitted through codified knowledge or labour mobility) is good for the economy but *bad for the individual firm*. [my emphasis]

This conclusion that mobility is good for the economy but bad for the individual firm cannot be a general conclusion. It is too static in its view of these processes. The individual firm (including research institute) is - as mentioned above - dependent on new people in order to get new ideas, new network connections etc. In short periods you can of course only expand, that is keep "your" knowledge workers and their tacit knowledge - and only hire new people in addition to them, but in the long run you are you have to have a certain mobility to get rid of people who has become less enthusiastic and replace them with new recruit. In short, one has to find an optimum between getting and loosing tacit knowledge. This is also related to the actual capacity of training and socialising those newly recruited and a series of other "constraints".

Later on in the same paper the authors touche upon the more dynamic aspect of these processes. They write:

> "In practice, the extent to which knowledge is codified is determined by incentives: the costs and benefits of doing so. For example, many factors - such as, to take the simplest argument, the high cost of codifying a certain type of knowledge - can decrease the incentives to go further, by lowering the private return on codification. This low rate of return can, in turn induce the maintenance of a large community of people possessing the tacit knowledge. In this case,

> there will be a labour marked that can be used to store and transfer the knowledge from firm to firm. Of course, the presence of a thick labour market as a way of transferring knowledge further reduces incentives to codify.
>
> A self reinforcing process of this kind can generate multiple equilibria. If, for example, there are high returns to codification, more knowledge will be codified. This will decrease the value of a thick labour market as a means of maintaining and distributing (tacit) knowledge. As the labour market shrinks, the relative value of codification increases further. Thus there are two possible equilibria: one with significant resources devoted to codification and a resulting high incentive to codify; and one with few resources so devoted, a thick active market for skilled labour as the mechanism for storing and dissemination knowledge, and thus low incentives to codify. This argument rests on there being substitutability in the production process between the types of knowledge transferred by these two mechanisms."

It is of course difficult to get data to prove such hypothesis, to say which of the possible equilibrium we are in, measure the substitution elasticities etc. But there is reason to believe that the rather costly travels of craftsmen in earlier centuries partly was caused by the low level of codification. One just had to learn the various crafts directly by working with those who mastered the different techniques. This is still a characteristic of the crafts and professions with an important "design" component. But I think one should also take into consideration the ever-expanding universe of knowledge. That means that when techniques become well known, codified and not the least that techniques become more user friendly, more adapted to the average user, then the knowledge frontier will move on. It will not be the same kind of knowledge that is tacit. With an expanding knowledge frontier, with a life cycle of knowledge from new, tacit to codified and trivial one might have a rather stable institutional set-up and not so different mobility rates in the labour markets for researchers since the rate of expansion is more or less the same in all developed countries. An indication that this is the case is those instances where rapid technological change means that firms cannot wait for knowledge to be codified then studied and mastered by their existing staff. Then firms have to be very active in recruiting, even use professional headhunting. This was the case with people that had some kind of competence in Internet technology in the latter half of the nineties. It was impossible to get enough "codified knowledge" to use existing staff. But one could also observe the negative effect of this scarcity - the same people changed jobs very often, which made it harder to get projects finished as key personnel left when things started to get "tough". It might be very tempting to go elsewhere - and in some cases get a significantly higher wage.

The definition of research sector

A study of the mobility of human resources related to the research sector has to start with a definition of the research sector. The definition of research is of course not uncontroversial, but in this paper we will not go into that discussion. We will use the conventional, but widely accepted concept of research and experimental development from the Frascati manual. According to this definition research is:

> [..] creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications[1].

[1] OECD Frascati Manual, 1993.

According to the 'common sense' concept of research we find the research producing entities both in universities, the institute sector and in business. If we leave aside universities, the research sector would be defined by using the current industrial NACE classification.

In NACE 'research and experimental development' is defined as NACE code 73000. This main sector is again subdivided into two parts:

- 73100, 'Research and experimental development on natural sciences and engineering'
- 73200, 'Research and experimental development on social sciences and humanities'.

This is not a very detailed subdivision. One might have expected further categories like 'basic' and 'applied' research which are widely used in the public debate and even expert discourse about research. In both cases the debate is not a 'philosophical' one, but a debate about resource allocation between 'basic' and 'applied' research. There is no consensus that this division is meaningful[2]. If one accepts this pair of concepts as useful, one still has the problem of making it empirically operational. One way to do that would be to say that 'basic' research is done at the universities since they are not contract research institutions. Many would argue that other institutions, often private, often connected to very large firms also do basic research, and maybe in some scientific fields – actually most for the 'basic' research. If not the institutional/financial arrangements can be used as a proxy for 'basic' research, one would have to evaluate the content, which would be much more controversial - and it would be also be very expensive to collect reliable data.

One might ask why there is no further subdivision between for example the social sciences and the humanities mentioned in the title of 73200. The answer might be that it is not that easy to find a way to implement such finer subdivisions in a way that would be more informative than misleading. The problem is first of all that many would argue that there is no obvious criterion for deciding what are 'social sciences' and what are humanities, besides rather accidental national conventions. Are economic history and ethnography part of humanities as opposed to all the varieties of sociology? There is a lot of cross-disciplinary research that would be difficult to classify. But maybe a further division in scientific fields like economics, law, history and political sciences is feasible. In a national context this might be done using the structure of scientific fields at the universities, in the national classification of education as a starting point. Often research institutions are characterised by the type of education of the employees. These things vary considerably from country to country, resulting in different patterns of institutes and scientific fields. Sometimes one finds economics and law combined, sometimes separate. In the last three decades there is a growing tendency to have new combinations of traditional scientific fields. One hypothesis might be that this 'confusion' reflects the fact that society is a complex system of relatively independent subsystems, but basically dependent on each other and with a common denominator in man.

Maybe it would be worthwhile to make meaningful subdivisions of the NACE 73100, the natural sciences and technology. One could imagine a division into three categories: Firstly the fields related to the study of living organisms (zoology, biology), secondly the disciplines related to dead matter (physics, geology, meteorology, hydrology), thirdly material science and engineering related

[2] Ref. to the NIFU/STEP book about research.

disciplines. Where to place mathematics, statistics and computer science would of course be a problem. They might be placed in a category of "auxiliary fields". It is not the purpose of this paper to try to solve this. The point is that one should not take the existing categories as given or as the only possible way to classify reality. As we will discuss in more detail below on a national level one often uses more fine-grained divisions of research along institutional lines, markets served, public vs. private etc.

The change in the firm ID numbers

In 1995 there was two major change in the Norwegian statistical system. Both the industrial classification system and the firm ID number system changed. The latter was a prerequisite for building up a unified business register from several separate business registers that had existed for years.

This was an operation that predictably lead to some misclassifications and other statistical artefacts. This shows up in peaks in mobility which do not reflect real job changes - only changes in ID-number of the same workplace. There are two types of artefacts: when there are changes in *establishment* ID-number when there is a change of ownership only. This should *not* happen according to the rules. But the number system used before 1995 was not robust in this respect. It used an 8-digit number for the enterprise and only attached a 3-digit number for the establishment level. That meant that when an establishment was bought by another enterprise this lead to a change in ID-number of the establishment. Also when large firms reorganised their formal structure new 3-digit numbers were introduced. There should have been - as is the case since 1995 - two separate number series and each geographical, physical workplace should have its own number[3]; one for enterprises and one for establishments.

In addition there are fusions and fissions – two workplaces merging to one, or spin-offs. Sometimes this reflects that a rather independent part/department of a research organisation is formally made into a legal unit. Since there is a new ID this will be counted as mobility - in some cases that is artificial since it no movement of people/competence only formal/legal changes. But such changes are minor and do not influence the overall picture.

The national implementation of NACE

Leaving the question of a more fine-grained classification of the research sector, it is still necessary to look at how the national implementation of the NACE classification is done for the research institutes and the universities. There are different configurations of universities, public research institutes and research firms in modern market economies, rather different even in countries as similar in many respects as the Nordic countries. In Norway for example most of the contract research is done in the institute sector, whereas in Sweden the institute sector is smaller and this type of research is to a great extent done at the universities. This has consequences for the mobility rates. One hypothesis is that applied research is generally more involved with the world outside the university. From this follows that contract researchers might have lower barriers to change jobs. This might 'bias' the mobility rates in the

[3] This is very important also for other purposes, spatial planning, environmental monitoring etc. etc.

Swedish university/industry upwards since they have more contract research at the universities.

To make the results meaningful and really comparable, one has to take a closer look at how the NACE codes have been used. There are several phenomena that needs a closer look:

"University Centres"

The last two decades there has been a growth in 'university centres'. These are research groups closely connected to the university, but not part of the traditional university structure, not having the same employment routines, the positions are not tenured etc. How do the national statistical systems treat such institutions – as part of the institute sector or as part of the university sectors?

The institute sector

In many countries it is actually the universities and the public (or at least non-profit) research institutes are regarded as the 'research sector' proper. That is because it is mostly they who produce research as their main activity. Some firms might do research for a particular company, or do only research for years before their product is on the marked, but it is in both cases doubtful if they should belong to the research sector. Some times the private research labs are not included when for example R&D statistics are made. The definition of the institute sector often based on those enterprises that get some form of basic, or long term strategic funding from the public sector although they are formally part of the state. In some cases they are "foundations", "Stiftungen" sometimes they are formally limited companies.

When it comes to the private - in the meaning of no basic or long-term funding from the public sector - enterprises classified under research they are basically of two types: One arch-type being the research departments of great firms and very specialised, often idealistic institutes that often would not be regarded as scientific by traditional scientific criteria. The latter are few and have few employees and are consequently of marginal importance.

The problem of "combined" institutes

Another problem when we want to for example compare the mobility patterns between researchers in the social sciences and the natural sciences is the emergence of combined "regional" research centres. They have departments in both natural sciences and social sciences of considerable size, and it might be rather coincidental whether they become classified as natural sciences or social sciences. Even if one of the fields were dominant when the institute first was classified over the years things may change rather radically, for example by a rapid growth in the ICT part, or by building up milieus for entirely new fields in social sciences. This shows the need for a more fine-grained system of entities in the register data. In some instances, when the regional combined institutes chose to be a shareholding company for some reason or another, often the different departments are turned into independent enterprises or establishments. If the regional institute is organised as a foundation, the statistical norms in Norway prohibit the establishment of independent statistical units. But otherwise the international statistical standards - if strictly adhered to say that if there are different activities engaging more than a certain number of persons, there should be separate establishments even if we are talking of activities that are done in the same location/building. One way of measuring the extent of such phenomena is -

besides detailed knowledge about each institute - to see what kind of educational background is most dominant - and whether that corresponds to the NACE code given to the combined institute.

The change from ISIC to NACE

In addition to these problems of using NACE we have the problem that until 1995 the industrial classification (ISIC rev. 2) did not divide research into natural sciences and social sciences. In order to get time series we then have use the NACE code in the 'transition' year, 1995 and write it back for all establishments[4] that existed in that year[5]. This has several consequences: changes in classification due to *real* changes in activity (from production to retail etc.) are not reflected - this would be possible but complicated. Generally real changes in activity are not that frequent. Our impression - and as we shall see in the research sector in Norway - most of the changes are either spurious - or changes from incorrect codes to more correct one. This problem is very visible in the years after 1995 - the change from one classification system to another predictably was not perfect from the start. This became very clear with the publishing of the 2000 data from Statistics Norway. Although there are - as there always will be - certain borderline cases, these data meant a significant cleaning up in the research sector.

These problems turn up in the case of the research sector as "peaks" in the number of employees in the research sector. A considerable amount of work has been done *manually* correct the most obvious of these wrongly classified firms in the years before 2000. In that year the new codes from Statistics Norway was to a large extent the same as the recoding that STEP group had developed for its own purposes.

	Version A	Version A	Version A	Version B	Version B	Version C	Version C
Year	Nat.sci	Soc.sci	ISIC	Nat.sci	Soc.sci	Nat.sci	Soc.sci
1986	5622	1548	2954	8549	1575	8288	1422
1987	5656	1600	3197	8681	1772	8453	1616
1988	5583	1562	3482	8642	1985	8481	1830
1989	5444	1780	3526	8574	2176	8435	2045
1990	5608	1879	4752	8683	3556	8486	3370
1991	6250	1973	3337	8826	2734	8638	2533
1992	6956	2154	2706	9284	2532	9142	2303
1993	7551	2538	2054	9517	2626	9375	2331
1994	7757	3776	244	8901	2876	8765	1347
1995	7595	3206		7595	3206	8437	1479
1996	8412	1433		8412	1433	8316	1540
1997	9622	1532		9622	1532	9684	1512
1998	9659	1379		9659	1379	9656	1511
1999	9946	1397		9946	1397	9812	1603
2000	9862	1580		9862	1580	9862	1580

The table has three different classification schemes:

Version A: only those firms who existed in 1995 and was given a NACE code in that year by Statistics Norway had their NACE code written backwards. The firms that had been part of the research sector as classified by ISIC but had disappeared in 1995 could not automatically be classified as either Natural sciences or Social

[4] It is only the establishment (production unit, workplace) that has a unique classification code. An enterprise (legal unit) might consist of many establishments belonging to different sectors.

[5] The principles and algorithm used is documented in Nås (1999).

sciences. Most of those 2000 - 3000 researchers belonged to the Natural sciences category as can be seen from the table comparing at

Version B: To get every institute classified as either Natural sciences or Soc.sci we manually classified the ISIC research sector institutes[6] and classified them into Natural sciences and Social sciences firms.

Version C: This reflects the recoding done by Statistics Norway in 2000 "written back" as far as we can trace the institutes. But the principles used in the 2000 recoding for example in not regarding the Research council(s) as research, but administration, are in our opinion correct and should be applied for the whole period.

All in all the change from ISIC to NACE, the change of firm ID's, the changing principles of classification, i.e. "what really do belong to the research sector" makes the numbers for the size of the sector more "jumpy" than they should have been.

The size of the research sector in percent of the size in 2000:

	Version B	Version B	Version C	Version C
Aar	Nat.sci	Soc.sci	Nat.sci	Soc.sci
1986	87	100	84	90
1987	88	112	86	102
1988	88	126	86	116
1989	87	138	86	129
1990	88	225	86	213
1991	89	173	88	160
1992	94	160	93	146
1993	97	166	95	148
1994	90	182	89	85
1995	77	203	86	94
1996	85	91	84	97
1997	98	97	98	96
1998	98	87	98	96
1999	101	88	99	101
2000	100	100	100	100

There are "problems" here, i.e. changes in the size of the sector as a whole and its component social sciences and natural sciences parts that we know are not reflecting reality which has been one of fairly slow stable growth. The major jump is the one from 1989 to 1990 of the Social sciences sector that affects both the B and the C versions of the classification. There are several factors contributing to this increase, but the main factor is a sudden reclassification of the Research Councils. During the eighties the relation and the attitudes around the relation between the various ministries – which roughly speaking had their own research councils and consequently their own group of institutes changed. The research councils became more independent from the ministries, and in 1993 they merged into one. As part of this process the institutes also became more independent. It is probably this process that is reflected in the industrial classification. Then in 1995 – with the change from ISIC to NACE – when every unit in principle was reclassified – the single research council went out of the research sector again. The reason why the classification of the research councils as part of the research sector is that many people on research

[6] We will use institute here, denoting both institutes and private research firms. Most of the entities belong to the public and semi-public research sector.

projects financed by the councils where formally employed by the councils. This was also the case for all kind of scholarships. According to the statistical guidelines – as soon as your main activity is research – and not research administration – you should be classified as research. That bias the estimate for the research sector upwards, to take the councils out would bias the estimate downwards. The best solution would have been to set up two units – one with research administration and one which employed all the actual researchers.

The other sources that define the research sector

The business register at Statistics Norway is of course the official definition of the research sector. There are however at least two other important sources; the "Institute Catalogue"[7] (Catalogue displaying the research units) published by the Norwegian institute for studies of research and education (NIFU) - and the "Yellow Pages".

The Institute Catalogue contains research institutes that are either public or private-non-profit institutes, many of them have core funding from the public sector[8]. The Institute Catalogue (IC) is a very useful publication. It was not made from register data, but is a list developed and maintained as a part of NIFU's work the last thirty years. It is actually not only a list of research institutes in the common sense – narrow - meaning. The list also contains "units with FoU" - - and that indicates that even for those that know the sector in detail it is not always easy to draw a line between the institute sector and other institutions and firms that do a lot of R&D. It is regrettable that the ID-numbers are not available. We have not been able to find all the units in the IC in the registers. We are lacking about 250 employees, about 200 R&D man-labour years. That is not in itself that much, but if ID-numbers had been used that would have put focus on the quality of the data, of the definitions used by Statistics Norway etc. We strongly believe that the consistency of the data would have been greatly improved if the experts on the sector (NIFU) and the experts on NACE had collaborated. It is beyond the scope of this paper to go through all the questions that turn up when one looks at this sector in detail. But fundamentally only the research institutes should have been part of the research sector. "Units with FoU" clearly has another main activity and should consequently *not* be classified as research.

The "Yellow pages" (YP) is quite different from the Institute Catalogue in that there is no authority deciding who can put themselves in "Research and development" part of the YP. If one compare the YP list with on the one hand the register data, and on the other the IC there are some interesting phenomena. Most of the firms that end up here are of course in the registers, but not all. And some of the more important research institutes do not find it necessary to be in the YP. More interesting are the firms that are in the YP, but not classified as research in the registers. As far as we can see this is for the time being not quantitatively big issues, but it poses some questions about who is to decide – and on basis of what information which firms belong to research. When looking at the firms that in the registers are classified as research, one gets the impression that this is based on what the firm reports as its main activity, and that is often not more than a couple of sentences when the firm is registered. It is not entirely unreasonable that being under research in the YP should

[7] See www.nifu.no for latest online version

[8] The Catalogue is published every second year as a bi-product of the official R&D statistics.

qualify at least for a serious consideration of whether this firm should be classified as research. There is in principle no difference between claiming to be a firm doing research when starting up and claming it by being in the YP. If the statistical authorities regarded the YP as a valuable source of information, not the least for changes in activity since reaching out to new markets often means putting your firm in a new – or even more frequent we believe in one or more additional categories in the YP.

The further development of the definition of the research sector

Our work with the research sector has revealed a set of issues that we think should be taken into consideration when analysing the available register data – and they are after all the basis for official statistics. These issues ¨have of course been the object of continuous debate and an excellent overview of definitions and their statistical consequences are given in Wiig and Christie Mathisen (1994), but since register data was in practice not available, the NACE had not been introduced into the Norwegian statistical system etc., the discussion do not relate to these issues – and of course their points of view are not the only ones possible. As W&CM emphasises the research sector is heterogeneous and there are a lot of borderline cases. But as mentioned above, the difference between research institutes and "units with R&D" should have led to the latter being taken out of the research sector. The criterion used is whether 50% of costs are related to R&D, but that is not the standard criterion for industrial classification – that is clearly the nature of the activity. If your main product is research services, then you should be in research, because then in principle all your costs are R&D related. So the way you look at costs is in fact determined by the nature of the activity and not the other way around.

Firms which are research intensive – but main product not being research

There are several examples in the registers of firms that are research intensive, but the research is clearly targeted towards developing a product. In the share of employment from such firms is not that important, but if one for example looked at stock marked value of the private firms in the research sector – the difference would at least for some years make an enormous difference.

One man research firms?

These firms are by their nature not important from an employment point of view, but as soon one starts to make averages "per firm" they may are getting more important. In our opinion it is an open question if not one-man-firms should be classified under consultancy as a general rule[9]. We shall not argue at length for this here, but we think that research is of a more collective nature, it needs to be institutionalised since close peer interaction is very important. That means that research in an industrial classification sense in almost all cases presupposes a small group, a small research laboratory, institute etc.

Maps and meteorology

It is of course a general problem of industrial classification that the institutional context is important. One example of this is the state institution that makes maps, Statens Kartverk. In the 1991 edition of the Institute Catalogue it is listed as having

[9] There is an increasing tendency that some people are not traditional employees, but have their own firm. In some cases this

600 employees. Of those between 10 – 24 is counted as R&D man years. In the register data Statens Kartverk is classified as research. In the 1995 IC it is no longer there. The following years Statens Kartverk also disappears from the register data, but not consequently – for some reason the institution making maps for marine purposes is still classified as research. Meteorology is a typical borderline case. One could argue that most of the data collection is done to forecast the weather with known models and techniques – that is according to Frascati not R&D because it lacks the element of novelty. On the other hand the Meteorological institute is doing a lot of top level research. This research department certainly belongs to the research sector, but do all the employees at the measuring stations? If they had been put there *only* for research, then clearly yes, but… This is parallel to the collection of register and other statistical data where the main purpose is administrative and political. Consequently such activities should not be classified as research. But the use of those data by social researchers and the data collected mainly for research purposes clearly should.

Towards a more detailed national classification?

We have touched upon this above and we would seriously consider if not all the work and results gathered by NIFU using a more detailed classification of the institutes would cost efficient. When NIFU used the following categories:

- Culture and society
- Environmental
- Medical
- Primary sector (agricultural, fishing and forestry)
- Technical and industrial

Actually these are only the top level categories. Wiig and Christie Mathiesen (1994) has an appendix where a more detailed categorisation is presented. All in all thirteen categories. These are the result of the Nordic co-operation around these issues. Maybe thirteen is a bit detailed, too few units in each sector. But clearly a common and more detailed definition would be very useful for many policy contexts – and as part of the industrial classification in the business register – not only as a specialised statistical survey.

The university sector

Thirty years ago this was a clear cut concept in Norway, but the development of the regional-university level high schools made it difficult to tell how big the university sector actually was since a lot of the of university level education was in relation to the regional colleges. And it is not certain that the quality of these high schools were markedly lower. Since there was stagnation in the number of jobs at traditional universities after a rapid expansion in the sixties many of the young and promising ended up in the ‘province’. Given modern transport, and not at least e-mail/ Internet, the province is not so provincial anymore. Anyhow the tendency was that the ‘provincial’colleges who were not intended to give higher university degrees and not at all PhDs ended up doing just that, so by now even the formal difference based on the levels of degree they could issue has vanished to a large extent. Consequently we

argue in this more general analysis of the diffusion of knowledge via human mobility that the regional university-level high schools should be treated as the traditional universities.

The institute sector – and consultancy

The division between research and consultancy is of course not always straightforward. One might say that consultancy is to apply already accumulated knowledge to give advice to those who do not master this body of accumulated knowledge, while research is to generate knew knowledge by solving applied problems[10] – and generating new knowledge in that process. In reality it is not always that black and white. Which projects end up to be solved by consultancy firms and by research institutes might be rather coincidental. There is in Norway an increasing tendency that research institutes and consultancy firms compete directly about the same public and (to a lesser extent) private research projects. This is a clear indication that at least the public authorities do not see any fundamental difference between the consultancy firms and 'their' (semi) public research institutes. In addition there has been a rather rapid growth in the consultancy sector. Again one could look at the educational background and career of the employees in the institute sector and the consultancy sector to see if there is any marked difference. These questions will not be pursued in this paper.

The overall sectoral breakdown

There are several factors that have determined the industrial breakdown used in this paper. Generally one like as much detail as possible since that gives a richer, less coarse picture of the knowledge flows. However one has to take into consideration the need to have a manageable number of sectors. Even on a two-digit level the NACE classification has 60 sectors. In addition there must not be too few mobile persons in each sector. If the breakdown is rather detailed like two-digit NACE the mobility rates will be very "jumpy" since there are very few persons mobile in each sector. Even the so-called two-digit NACE used in R&D statistics and in the Community Innovation Survey (CIS) has 30 sectors, which still are quite hard to present on an A4 page and sometimes even harder to grasp. In addition this paper focus on the time dimension of mobility of researchers, looking at the trends and variation in the mobility over time. As a consequence we have chosen a breakdown where the research producing sector is divided in three: universities, and R&D establishments - most of them public or semi-public research institutes. The R&D establishments are divided into Natural and Social Sciences. The rest of the economy is divided very roughly into some "meta" sectors (goods, services) and some more specialised sectors, ICT and "Other education".

There are obvious arguments for looking at the ICT sectors separately given their central role in the development and diffusion of today's new and highly dynamic generic technology. Other education is singled out since there is a special relation

[10] "Applied problems" must be understood as beeing on many levels and include "basic" research, that is research where the problem is stated in rather general terms, like "understand the strutcure of materials better" is regarded as applied, problem oriented research.

between the research producing sectors and education in terms of labour market. A pragmatic reason is that this breakdown is used in the other Nordic countries in their studies of the mobility of researchers. And since we are in an very early stage of research in this field there are not yet strong evidence saying that one particular breakdown has the right mix of detail and aggregation, i.e. that best captures the the interesting flows in the system.

Goods producing	Manufacturing, Construction, Energy, Mining, Agriculture, Fishing, Forestry,
ICT sectors	Computer hardware, Computer services, Telecom (30, 32, 642)
Services (products)	Wholesale and retail trade, Transport, Post
R&D inst. Nat.Sci.	NACE 73100 (the most detailed possible)
R&D inst. Social Sc.	NACE 73200 (the most detailed possible)
Services (humans)	Administration, Health, Social services (public and private)
Other Education	NACE 80309-80399
Universities	NACE 80301-80308

Earlier studies on researcher mobility

There are a few earlier studies of researcher mobility in Norway. There are the pioneering works of Baklien, Wille Maus and Skoie (1975) and Berge (1981). Both studies used the Norwegian register of employees of university and research institutes and then by "manual" means found out where those that had quit had moved. With the very rapid expansion of the research-producing sector it became clear that only the use of databases could make it possible to have such mobility studies without cost being prohibitive. The next round of studies came more than ten years later, see Tvede (1992) and Kyvik and Tvede (1994), when the development of databases and computers made it much more feasible to do such studies. These studies also took as their starting point the register of research personnel. But their main focus was on the relationship between the institute sector and the universities. The mobility to other sectors was not studied in much detail. That of course was to a large extent a result of the fact that the data for making such studies possible were not available – or more correctly - not easily accessible. At the same time there was done a serie of ad hoc surveys on researcher mobilitywas done, which focussed on the mobility to the private business sector (Riiser and Wiig, 1993, 1993, Ekeland, Riiser and Wiig 1994). These studies were not done using the RPR (Research Personnel Register) but by sending surveys by fax to the institutes.

This changed when Statistics Norway started producing a set of matched employee-employer files in the mid-nineties. Then there came some of studies that looked at the mobility of researchers between the research producing sectors and the rest of the economy. Either as their main focus as in Tvede and Sarpebakken (1998) or as a part of broader studies Nås et al. al (1998)

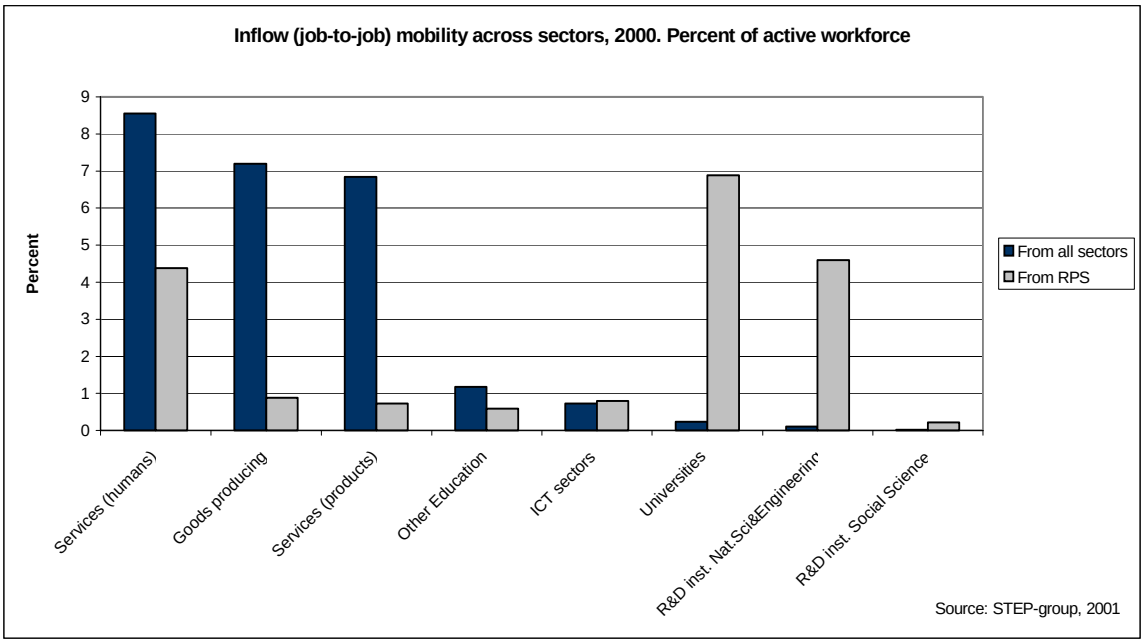
Of the two studies Tvede and Sarpebakken (1998) is of most relevance to this paper. Their starting point is the RPR to which they join data from the matched employer-employee files. The period of study is generally from 1989 to 1995 but differs between outflow and inflow, and between universities and institutes. A discussion of

the results is outside the scope of this paper, but not surprisingly there is a great deal of stability. This is of course as expected for tenured persons form the universities to other sectors. There is more mobility from the institute sector. This is as expected, but is also an effect of the fact that since there is no tenure system in the institute sector it is not a formal characteristic of the researcher that he is tenured. That means that the mobility rates includes young people, and they are always more mobile. The population also include people working on special, projects on an engagement bases. It would have been interesting to delineate a group of "senior, experienced" researcher and compare their mobility with the tenured persons at the university. This could be done using age, wages, number of years in the institute sector etc. Another alternative would be to use the classifications of researchers used by the institutes themselves – which often parallel the "lecturer, assistant-professor, professor". But all institutes do not use this system so there would be some tedious manual work to classify all researchers in the institute sector this way.

Tvede and Sarpebakkken uses a four year period as a consequence of the sampling period of the RPS in ordere to get a "thicker" stream of mobile persons. This is maybe easier to understand as a "survival rate" than a mobility rate, which often is calculated on a 12 months basis. In this paper we use a yearly rate. But the rates are not comparable since we do not use the RPS as the "population", but all employees in the research sector, and all employees at the universities. That means that we include more young persons early in their career. These people are much more mobile than the more senior person is. The rates in this paper are then generally higher than in Tvede and Sarpebakkken.

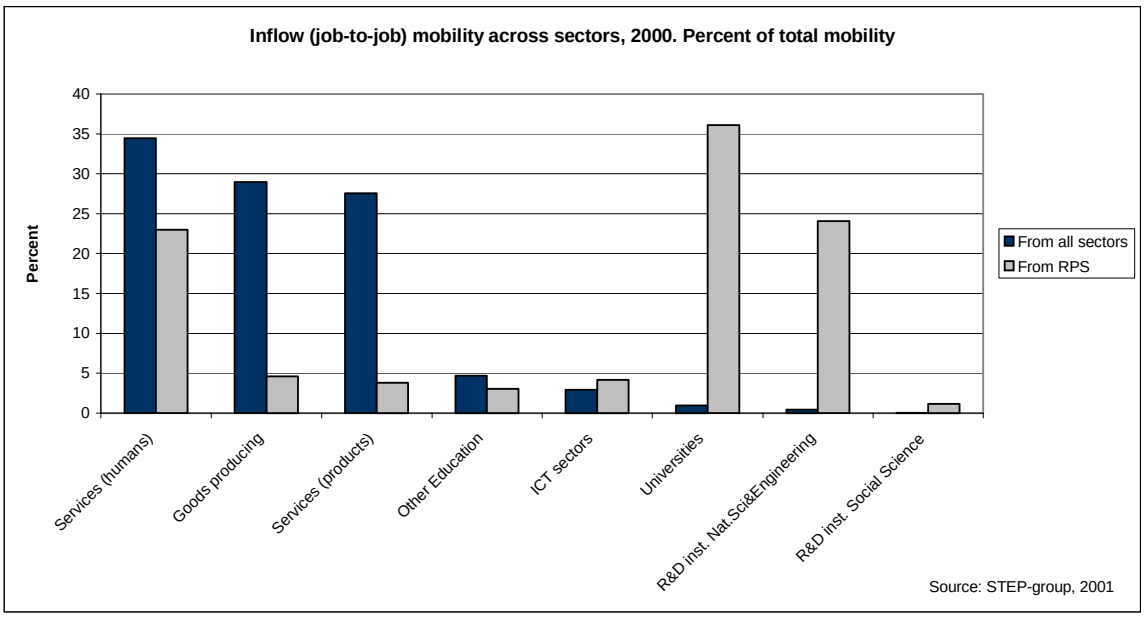
The original intention was to use the RPR with its detailed information about occupation/position of university personnel, but due to various institutional and time constraints that was not possible. Consequently we decided to focus on the major patterns of the flows in a longer period 1987-2000 in order to observe the variations from year to year. In coming studies one should use the RPR and the matched employer-employee files to the maximum, both the details about position, type of institute etc. and the full time span of the matched employer-employee files.

Figure 1:



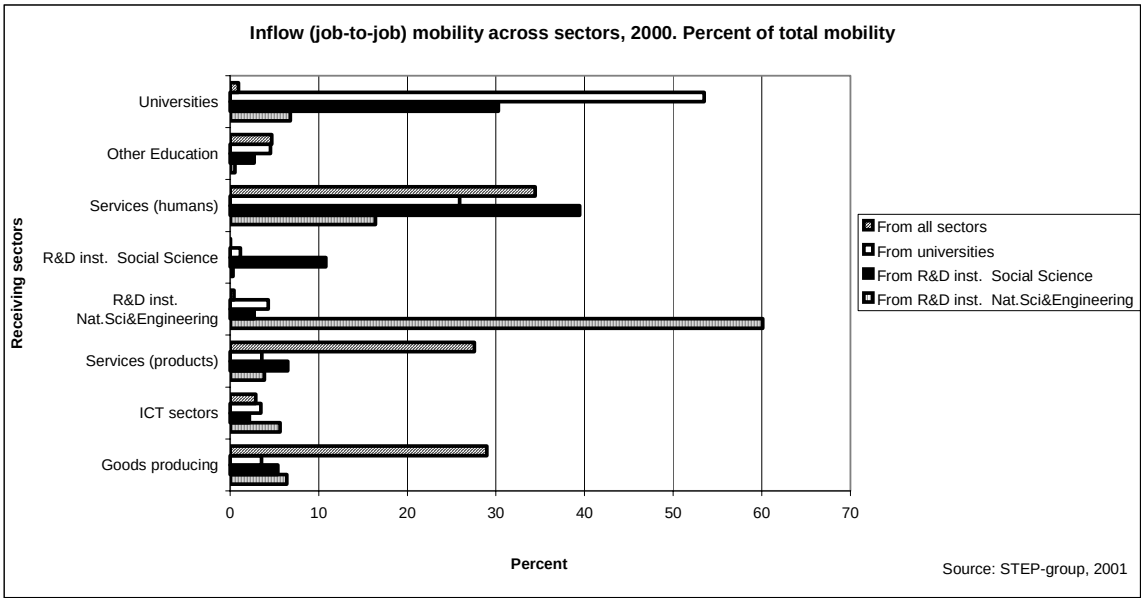
When looking at the overall mobility rates for year 2000, we see that services and goods producing sectors are the major receiving sectors of people changing jobs from all sectors. When focusing only upon people changing jobs from the RPS (the research producing sector), we see that the majority of these move to universities and R&D inst. natural sciences. A significant share also moves to human services, a sector including consulting, teaching and administration. Figure 2 below, illustrated as percentages of total mobility, shows the same pattern, although with a relatively larger share of people moving from the RPS than from 'all sectors' when compared to the percentage distribution of active workforce in figure 1.

Figure 2:



The share of people moving from all sectors to jobs in the RPS is below 1 percent for all the three types of RPS.

Figure 3:



When looking at the mobility rates (of total mobility) from the RPS to all sectors, both universities and R&D inst. natural sciences. have high internal mobility rates, varying from 53-60%. Opposed to this pattern, only 11% of personnel changing job in R&D institutes of social sciences. moves to another job in the same sector. The majority of personnel moving from R&D institutes of social sciences. moves to human services, whereas a significant share similarly moves to universities.

Table 2:

Inflow (job-to-job) mobility rates across sectors, 2000. Percent of active workforce

	Goods producing	ICT sectors	Services (products)	R&D inst. Nat.Sci & Engineering	R&D inst. Social Science	Services (humans)	Other Education	Universities	Sum mobility	Same Job	Grand Total (N = 1 865 258)
Goods producing	22		3			2			27	73	100
ICT sectors	2	13	3			4			23	77	100
Services (products)	3	1	18			4			25	75	100
R&D inst. Nat.Sci&Engineering	1	1	1	13		4		1	21	79	100
R&D inst. Social Science	1		1		2	6		4	14	86	100
Services (humans)	2		3			18	1		25	75	100
Other Education	1		1			5	9		17	83	100
Universities	1	1	1	1		5	1	10	18	82	100
Grand Total	7	1	7			9	1		25	75	100

When looking at the overall mobility rates for 2000, human services is the sector which receives the highest share of moving personnel, followed by product services and goods producing. The internal mobility rates vary from 10 to 20 percent across the different sectors. Focusing on the RPS, both kinds of R&D institutes and universities have low inflow mobility compared to the other sectors. R&D institutes social sciences. has the lowest internal mobility of the three kinds of RPS.

Figure 4:

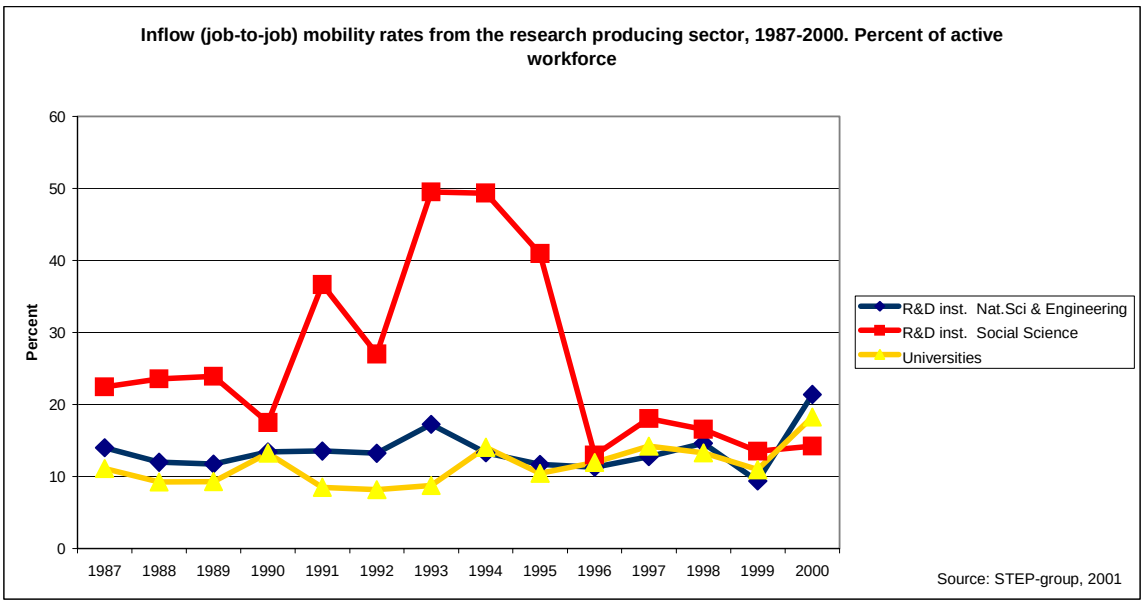


Figure 4 illustrates the inflow mobility from the different types of RPS to all sectors from 1987 onwards. R&D inst. natural sciences. and universities show more or less the same mobility pattern during the period, whereas R&D institutes of social sciences. has a significantly higher and more irregular mobility pattern than the other

two. This variance can partly be explained by the relatively low numbers of employees in the R&D social sciences., according to figure 5 below.

Figure 5:

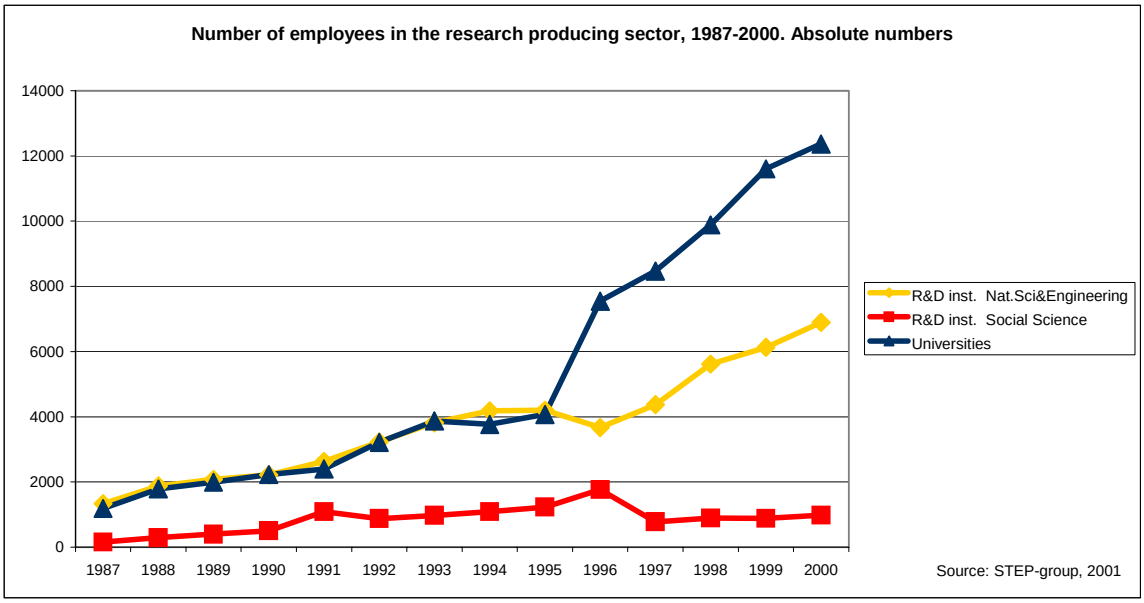


Table 3:

Delivering sector: Universities. Inflow (job-to-job) mobility rates, 1987-2000. Percent of active workforce

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci & Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility	Same Job	Grand Total
1987	1		1	1	1	5	1	1	11	89	100
1988	1		1	1	1	4	1		9	91	100
1989			1	1	1	3	1	1	9	91	100
1990	1		1	1	5	3		2	13	87	100
1991	1		1	1	1	4	1	1	8	92	100
1992	1		1	1	1	3	1	1	8	92	100
1993	1		1	1	1	3	1	1	9	91	100
1994	1		1	1	1	4	1	6	14	86	100
1995	1		1	1		5	1	2	10	90	100
1996	1		1			5	1	4	12	88	100
1997	1	1	1	2		6	1	3	14	86	100
1998	1	1	1	1		5	1	4	13	87	100
1999	1		1	1		5	1	2	11	89	100
2000	1	1	1	1		5	1	10	18	82	100
Average	1		1	1	1	4	1	3	12	88	100

The overall mobility rate varies around ten percent throughout the period, showing a slightly increasing tendency. Of personnel moving from universities a significantly higher share move to services than to other jobs in the same sector.

Table 4:

Delivering sector: R&D institutes within social sciences. Inflow (job-to-job) mobility rates, 1987-2000. Percent of active workforce

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci & Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility	Same Job	Grand Total
1987	2		1	2	1	9	2	6	22	78	100
1988	2	1	2	1	3	9	1	6	24	76	100
1989	1		2	1	6	7	1	5	24	76	100
1990	1		2	1	3	6	1	5	18	82	100
1991	1		4	2	4	11	1	13	37	63	100
1992	1		2	4	3	7	2	8	27	73	100
1993	1		1	1	35	5	1	6	50	50	100
1994	1		2	2	31	5	1	7	49	51	100
1995	1			3	6	8	2	21	41	59	100
1996	2			1	1	4	1	3	13	87	100
1997	1	1	1	1	3	7	1	3	18	82	100
1998	1	1	1	2	2	6	1	3	17	83	100
1999				1	3	5	1	2	13	87	100
2000	1				2	6	1	4	14	86	100
Average	1		1	2	7	7	1	7	26	74	100

One pattern that emerges from table 4 is that the overall mobility decreases during the period, and this influences the mobility flow to most of the sectors. A significant share of personnel however moves from R&D institutes of social sciences. to the universities. With a few exceptions (1991 and 1995) this tendency seems to increase until the mid nineties, and then decrease until 2000 ending on a lower level than in 1987. The overall mobility from R&D institutes of social sciences. also seems to decrease during the period. Again the numbers for 1991 and 1993-1995 seem to deviate from the overall pattern. The transition from ISIC to NACE in 1995 might be part of an explanation of why this is so. Within RPS R&D institutes of social sciences. has the highest flow of personnel to the other two parts of RPS.

Table 5:

Delivering sector: R&D institutes within natural sciences. Inflow (job-to-job) mobility rates, 1987-2000. Percent of active workforce

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci & Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility	Same Job	Grand Total
1987	2			4		3	2	1	14	86	100
1988	2	1		1	1	4	2	1	12	88	100
1989	3			2	1	3	1	1	12	88	100
1990	2			5	1	2	1	2	13	87	100
1991	2			7		2	1	1	14	86	100
1992	2			4	1	2	2	2	13	87	100
1993	1			11	1	2	1	2	17	83	100
1994	1			1	3	5	1	1	13	87	100
1995	3	1		2		3	2	2	12	88	100
1996	1	1		3		4	1	1	11	89	100
1997	2	1		3		4	1	1	13	87	100
1998	2	1		4		5	1	1	15	85	100
1999	1	1		2		3	1	1	9	91	100
2000	1	1		13		4	1	1	21	79	100
Average	2	1		4	1	3	1	1	14	86	100

Of the three kinds of RPS, R&D institutes within natural sciences is the only one

where the internal mobility within the sector has the highest mobility rates. The flow of personnel from R&D inst. natural sciences. to universities and R&D social sciences. is similarly very low. A higher share of personnel move to goods producing sector than to universities and R&D soc. sci.

Table 6:

Delivering sector: Universities. Inflow (job-to-job) mobility rates of highly educated personnel, 1987-2000. Percent of total mobility

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility (%)	Sum mobility (absolute numbers)
1987	10	3	6	17	17	39	4	4	100	396
1988	7	2	8	15	20	39	4	4	100	411
1989	4	1	6	21	17	38	4	10	100	378
1990	3	1	4	10	49	19	1	13	100	497
1991	9	2	9	18	15	38	2	6	100	500
1992	8	2	8	22	17	27	3	11	100	592
1993	6	2	11	18	14	39	3	7	100	810
1994	5	2	11	12	10	28	3	28	100	579
1995	4	3	6	7	5	52	4	19	100	496
1996	8	4	6	5	2	37	4	34	100	435
1997	6	3	7	17	2	38	2	25	100	506
1998	7	4	6	8	2	38	3	32	100	585
1999	6	4	10	8	4	44	5	20	100	444
2000	3	3	5	6	1	23	2	57	100	1071
Average	6	3	7	13	13	36	3	19	100	550

The majority of personnel changing job from universities move to human services, which is mainly constituted by public sector. The share of personnel moving to a new job within the university system is surprisingly low, especially until the mid nineties. Until the mid nineties there is a considerable share moving to new jobs in the institute sector. It seems that from the mid nineties the universities have taken over some of the personnel that used to go to the institute sector.

Table 7:

Delivering sector: R&D institutes within social sciences. Inflow (job-to-job) mobility rates of highly educated personnel, 1987-2000. Percent of total mobility

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility (%)	Sum mobility (absolute numbers)
1987	4	1	7	11	7	36	3	32	100	180
1988	3	2	8	5	14	35	2	30	100	229
1989	1	1	8	6	26	30	1	27	100	271
1990	5	1	12	6	15	28	2	31	100	236
1991	3	1	7	7	10	28	2	43	100	803
1992	4	1	6	15	15	22	4	33	100	388
1993	1	1	3	2	70	8		15	100	783
1994	1		4	5	64	9		17	100	806
1995	2	1	1	7	10	18	2	58	100	784
1996	13	5	2	7	6	32	5	31	100	219
1997		3	5	8	20	33	5	26	100	124
1998	4		5	17	14	30	2	29	100	131
1999	2	1	2	6	24	36	4	24	100	96
2000	3	2	2	3	15	36	3	35	100	124
Average	3	1	5	8	22	27	3	31	100	369

The majority of personnel changing job from R&D institutes within social sciences move to jobs in universities, human services or to another job within the same sector. There is also, perhaps surprisingly, a considerable share of personnel moving to R&D institutes within natural sciences.

Table 8:

Delivering sector: R&D institutes within natural sciences. Inflow (job-to-job) mobility rates of highly educated personnel, 1987-2000. Percent of total mobility

	Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility (%)	Sum mobility (absolute numbers)
1987	14	3	3	27	6	24	6	18	100	477
1988	12	5	5	13	10	28	7	18	100	397
1989	15	3	5	25	7	22	4	19	100	432
1990	10	3	2	37	10	15	4	18	100	746
1991	15	3	4	42	3	17	3	14	100	386
1992	16	1	3	35	5	14	11	16	100	433
1993	8	1	1	60	5	10	4	11	100	496
1994	8	3	4	13	30	28	4	11	100	603
1995	21	4	1	14	3	28	8	21	100	526
1996	13	9	2	21		31	6	18	100	978
1997	20	8	1	19	2	28	6	16	100	1249
1998	18	10	1	22	1	29	6	13	100	1169
1999	15	11	2	24	1	27	6	13	100	1003
2000	5	6	1	63	1	13	2	10	100	1872
Average	14	5	2	30	6	23	6	15	100	769

Whereas the majority of personnel moving from universities or R&D institutes within social sciences moves to other sectors, the majority of people changing jobs in R&D institutes within natural sciences change jobs *within* the sector. A significant share also moves to human services. Except for certain years, there is a very modest share moving from R&D inst. natural sciences. to R&D institutes of social sciences. As one might expect, there is a considerable workflow between R&D inst. natural sciences. and the goods producing sector.

Table 14:

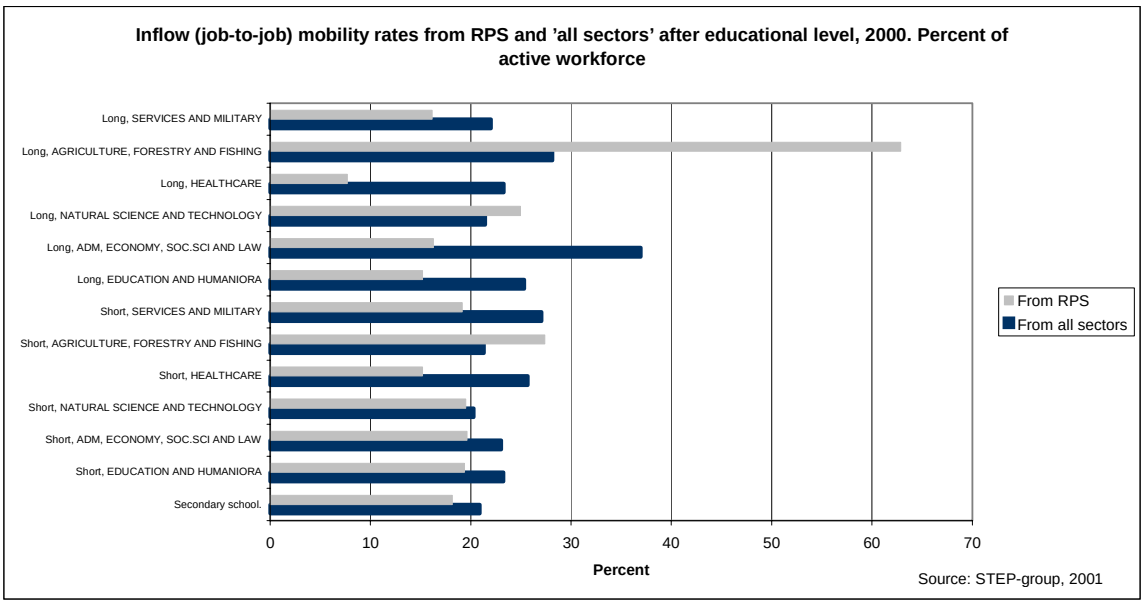
Delivering sector: The research producing sector. Inflow (job-to-job) mobility rates of highly educated personnel, 1987-2000. Percent of active workforce

		Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility	Same Job	Grand Total (percent)
R&D inst. Nat.Sci&Engineering	1987	2			4	1	3	1	2	14	86	100
R&D inst. Social Science	1987	1		2	3	2	9	1	8	25	75	100
Universities	1987	1		1	2	2	5		1	12	88	100
R&D inst. Nat.Sci&Engineering	1988	2	1	1	2	1	4	1	3	14	86	100
R&D inst. Social Science	1988	1	1	2	1	4	9		8	26	74	100
Universities	1988	1		1	2	2	4			10	90	100
R&D inst. Nat.Sci&Engineering	1989	2		1	3	1	3	1	2	13	87	100
R&D inst. Social Science	1989			2	2	7	8		7	27	73	100
Universities	1989			1	2	2	4		1	11	89	100
R&D inst. Nat.Sci&Engineering	1990	2	1		6	2	2	1	3	16	84	100
R&D inst. Social Science	1990	1		2	1	3	6		6	20	80	100
Universities	1990	1		1	2	9	3		2	18	82	100
R&D inst. Nat.Sci&Engineering	1991	2		1	6		3		2	15	85	100
R&D inst. Social Science	1991	1		3	3	4	12	1	19	44	56	100
Universities	1991	1		1	2	1	4		1	10	90	100
R&D inst. Nat.Sci&Engineering	1992	3			6	1	2	2	3	18	82	100
R&D inst. Social Science	1992	1		2	4	4	6	1	9	28	72	100
Universities	1992	1		1	2	2	3		1	10	90	100
R&D inst. Nat.Sci&Engineering	1993	2			14	1	2	1	2	23	77	100
R&D inst. Social Science	1993	1	1	2	1	40	4		9	57	43	100
Universities	1993	1		1	2	1	4		1	11	89	100
R&D inst. Nat.Sci&Engineering	1994	1		1	2	5	4	1	2	16	84	100
R&D inst. Social Science	1994			2	3	36	5		10	56	44	100
Universities	1994	1		1	2	1	4		4	13	87	100
R&D inst. Nat.Sci&Engineering	1995	3	1		2		4	1	3	14	86	100
R&D inst. Social Science	1995	1	1	1	3	5	9	1	29	50	50	100
Universities	1995			1	1	1	6		2	11	89	100
R&D inst. Nat.Sci&Engineering	1996	2	1		3		4	1	3	14	86	100
R&D inst. Social Science	1996	2	1		1	1	5	1	5	15	85	100
Universities	1996	1		1	1		4		4	12	88	100
R&D inst. Nat.Sci&Engineering	1997	3	1		3		4	1	2	15	85	100
R&D inst. Social Science	1997		1	1	1	3	6	1	4	17	83	100
Universities	1997	1		1	2		5		4	14	86	100
R&D inst. Nat.Sci&Engineering	1998	3	1		3		4	1	2	15	85	100
R&D inst. Social Science	1998	1		1	3	2	5		5	16	84	100
Universities	1998	1		1	1		5		4	12	88	100
R&D inst. Nat.Sci&Engineering	1999	2	1		3		3	1	1	11	89	100
R&D inst. Social Science	1999				1	3	5	1	3	13	87	100
Universities	1999	1		1	1		4		2	10	90	100
R&D inst. Nat.Sci&Engineering	2000	1	1		16		3	1	2	25	75	100
R&D inst. Social Science	2000					2	5		5	15	85	100
Universities	2000		1	1	1		4		10	18	82	100

The table above illustrates the mobility patterns of highly educated personnel within the research producing sector from 1987-2000. Universities have the lowest mobility rate of the three units within this sector, followed by R&D inst. natural sciences. The overall pattern is that the mobility flow varies between 10% to 20% for highly educated personnel, and also that both universities, R&D inst. natural sciences. and

R&D institutes of social sciences. have a more similar mobility pattern from the mid nineties and onwards.

Figure 6:



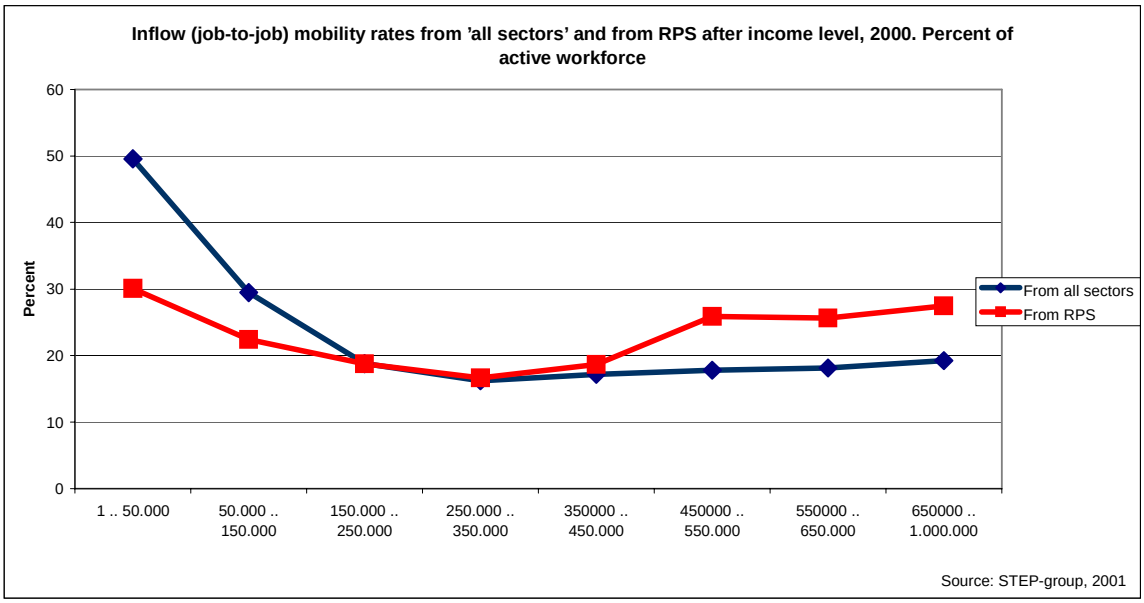
As we see, there is no obvious pattern between the level of education and mobility rates. Neither are there any clear tendencies to comment upon between the research producing sector in relation to 'all sectors', except that the mobility rates from the RPS are slightly lower than the rates from all sectors. The RPS mobility rate might seem slightly more varying, but this is rather due to few units in the data material. Among personnel with long higher education (three years or more), the average mobility rate across all sectors is 26 %. The corresponding average number for personnel with short higher education (less than three years) is 22 %. This means higher education gives higher mobility independent of sectors. In the RPS however, the mobility rates between short and long higher education are more or less the same.

Table 15:

Inflow (job-to-job) mobility rates of highly educated personnel, 2000. Percent of active workforce

	Goods producing	ICT sectors	Services (products)	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Other Education	Universities	Sum mobility	Same Job	Grand Total (N = 117 346)
Goods producing	15	1	2			4			23	77	100
ICT sectors	1	15	2	1		4		1	24	76	100
Services (products)	3	2	15			6			27	73	100
R&D inst. Nat.Sci&Engineering	1	1	1	16		3		2	25	75	100
R&D inst. Social Science					2	5		5	15	85	100
Services (humans)	1	1	1			26	1	1	31	69	100
Other Education						3	7	1	12	88	100
Universities		1		1		4	1	10	18	82	100
Grand Total	3	2	2	1		15	1	2	26	74	100

Figure 7:



When studying the mobility rates according to income, there seems to be a tendency towards a disproportionate relation between income and mobility until a certain income level. The higher income, the lower mobility seems to be the rule until an income level of 350.000 NOK. When exceeding this income level, the mobility rates slightly increase. This pattern holds for both 'all sectors' and for 'the research producing sector.' The mobility rates however increase more when exceeding 350.000 NOK in 'the research producing sector' than the corresponding rate for 'all sectors'. This might be seen as an expression of a higher degree of 'freedom' related to the RPS than from traditional managerial jobs. Researchers have the possibility to switch between jobs and projects without causing too comprehensive consequences for the research institute, whereas other managerial jobs might be more attached to the job and the locality.

Table 16:

Inflow (job-to-job) mobility rates of personnel with income more than NOK 250 000 p.a. across sectors, 2000. Percent of active workforce

	Goods producing	ICT sectors	Services (products)	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Other Education	Universities	Sum mobility	Same Job	Grand Total (N = 810 713)
Goods producing	10 %		2 %			2 %			14 %	86 %	100 %
ICT sectors	1 %	13 %	3 %			3 %			21 %	79 %	100 %
Services (products)	2 %	1 %	13 %			2 %			19 %	81 %	100 %
R&D inst. Nat.Sci&Engineering	1 %	1 %	1 %	14 %		3 %		1 %	22 %	78 %	100 %
R&D inst. Social Science	1 %		1 %	1 %	2 %	5 %		4 %	14 %	86 %	100 %
Services (humans)	2 %	1 %	2 %			13 %	1 %		18 %	82 %	100 %
Other Education						3 %	8 %		12 %	88 %	100 %
Universities				1 %		4 %	1 %	10 %	17 %	83 %	100 %
Grand Total	4 %	1 %	5 %			5 %	1 %		17 %	83 %	100 %

Compared to the similar numbers for personnel with higher education independent of income level, the mobility among the higher educated is higher than among personnel with income more than NOK 250000-. This means education is a stronger variable than income level when discussing factors that influence on mobility.

Table 17:

Inflow (job-to-job) mobility from RPS across sectors and gender, 2000. Percent of total mobility

		Goods producing	ICT sectors	Other Education	R&D inst. Nat.Sci&Engineering	R&D inst. Social Science	Services (humans)	Services (products)	Universities	Sum mobility	Mobility rate of total workforce	Grand Total (active workforce)
	Female	5	3	1	58		22	5	7	100	21	3580
R&D inst. Nat.Sci&Engineering	Male	7	7		61		13	3	7	100	22	5722
	Female	5		3	2	11	45	11	25	100	11	588
R&D inst. Social Science	Male	6	3	3	3	11	37	4	33	100	17	716
	Female	3	2	8	3	1	33	4	47	100	16	8619
Universities	Male	4	5	2	5	1	21	3	58	100	20	10123
Grand Total		5	4	3	24	1	23	4	36	100	19	29348

When studying the distribution of mobility rates between the sexes the overall pattern (independent of sector) is that men tend to have higher mobility rates than women. In 2000 the job-to-job-mobility rate for men independent of sector was 26% (of active workforce), whereas the mobility rate for women was 23% (of active workforce). The corresponding number for the RPS is respectively 21% (of active workforce) for men and 17% (of active workforce) for women. The relation between the sexes turns out to hold across both types of R&D institutes (natural sciences and social sciences.) and universities, although this tendency seems to be weaker for R&D institutes within natural sciences.

The table above states the mobility rates across sectors (of total mobility) and the relation between the sexes. Within the RPS, R&D institutes within social sciences have the lowest degree of internal mobility. When comparing the number of personnel from the RPS moving to other sectors, the largest receiving sector is human services (public sector). As we see, there is a higher share of women moving to human services than men. This pattern holds for all three types of RPS. On the other hand, and not so surprisingly, there is a higher share of men moving to the goods producing sector and ICT sectors.

One might expect that a higher share of personnel from R&D institutes within natural sciences moves to goods producing sector than personnel from R&D institutes within social sciences. Therefore it is perhaps interesting and surprising to note that the two types of institutes have about the same mobility rates to the goods producing sector. This pattern is to a certain extent influenced by the way of calculating the numbers. Here, the findings are based upon mobility rates of total mobility, whereas the findings do not become that clear if one calculates the mobility in relation to and as a percentage of total workforce.

Conclusion

Since this paper has been a explorative one, having more the character of looking for patterns than answering one particular hypothesis we will round up this by focussing on those findings and those aspects of the data that we found the most interesting.

The high share of researchers mobility to to the ICT sectors

As shown in figure 1 the inflow mobility to the ICT sectors more than 50% of the inflow is from the research producing sector. That is a high share and the consequences are well-know: that the university and institutes sector are drained. Students do not finish their degrees, teaching and research posititions are vacant. Which in its turn is just another way of saying that demand for ICT skills are way above supply, raising wages in the private sector in order to attract skills. The long term underinvestment in the production of ICT skills must inevitable result in marked imbalances and a mobility that is to high from the RPS sector. Such a high mobility is an obstacle for knowledge accumulation and development in the research sectors being non-optimal in the long run.

The high general high rates of mobility

As many studies now confirm. The Norwegian and other Nordic mobility rates are high. Seldom below 10%, as a general rule around 15% in job-to-job mobility for people above 25 years, and not infrequently higher. The mobility of researchers is of course higher for the younger since mobility declines monotonically with age. Part of this mobility we think are “artificial”, that is a result of how firm ID numbers are allocated and changed. But even if we take that into consideration there is no need to stimulate mobility on a large scale or for rearchers in particular.

The need for high quality data - use of all data sources

The original intention was to use the Research Personel Register. That would have enabled us to look at the researchers more specifically. This has probably the greatest consequences for the mobility from the Universities. In the present study we cannot look at tenured persons separately. That means that we get that stable group mixed up with all kind of temporary assignments, even when looking at the highest level of education. This biases the mobility rate from the university sector upwards, making it hard to draw any policy conclusions about the university sector specifically.

The other problems, the problem of the quality of the industrial classification of especially the social science part of the research sector introduces so much noise in the data that serious analysis becomes impossible. But in a way this is as expected. Until now nobody has looked at the the two subsectors of research in detail over many years and consequently the anomalies in the data are not revealed.

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STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.