DOCUMENT RESUME

ED 480 303 CE 085 360

AUTHOR	Ekeland, Anders; Tomlinson, Mark
TITLE	The Supply and Demand of High Technology Skills in United Kingdom, Norway and Netherlands: A Report from the European Science and Technology Observatory (ESTO).
REPORT NO	EUR-20122-EN
PUB DATE	2001-10-00
NOTE	141p.; Produced by the European Commission, Joint Research Centre.
AVAILABLE FROM	For full text: ftp://ftp.jrc.es/pub/EURdoc/eur20122en.pdf.
PUB TYPE	Reports - Research (143)
EDRS PRICE	EDRS Price MF01/PC06 Plus Postage.
DESCRIPTORS	Access to Education; Developed Nations; Economic Change; Employment Patterns; Foreign Countries; *Job Skills; Labor Force; *Labor Needs; *Labor Supply; Occupational Information; *Occupational Mobility; Occupational Surveys; *Research Utilization; Skill Development; Statistical Data; Statistical Studies; Statistical Surveys; Supply and Demand; *Technological Advancement; Training
IDENTIFIERS	Economic Indicators; *Europe; Netherlands; Norway; United Kingdom

ABSTRACT

This document reports a study of the possibility of making indicators of demand and supply of high skilled labor based on the Labor Force Survey (LFS), a data source available in all European countries. Part 1 is a summary of a pilot study of three countries: United Kingdom (UK), Netherlands, and Norway. It concludes LFS is a limited data source for stock and flow variables. Part 2, the UK report, describes a pilot study of possibilities in the under-explored area of labor mobility research and its relation to innovation and competitiveness in the UK. It outlines possible data sources, published sources, and case study materials that can be used in a national systems framework for future work in mobility and human capital allocation and formation. Part 3, the Norwegian study, has two aims: to study development of high tech sectors in terms of labor mobility and supply of training and to use and discuss the strengths and weaknesses of Norway's register data and LFS. Part 4, the Dutch study of supply and demand for high technology skills, examines skills in the high tech sectors of the Dutch economy. After a literature review, the study looks at trends in the economy as a whole to delineate more general trends in the Dutch economy from the more specific development of the chosen high tech sectors; distribution of training in the Dutch labor market; and mobility of highly skilled persons in the Dutch economy. (YLB)

The supply and demand of high technology skills in United Kingdom, Norway and Netherlands

a report from the European Science and Technology Observatory (ESTO)

Anders Ekeland
STEP Group,
Studies in technology, innovation and economic policy
Storgaten 1,
N-0155 Oslo,
Norway

and

Mark Tomlinson,
CRIC, University of Manchester
University Precinct Centre
Oxford Road
Manchester M13 9QH
United Kingdom

Co-ordinator at IPTS

Odd Björn Ure, visiting scientist

Seville, October 2001.

PREFACE

Policy measures in a knowledge-intensive society should rely on solid information on the skill structures in the sectors of which the economy is composed. This was the underlying idea when IPTS launched the study. It attempts to find out how useful statistics from the Labour Force Survey are in the delineation of labour demand and supply in seven high technology sectors.

It turned out that there are substantial differences in skill structures and with regard to the provision of training, also at national level, among the three countries covered. Furthermore, this phenomenon is observed in sectors that often are grouped together and considered as quite similar, like computer and telecommunication services. A "one size fits all" training strategy is therefore questioned by the authors.

A comparison of how the seven high tech sectors contribute to the overall employment share in national economies, indicate that these sectors are not employment generators per se, with the exception of computer services characterised by rapid growth and high skill intensity. When interpreting these findings one should bear in mind that the study had a limited scope. However, the results are interesting for contemporary research and debate on the relationship between technology, economy and employment.

High Tech Sectors In A Knowledge-Intensive Economy

There is no common agreed standard on what economic sectors should be labelled high tech. However, the seven high tech sectors chosen for this study refer to the traditional list from the OECD from the late 1980s:

NACE	
244	*Manufacture of pharmaceuticals, medicinal chemicals and botanical products*
300	*Manufacture of office machinery and computers*
320	*Manufacture of radio, television and communication equipment and apparatus*
353	*Manufacture of aircraft and spacecraft*
642	*Telecommunications*
720	*Computers and related activities*
730	*Research and development*

At that stage, OECD divided manufacturing into 22 sectors. Those having a share of own, internal R&D of more than 4% of sales were labelled high tech, between 1 - 4% medium tech and those below 1% were called low tech. For the purpose of this study pharmaceuticals, office machinery and computers, radio/TV/communication equipment and aircraft manufacturing are included in high tech. The inclusion of telecommunications, computer services and R&D services was an attempt to redress the bias towards manufacturing.

The choice of sectors opens up a systemic approach that takes on board interactions between knowledge based services and high tech manufacturing. This perspective corresponds to innovation policies in which producer services and manufacturing are considered as intertwined and dependent on each other in a systemic manner.

Partners of the European Science and Technology Observatory (ESTO) carried out the study. Data from Labour Force Surveys carried out in the United Kingdom, Norway and the Netherlands were analysed. The Labour Force Survey is based on a sample of 0,5-1,5% of the population. It turned out that the quality of LFS data varies from country to country. This is due to the "cell size problem", linked to the fact that the number of observations in each technology sector become so small that the results lose reliability. In a (long-term) policy perspective it is important to overhaul and redesign statistics for knowledge-intensive economies.

In the UK the employment share of the seven sectors rose from 3,6% in 1992 to 4,5% in 1999. The Norwegian data show a decreasing tendency because the flourishing oil sector[1] is one of the country's most knowledge-intensive sectors. When this sector is included for the UK and Norway, the employment shares become more equal (1999: 4,8% in the UK and 4,1% in Norway). The quality of the Dutch data imposes cautious interpretations, but the share of high tech sectors (even when extraction of petroleum and gas is included) seems to be lower than for Norway and the UK.

Labour Market Flexibility

The analysis of labour force mobility shows that there is a relatively large degree of movement between many sectors in all 3 economies. Having a lot of mobility of people - especially outflows - may actually be damaging to a sector's competitiveness. This does not preclude the argument that mobility is a useful way of diffusing knowledge in an economic system. The point is that a high turnover also has negative aspects due to the loss of "tacit" knowledge with the departure of experienced personnel.

In the UK telecommunications and office&computer equipment especially suffer from high outflows. Computer services and pharmaceuticals appear not to suffer from this problem having higher inflows than outflows[2]. The Norwegian mobility data reveal higher fluctuations to the extent that there seem to be higher mobility rates in Norway. One should be cautious to interpret this in the sense that the Norwegian labour market is more flexible than in the UK.

Flexible labour markets are often seen as a cure for badly competitive sectors, but we observe that some segments of the labour market are far from inflexible. Hence, general pleas for more labour market flexibility can send the wrong signals to key players.

[1] NACE 11: Extraction of crude petroleum and natural gas
[2] It should be noted that the study primarily dealt with mobility between sectors and that the data on mobility inside sectors only were a by-product.

The Dutch mobility data are somewhat unreliable, but interesting observations occur in the literature review for the Netherlands. Statistics on the dispersion of fields of studies over occupations reveal that graduates in humanities are increasingly employed in occupational sectors outside their traditional labour markets (i.e. public administration, education, socio-cultural sectors and arts). These statistics underscore the tendency towards broader recruitment patterns in the ICT sector. On the other hand, Dutch graduates in medicine, veterinary science and dentistry predominantly get jobs in their traditional occupational sector, which is the health sector. This phenomenon can be explained by the fact that they are regulated by certificates and licences.

Polarisation of skills ?

There is quite an uneven opportunity for training across the seven high tech sectors. UK computer services which have a high level of stocks of qualified staff, provide less training compared with telecommunications. There are several possible explanations for this. When e.g. computer services score low in the UK, this might be linked to the fact that many of these employees arrive already trained.

In the UK and Norway knowledge workers and already qualified staff are more likely to get training than the overall worker. This suggests that a polarisation of skills and knowledge might take place in certain sectors. This result is clear in Norway and the UK. In the Netherlands we find the opposite on the level of the whole economy, the low educated get more training than the highly educated. If we look at the high tech sectors we get a more nuanced picture.

The Dutch training statistics indicate that the medium skilled echelons receive most training, apart from those in telecom&post and aerospace&other transport. Among the seven high tech sectors chemicals&pharmaceuticals are less training intensive than telecom&post and computer services. A similar trend can be observed in the UK.

All in all, those who are already ahead in the game are more likely to receive further training. Staff with medium formal skills is more often trained than people with high or low formal skills. Therefore it turns out that there is no clear-cut polarisation between high and low skilled. However, the provision of training is clearly biased and we might never enter a lifelong learning society if this state of affairs persists.

Key Observations From The Literature Surveys

In addition to analysing the data from the Labour Force Survey the project partners carried out literature surveys, from which two striking points occur:

- there is a continuous disequilibrium between labour demand and supply
- there is a certain (institutional) inertia in adapting to skill needs revealed in national economies

The consequence of the first point is that a sound analysis has to use a number of labour demand and supply indicators. The second point entails that policy formulation also has to reflect the problems of rapidly shifting education and training resources between subjects and sectors.

A number of other lessons can be drawn from the literature surveys forming part of the three country reports.

The general impression from the literature review of skill problems in the UK economy points to the need for the government to focus on several key areas:

- Fostering more management skills among skilled employees
- Fostering a more business like orientation and entrepreneurial style among professionals
- Promoting multidisciplinarity
- Reducing brain drain especially to the US in key sectors
- Promotion of clusters of high technology industries
- Encourage the creation of professional bodies for new high technology industries such as photonics

The first three points could be addressed at university level. If more graduates are trained or given the opportunity to undertake some management courses and focus on courses with multidisciplinary awareness, this could reduce problems experienced by many high technology and knowledge based firms. The last three points suggest a focus on creation and maintenance of a suitable infrastructure for certain key sectors. This would involve the maintenance of e.g. science parks, regional development and grants for specific industrial clusters as well as the fostering of dynamic local labour markets that reduce the level of brain drain.

From the Dutch literature review it is interesting to notice that the share of low educated employees rose from 17,9% in 1993 to 30,8% in 1999. Apart from a change in statistical codes during this period, the observation might confirm that an economic boom enhances the employment chances for the lower educated, without necessarily making them more employable in a longer time perspective. In the high tech sectors the share of high educated was fairly stable, oscillating between 12,7% and 14,2% over the same period. The telecommunication sector shows one interesting deviation from this rule. Here, it appears that low skill employees have lost their jobs while the higher educated telecom staff remains on the payroll.

The Norwegian literature review features the history of public and private plans to provide the country with sufficient ICT skilled people. In 1986 an ambitious plan was set up containing radical forecasts of the future needs in the ICT industry as well as in application sectors. Some follow-up measures were put in place, but these were to a large extent shelved during a dip in the business cycle in the mid-90s. In the late 1990s the need for ICT skills became once more en vogue. Apparently, the implementation of the ICT upskilling plans was not robust enough to be sheltered from temporary fluctuations. However, the 1986 skill plans were not necessarily apt for the ICT industries by the late 1990s.

Open Method Of Policy Co-Ordination

The open method of co-ordination was introduced during the spring 2000 presidency of the European Union hosted by Portugal. The method is now a widely used policy instrument. The present ESTO study could nurture some further thought to policy implications of comparisons revealing substantial differences between European countries.

Perhaps the benchmark best-practice approach widely used today could be supplemented by different scenarios for each country in which the governments could compare differences between each other and learn about potentially 'better practices' from other states [3]. In such an open method of co-ordination it would be vital to have an open ended dialogue between Member states as to whether common policies would be effective or whether what is a best practice for one country might be less relevant in another. Moreover, polices in one country often have consequences for others (e.g. immigration policy at the moment). If we learn by comparing policies and have a meaningful dialogue then the Member states could improve the timing of the introduction of policies.

Future Research

Two main lessons can be drawn with regard to follow-up research:

Forecasting of skills is a useful exercise when we refrain from drawing drastic conclusions, but the data at hand are fraught with problems: changing classifications, small samples etc.

The study of the dynamics regulating the stocks and flows of skills in the economy has shown itself to be a potentially rewarding approach. However, sectorial stock and flow indicators should be complementary to indicators based on other quantitative data (counting of the number of vacancies, including career data and education statistics) as well as qualitative surveys. Skill demand and supply is a multidimensional phenomenon and policy formulation should rely on multiform methods.

[3] One approach to the open method of co-ordination is described in ftp://ftp.cordis.lu/pub/improving/docs/g_ser_abcproject.pdf.

TABLE OF CONTENTS

<u>Country Report Norway</u>

Country Report Netherlands

Synthesis report from the ESTO project

Anders Ekeland
STEP Group,
Studies in technology, innovation and economic policy
Storgaten 1,
N-0155 Oslo,
Norway

and

Mark Tomlinson,
CRIC, University of Manchester
University Precinct Centre
Oxford Road
Manchester M13 9QH
United Kingdom

Background to the study[1]

There is consensus between economists that high technology sectors stimulate economic growth. An essential precondition for their emergence and competitiveness is the existence of highly skilled workers employed in these sectors. There is in fact convincing macroeconomic evidence on the positive effect of skilled labour on productivity growth. For instance, Kahn and Jong-Soo found that between 1958 and 1991 US manufacturing industries with high shares of skilled labour experienced significant economic growth[2].

A study on skills and mobility of labour in high technology sectors should provide input to IPTS on skills mismatches in Europe. Several reports in the frame of the FUTURES project have touched upon this issue which, however, needs to be further deepened. Furthermore, the outlined project should support the GATEWAY project carried out by some institutions belonging to the JRC as well as other European Commission services such as DG Education and Culture. This project aims at setting up a European interactive information system providing access to high quality education and training opportunities and resources as well as to a variety of learning experiences, across the full range of formal and informal learning contexts. The feasibility study on the GATEWAY project was completed at the end of 2000.

In order to strengthen the foresight dimension in the field of education and training it is important to better grasp the skills that are likely to be needed across Europe over the next few years in high technology industries. As a consequence, the results of this study should be used by **private and public decision-makers** (including SMEs) to begin to comprehend the following areas:

a) to identify areas where one would expect to find a mismatch between the skills offered by institutions of higher education or other organisations and the skills needed by high technology sectors.

b) to upgrade the content of educational programs and services. It is crucial for European decision makers to be sure not only that higher demand for certain skills will be met by the relative supply, but also that enough public resources are spent to impart those skills that are likely to play a major role in the future development of high technology sectors.

The essence of the project is therefore to study whether in some selected European countries the higher demand for high skilled labour, triggered by the expected future development of high technology sectors, will be matched by the relative supply.

[1] This section is largely taken from the original project proposal.
[2] Kahn J. A. and Jong-Soo L. 1998, "Skilled Labour Augmenting Technical Progress in US Manufacturing", in *Quarterly Journal of Economics*, 113(4), pp. 1245-1280.

Executive summary

Purpose

To investigate the possibility of making indicators of demand and supply of high skilled labour based mainly on the Labour Force Survey since this is a data source available in all European countries.

Pilot study

The study is a pilot study of three countries: the UK, Netherlands and Norway. The study is also a pilot study in terms of resources. The whole study was budgeted to 120 days, 30 for each country study and the rest for synthesis and coordination.

Country studies in two parts: literature review and stock/flow indicators

The three country studies start with an overview of the existing literature on skill gaps and mismatch – including public policy and conceptual/measurement problems. The other part is an effort to use various stock and flow indicators for demand and supply forces and their dynamic interaction. An important aspect of this effort is to investigate the strengths and weaknesses of the existing data sources. The only common data sources are the national Labour Force Surveys (LFS). In Norway there are in addition to the LFS, databases based on public registers.

The main findings of the literature reviews

There is no doubt that employers feel skill gaps and skill mismatches as a real problem. A problem that inhibits their innovative performance and has various other negative consequences for their business. This is revealed most forcefully by the results from the surveys done as a part of the UK "Skills Task Force". These surveys are among the most extensive skill studies recently done in a European country. The problem is to address the revealed problems in an adequate way since there is a danger that the employers are too myopic. They are acutely aware of the present skill gaps, but less aware of future skill needs. So a public policy only based on "revealed" needs would be incomplete.

At the same time there emerges from the literature on skill mismatches a more mature view on the value of various types of forecasting efforts than was the case from the mid-sixties to the mid-eighties (the first period of expansion of higher education). There seems to be a broad consensus that using forecasting is very difficult – if not impossible – to foresee future skill needs in detail. The answer to such forecasting problems is not resignation or inaction, but to have realistic assessments of what can be done and to try to improve the methods being used, to be more clear about what level of detail is needed and what time horizon should be used. The need for ICT skills has been known for a long time - to take one example - and there are systemic reasons why not more has been done about it. The present ICT skill deficit on a world scale has been forecast on several occasions, but there are several intermediary links between the forecasts of researchers and public policy making. But one part of the explanation is that since the other forecasts were wrong why should the need for ICT skills be correct.

Stock and flow indicators

Seven sectors were chosen that according to OECD definitions are regarded as "high-tech"[3]. These sectors are:

NACE	
244	*Manufacture of pharmaceuticals, medicinal chemicals and botanical products*
300	*Manufacture of office machinery and computers*
320	*Manufacture of radio, television and communication equipment and apparatus*
353	*Manufacture of aircraft and spacecraft*
642	*Telecommunications*
720	*Computers and related activities*
730	*Research and development*

Measured by the share of highly skilled workers they are above the average of most other sectors. Their share of total employment is rather small, around 3-5% in the UK, the Netherlands and in Norway.

There is one small, knowledge intensive and rapidly growing sector: computer services. Telecommunications has a changing skill composition, highly educated flows in, lower educated out. There is a tendency for this sector's share of employment to be declining or stagnant. For the other sectors there are not such marked growth aspects.

The limitations of the Labour Force Survey

From the outset it must be borne in mind that the LFS was not designed for doing detailed studies of stocks and flows. But it is the only data source that is available in all European countries. One of the aims of this study was to investigate to what extent the LFS could be used for more detailed studies of sectors, educational and occupational subgroups. The conclusion is that there are serious limitations. These limitations are first of all due to the size of the sample in the national LFS, but they also depend on the size of the subgroups one wants to study. They might vary considerably from country to country as a result of a different size/composition of the national economy. For example, the fact remains that sometimes there are too few observations to make robust estimates of the size of the research sector, an important 2-digit sector. It is clear that the sectoral, educational and occupational breakdowns have to be at a rather aggregate level to be reliable. Flow indicators are even more difficult, since the mobile part of any subgroup of employees is somewhere between 5-25% of the total. If one wants to make studies with a degree of detail as in this study one has to look for other data sources.

[3] In manufacturing the OECD distinguish between high, medium and low technology sectors. Thus pharmaceuticals, office machinery and computers, radio/TV/communication equipment and aircraft manufacture are included in high tech. The inclusion of telecommunications, computer services and R&D services was an attempt to redress the bias in discussions of this kind towards manufacturing. Many producer services now also play a crucial role in innovation systems.

14

The digitalisation of all kinds of data about firms, employees, education, vacancy registers, advertisements etc. makes it feasible to have databases with provide input from an array of different sources as the primary source of data for the mapping of skills in the economy. Such register-based information is in the long run the only way forward for such studies. In the short and medium term minor modifications of the LFS and greater harmonisation is a feasible way forward.

Challenges for Public policy

The fact that the seven high tech sectors have a stable share of the employment does not mean that there are no skill mismatches (for example, that the supply of ICT competence is matching demand). These sectors compete with the rest of the economy for highly skilled human resources. They might often be forced to use persons whose competence is not the desired one, leading to increasing costs due to more resources being devoted to training newly employed people. So although there are at any point in time uncertainties and contradictory forecasts about future skill needs, there clearly is a role for an active public policy. What one should try to learn from the failures of the past are the limitations of forecasting. Use the forecast more as a heuristic focusing device; use dynamic models and scenarios. Do not see the forecasts as traditional estimates with a greater or lesser standard deviation. Since there are many substitution mechanisms. It is important that policy is made with an appropriate degree of detail and time horizons.

When formulating public policy one should take into consideration such substitution effects. More knowledge of such effects would make policymaking easier. One should also not forget the fact that many higher education qualifications are rather general, so newly graduated people need substantial on the job training to get really productive. Since a good general education and problem solving ability is the basis for adaptability with a minimum of costs, it might be discussed whether one can overinvest in education and skill upgrading.

Synthesis of country studies

This chapter summarises the three country studies, while trying to highlight some policy recommendations that will be put forward in order to deal with potential skills mismatches.

Purpose of the study

The purpose of the project was to undertake a first attempt to investigate whether the demand for high skilled labour in some selected European countries – triggered by an expected future development of high technology sectors – is or will be matched by an adequate supply. Closely connected with this is the question to which degree measuring future skill needs in various sectors will induce policy initiatives that really are able to meet those challenges.

Working method and approach

This study[4] covers three European countries (UK, Netherlands, Norway), reflecting a variety of education, training systems and institutional set-ups. The UK study has been the "template" for the Norwegian and Dutch studies. Many of the findings are related to the challenges faced when one tried to make comparable indicators for skill mismatches in the high-tech sectors that are used in the UK study. Each country-study tries to accomplish two main tasks:

Firstly, to look at past developments, the work analyses the evolution of demand and supply of skilled labour in high technology sectors over the last decade. Technological change may be one of the driving forces behind the increase in skill requirements in the labour market especially in high technology industries.

Secondly, assuming that previous trends will continue and considering other important factors that are likely to influence the supply and the demand for skilled labour over the next decade (e.g. change in educational policy priorities), future patterns of demand and supply of skilled labour in high technology sectors are identified.

The studies proceed taking the following three levels into consideration:

- Cross-sectoral (we examined and compared at national level flows of people from and into the following sectors: The sectors are Aircraft; Office and computing equipment; Chemistry/Drugs and medicines; Radio, TV, Communications equipment. We also explored certain knowledge intensive service sectors, namely: telecommunication services, computer services, R&D services).
- Occupational – we compared different types of worker within sectors
- We also assessed the differential access to training and human capital formation by different sectors and occupational groups.

Skills: The question of demand, supply and equilibrium

Different schools in economics will treat the question of skills demand and supply differently. Most mainstream economists will try to treat this within a standard, static, partial equilibrium supply/demand framework. Graphically this is done using the very static, but very familiar analysis of supply and demand curves. As many have pointed out, this type of model presupposes that the crossing of supply and demand is actually an equilibrium point. But as we know by now this has very little to inform us about the dynamic processes that determine at which quantity/quality/price supply and demand will eventually match. For example, time is one often neglected, but crucial, element in skill supply. The decisions taken about education and career paths are taken on another timescale than those that determine the demand for skills[5]. Furthermore, people, firms and the

[4] It should be noted that this is a very small pilot study, and it could serve as a starting point for a much more extensive research project. Each of the national studies was calculated to be 30 working days each and it goes without saying that what one can achieve during one month – both summing up the existing literature, giving an overview of data sources and generating some empirical results is indeed limited.

[5] In addition one also have to face the tricky issues in actually estimating the demand and supply curve, since what one observes are quantities sold at certain price. But that only gives us a scatter, a cloud of points, but no basis for *simultaneously* estimating both the demand and the

authorities engage in complex individual decision making processes (similar to those analysed by proponents of game theory). This implies that the outcomes of these individual decisions do not always appear rational in a collective sense and are therefore often very hard to analyse. The "heterodox" schools of economic thought would argue – with different emphasis on different factors and mechanisms – that there is continuous innovation and consequently a continuous situation of disequilibrium. In a paper from the most recent major study of skills, the UK Skills Task Force, "The Dynamics of Decision-making in the Sphere of Skills' Formation" (Penn 1999) one of the conclusions is that:

> "Decision-making within the sphere of skills' formation is complex. In particular, **different actors have differing perceptions and different goals**. This may not produce an equilibrating situation. Indeed, it is clear from the wide array of research findings reviewed in this paper that such an equilibrium has not pertained during the last 30 or 40 years. Nor will an equilibrium be produced by improving knowledge and information *per se*."

The situation of continuous disequilibrium does not mean that the development of supply and demand is totally unpredictable. However, it means there can be important non-linearities, limiting the use of an overly simple and fully deterministic model. But one might be on a stable "path" that can be described by a fairly simple *dynamic* model or a model with two or three "attractors" leading to a limited number of possible scenarios.

This non-equilibrium situation is basically the reason why one – from a policy point of view – has to try to develop various indicators of supply and demand and their dynamic interaction. This study intends to be a small contribution to this indicator development process.

The literature on skill mismatches

From the literature on skills and skill mismatches there emerges a set of questions that are frequently raised.

Forecasting the need for skills – can it be done – should it be done?

There is no single answer to the question whether skills forecasting could or should be done. In this respect it will be useful to keep the different levels and time horizons in the different types of forecasts apart. In the literature, there is a consensus that it is possible on a rather general level with a time horizon of five to ten years to forecast the need for certain skills – ICT skills being one prime example. But to forecast the need for more specific skills is difficult due to the open, dynamic, "chaotic" properties of socio-technological development. It is in many ways like forecasting the weather, clearly useful, not impossible, but inherently difficult. One has to use different methods for short, medium and long-term forecasts.

It seems that multidisciplinary case studies, interviewing employers, collecting data about vacancies etc. are giving the best indicators of urgently felt needs for specific skills. Since more and more information is available in databases one can today collect types and amounts of data that

---

supply curve, one has to make further assumptions so that one uses the scatter to estimate the best fit of either supply or demand.

were foreseeable, but not feasible ten yeas ago. But such an approach runs the danger of being too limited when it comes to forecasting the need for medium and long-term skills.

Even if such indicators were reliable, the problem is that the education system for obvious and rational reasons generally cannot adapt quickly to such needs if they are of a more transient nature. Generally the costs of rapid changes in staff, of all the mundane tasks connected to establishing new lines of study, not to speak of new institutions, are probably too high. That means that there is a certain necessary inertia in adapting to the revealed need for skills. The case of primary school teachers is an excellent illustration of this point. In many countries the public is surprised that there are sometimes too few, sometimes too many primary school teachers; especially since the demographic variations in school children cohorts are easily predictable. We know how many school entrants there will be 5-6 years in advance yet still the supply of primary school teachers is not straightforward. Basically this is because it takes four years to train the teachers. When there is a lack of teachers one increases the number of students, but at the same time people with less and/or different qualifications are employed as teachers. These people cannot be sacked when the new large cohorts of graduates come onto the labour market. Some of them turn out to be excellent teachers, but we then get a situation of oversupply. This sends a signal to people not to go into teaching, so as time go by there are fewer students. These cyclical waves should then be matched to the variations in birth rates[6]. However, even this is probably not rational, and in any case very few politicians would be willing to undertake drastic, short-term up/down-sizing of the institutions that educate primary school teachers[7]. This is not to say that the present educational systems in the countries concerned are as responsive, are as aware of present and future needs for skills as they could be.

ICT skills might also serve as example of this. Although there has been a continuous under-supply of such skills for two decades, public policy in this field has not expanded the educational capacities as much as needed to satisfy the demand. Part of the explanation is probably that in the last two decades anti-inflationary policies have generally made it difficult to radically expand certain fields of study like ICT while reducing drastically those not in such great demand. But a note of caution is needed here, because in the long term there is a risk of a feedback loop between ICT skills and new technology: the more people with ITC skills, the more projects are initiated, and the more rapid the technological development, the more people are needed to staff ICT departments, to diffuse the knowledge and to use these new technologies in a productive way. Since supply by such mechanisms creates more demand, we should consequently expect to be in a situation of continuous "under-supply"[8]. The real questions are therefore: How great should the under-supply be? How many of those wanting to get an ICT-education should be given the opportunity to get one? What consequences are there when people educated and/or trained in other fields are filling the empty ICT positions?

The forces of substitution

In general the process of substitution and re-training seems to be widespread. The well-know biologist and historian of science J. D. Bernal said: "Give me two years – and I shall be an expert in any scientific field"– and there seems to be much truth in this. Partly because people are rather

[6] It is a well know mathematical result that even a simple dynamic system of three deterministic equations can generate chaotic behaviour, i.e unpredictable oscillations within certain bounds.
[7] See the Norwegian literature study for details.
[8] These sectors are notoriously labour intensive and although even software production is getting more automated, increasingly using ready made components there is nothing like the increases one gets in industry by introducing new machinery.

flexible and able to learn new things – and because even if they have the appropriate education, there is a lot of sectoral, firm, and technology specific knowledge– both codified and tacit that has to be learned in any case. Even specialised professions like medical doctors, lawyers and economists need a substantial amount of on the job training before they really become productive. This indicates that the difference between training a person with the "right" education and training a person with the same level of education in a different field might not be so big for a considerable number of occupations since a considerable proportion of the skills required are acquired on the job.

If forecasting the need for skills is hard to do for policy makers, it is probably even more so for the individual. There has been a long debate as to what extent the state should try to influence choice – and it is well known that very often people behave differently from the paternalistic advice given by the authorities. Penn (1999)[9] illustrates this point in the following way:

Let us imagine that somehow it was possible to ascertain that in ten years' time only 10% of current 16-year-olds would need a degree for their job. Is it likely that 90% of this age group would decide spontaneously to abandon their hopes and plans for higher education based upon this knowledge? It is far more likely that the present trend for an increasing demand and desire for higher education would persist and the net effect would be that the job market for those with degrees would become far more competitive over the next decade. It is also probable that a process of credentialism' would ensue whereby jobs that traditionally had not required degrees would use them as a new entry requirement. Only a draconian reduction of higher education places could ensure an equilibrium.

But the fact that children do not follow the advice given by their parents is not to say that such recommendations should not be given by parents. Such explicit or implicit advice forms part of the information and knowledge base that people use when they make their individual choices. There is a complex relationship between individual choices and the resulting collective behaviour since the individual choices of other people enter into the "equation".

As a part of the UK DfEE "Skills task force" project a very interesting overview has been written by Jonathan Haskel and John Holt, *"Anticipating Future Skill Needs: Can it be Done? Does it Need to be Done?"*[10]. The paper gives a very useful overview of these problems. In their concluding chapter they write:

> At first sight the obvious conclusions of this paper would seem to be that individuals and employers are not very good at seeing the skill needs of the economy, and not very good at responding to those needs when they do see them; and that forecasts from economists are fraught with difficulties and so not much help either.
>
> In particular, most measures of skill shortages underestimate the severity of the problem of under-investment in skills because they fail to pick up the extent to which employers adapt to skill shortages by opting for product strategies that do not require high skills, thereby eliminating the skill shortages but at the cost of a poorer performance for the economy at large. Equally, forecasts of skills are likely simply to extrapolate such low skill traps into the future - so that if individuals use the forecasts they will merely replicate the existing problem.

[9] Penn, R. and Holt, R. (1999) Skills Issues in Other Business Services - Professional Services, National Skills Task Force Research Paper 16, DfEE.

Like most researchers Haskel and Holt conclude that it is more sensible to improve the existing forecasting methods than to refuse to try to think rigorously about the future. These are some trajectories for improved forecasting methods:

- Better data – not the least as the spread of the information society gives us much more in structured, electronic form. If one really takes skills seriously one has to improve considerably the scope and quality of data.
- More dynamic (scenarios) and less linear models. Very many researchers are not trained in using dynamic models, partly because they demand numerical solutions that need advanced software and computers. Policy makers are not used to dynamic models either, and have not been very demanding customers in this respect.
- A better understanding of the mechanisms of substitution, of life-long learning, shifting the emphasis of the problem from forecasting needs for specific skills to proactively adapting to identified skill needs – provided that the learners have a solid general education.

Indicators and data sources

The only common data source in the UK, Netherlands and Norway is the Labour Force Survey (LFS). But as is well known this is not a standardised data source. The national LFSs are marked by their history and are not constructed according to any common standard. There has been ongoing work of harmonising the national LFS in Eurostat, and the UK has been part of this process since it started in the early 1990s. Norway made some significant steps in harmonising their LFS from 1996 onwards.

When it comes to Dutch data the situation is that the Dutch Central Bureau of Statistics does not regard their data on mobility reliable enough to be used as a basis for mobility research. The authors of this study respect this point of view. But since the authors regard it is a pilot study partly aiming to explore the data quality, we have used the Dutch LFS data that Eurostat uses in their work on the Community Labour Force Survey.

The question of data quality must always be discussed in relation to the problem to be analysed. One of the aims of this study was to do a pilot study to investigate if the Labour Force Survey could be used for mapping stocks and flows with a rather detailed industrial breakdown, and the short answer to this is that the quality of the data is limited. Certainly, there are national differences, but as always in comparative studies the weakest data sets the limit for what kind of comparative indicators can be constructed. In this case, UK was used to set a standard that Norway and the Netherlands were not able to match. As is clear from the table below, not even a basic variable such as the NACE codes have the same degree of detail in the three countries. Only the UK has a three digit-NACE required to study the high-tech sectors that we wanted to focus on. But the reason why many countries do not have such detailed NACE codes is that the number of observations in each industrial sector becomes so small that the estimates become unreliable.

[10] Haskel, J. and Holt, J. (1999) Anticipating future skill needs: Can it be done? Does it need to be done? National Skills Task Force Research Paper 1, DfEE.

Table 1: Labour forces survey (LFS) variables in UK, NL and NO, plus Norwegian register data.

VARIABLES AND DATA SOURCES	UK - LFS	NL – LFS	NO LFS	NO REG.DATA
3-DIGIT NACE	*Yes*	*no*	*no*	*Yes*
OCCUPATIONAL CLASSIFICATION	*Yes*	*Yes*	*yes*[11]	*No*
EDUCATIONAL CLASSIFICATION	*yes*	*Yes*	*yes*	*Yes*

Table 2: Industrial sectors - preferred break down – used in UK study

NACE	3-DIGIT	TITLE
244	*X*	*Manufacture of pharmaceuticals, medicinal chemicals and botanical products*
300		*Manufacture of office machinery and computers*
320		*Manufacture of radio, television and communication equipment and apparatus*
353	*X*	*Manufacture of aircraft and spacecraft*
642	*X*	*Telecommunications*
720		*Computers and related activities*
730		*Research and development*

In the Dutch and Norwegian LFS there are industry data available only at NACE two digit level. This is of course less of a problem in the Norwegian case, since the Norwegian register data have the most detailed – i.e. 5 digit –classification. The persons interviewed in the LFS are of course also in the registers and it is in principle possible to take the detailed industrial classification from the registers and use it in the LFS. This has not been done in any study as far as we know – and would demand more resources than have been available in this project.

Table 3: Industrial sectors, 2-digit level –Dutch and Norwegian study LFS

11	*Extraction of crude petroleum and natural gas; related services, excluding surveying*
24	*Chemicals & Pharmaceuticals*
30	*Manufacture of office machinery and computers*
32	*Manufacture of radio, television and communication equipment and apparatus*
35	*Aerospace & other transport*
64	*Telecom and post*
72	*Computers and related activities*
73	*Research and development*
ALL OTHER	*Other Manufactoring (the manufacturing not belonging to the hi-tech sectors)*
ALL	*Other sectors (all remaining sectors, i.e. the rest of the economy)*

As one will see, the sector breakdown is not identical in the three studies. In the Norwegian and Dutch country studies the oil sector is included and the rest of manufacturing and all other sectors are lumped together. The reason for the inclusion of the oil sector was to show that a non-industrial extraction sector that often is regarded as a bit low tech at least in the Norwegian economy is one of

[11] Occupational classification, i.e. ISCO 88 has been introduced from 2000, and has been extended back to 1996, building on a national occupational classification used earlier.

the most engineering intensive sectors[12]. The oil sector in Norway is much bigger than each of the high-tech sectors that represent the core sectors in this study. In the UK and the Netherlands the oil sector is very small.

It is well-know that the oil sector is attracting many engineers and consequently it contributes to the shortage of engineers in other branches and probably to skill mismatches, since people with fields of study that might be more relevant in other sectors have been "sucked" into the oil sector, causing – to lesser or greater degree - skill mismatches in other sectors.

The limitations of the LFS as a data source

The Labour Force Survey, like all surveys, is based upon a sample of the population, from 0.5% - 1.5% of the population. And as with any other representative sample the data set has a sampling error, i.e. when the number of observations gets small, the data become unreliable. The number of observations of a special combination of characteristics like "male, researcher, Ph.D." will be represented with only a few observations in the sample. This small number will in relative terms vary a great deal. Five observations in one quarter and ten in the next is an increase of 100%. That means that even though the sample is a randomly drawn representative sample you do not get reliable estimates of the total number in the economy. This is often referred to as the "cell-size" problem.

For the present purposes the LFS has shown itself to be of limited value due to the cell size problem. The sample size is too small to get reliable estimates – not only of detailed educational and occupational subgroups. The estimate of whole sectors, for example the 2-digit sector "Research and development", is unreliable. If one wanted to study only the science part (that is going down to a 3-digit level) the problem of course gets worse. This cell-size problem makes it very difficult to give very strong policy advice for "small" sectors and subgroups of the economy based on the LFS. That does not at all mean that the results are of no value, but that they ultimately need to be complemented by other data sources.

In this respect the register data is one alternative as is shown by the Norwegian country study. Using register data eliminates the problems of sample size, since registers are a census of the whole population. But the registers were made for administrative purposes and consequently they do not contain all the variables one would like to use. One relevant example for this study is the lack of occupational data. But since the LFS uses – in Norway at least – the official person ID number – one can get information about occupation from the LFS. It is our opinion that the LFS and register data should be used – and modified – in order to get the maximum synergies from them.

The use of registers do not always solve the problem of few observations. The chosen sector still often gets very small, the numbers get very jumpy and hard to interpret; like in the case of "Office and computer equipment in Norway", a comparable small industry in a small country. That is of course not due to a defect in the register data, it only shows that statistical analysis builds on the law of large numbers. On such a detailed level –we are talking about a handful of firms and 300-500 employees – the noise in the data is getting much more influential. In such cases a supplementary case study together with register data is probably the most appropriate method.

[12] In the early eighties many were worried about the "deskilling", the loss of competence when the traditional shipbuilding industry turned its attention to this new expanding marked of building oil platforms.

Stocks and flows

Employment shares

The country studies should provide results that are intended to increase the knowledge base for the policy discussion about future skill needs in Europe. Let us start with such a simple thing: the size of these sectors in terms of employment.

Table 4: Employment shares, 1987 – 1999, UK, Norway and the Netherlands

		87	88	89	90	91	92	93	94	95	96	97	98	99
HI-TECH, 3 DIGIT	UK						3,6	3,6	3,5	3,6	3,7	4,0	4,1	4,5
HI-TECH, 3 DIGIT	NO	3,1	3,0	3,0	2,9	3,0	2,9	2,9	2,9	2,8	2,5	2,5	2,4	2,7
HI-TECH, 3 DIGIT W/OIL	UK						3,9	3,9	3,7	3,8	3,9	4,2	4,3	4,8
HI-TECH, 3 DIGIT W/OIL	NO	4,2	4,1	4,1	4,1	4,2	4,2	4,3	4,3	4,2	3,7	3,6	4,2	4,1
HI-TECH, 2 DIGIT W/OIL	NO	13,5	13,2	13,1	12,8	13,1	13,1	13,0	12,8	12,5	10,9	10,8	10,4	10,8
HI-TECH, 2 DIGIT W/OIL	NL							7,5	7,2	6,2	6,0	6,5	6,5	6,6
OTHER MANUFACT.	NO	15,2	15,0	14,6	14,0	13,8	13,5	12,9	12,6	12,5	11,7	11,9	11,9	11,7
OTHER MANUFACT.	NL							14,4	14,0	14,3	14,1	14,0	13,8	13,5
OTHER SECTORS	NO	71,3	71,8	72,3	73,2	73,2	73,4	74,1	74,6	74,9	77,4	77,4	77,7	77,6
OTHER SECTORS	NL							78,1	78,8	79,5	79,9	79,5	79,7	79,9

The employment shares for 3-digit sectors in the UK and Norway have a marked difference if we exclude the oil sector, the UK being more hi-tech by this definition.

If we include oil, one of the most engineering/knowledge intensive sectors in Norway, this difference is somewhat reduced. The underlying tendencies in both countries are the same. All other sectors than computer services are fairly stable. Computer services are increasing by around one percentage point in all three countries. In UK the decline of the other hi-tech sectors (especially telecomms.) is less, and consequently the hi-tech share is rising.

The Netherlands have a lower hi-tech share measured on a 2-digit level than Norway and the UK. The reason for this is that oil is small, and transport consumes less labour than Norway for obvious geographical reasons. As an employment generator one cannot expect too much from these sectors. Only computers services are growing fast. So in terms of demand for skills the employment growth in itself do not create a new great demand for skills. The exception being computer services. But since IT-skills are generic, i.e they are in great demand in most sectors, the growth of the employment share of computer services is not a very good indicator of the demand for ICT skills.

Another important point here is that any definition of hi-tech sectors is to a certain extent arbitrary and consequently so is the apparent "hi-techness" of the country. The international division of labour and international competition tend to make countries specialise. It is not rational or possible to have a large computer equipment industry in all countries. The inclusion or exclusion of the oil sector illustrates another example of this. This is very important in Norway from a skill and competence perspective, less so in the UK and Netherlands.

Table 5: Sectoral shares of highly educated, 1987 – 1999, register data NORWAY

	87	88	89	90	91	92	93	94	95	96	97	98	99
OIL AND GAS	21,9	21,4	20,6	21,8	22,4	23,3	23,0	24,3	24,5	25,1	24,3	23,8	23,8
CHEMICALS& PHARMACEUTICA	7,8	7,8	7,1	8,3	9,0	10,0	11,5	13,0	13,6	14,3	15,2	15,5	15,6
OFFICE/COMP EQUIPT	20,3	19,8	19,5	18,9	19,0	19,6	16,1	19,6	17,7	16,6	19,0	27,4	21,2
RADIO/TV/COMMS	7,2	7,7	10,4	12,2	13,5	14,9	16,7	19,5	21,8	23,3	25,3	24,8	20,4
AEROSPACE& OTHER	1,8	1,9	2,2	2,7	3,0	3,1	3,1	4,1	4,6	5,5	5,6	6,4	6,9
TELECOM AND POST	5,3	5,7	5,9	6,5	6,7	7,0	7,3	7,9	8,6	9,5	10,3	11,3	12,5
COMPUTER SERVICES	17,2	17,5	19,2	20,3	21,7	23,3	24,6	27,2	29,9	32,3	33,2	34,9	36,7
RESEARCH	43,7	45,5	47,0	50,3	53,1	51,5	52,1	52,9	54,5	53,2	53,5	55,5	56,7
OTHER MANUFACT.	2,5	2,7	2,8	3,2	3,5	3,7	3,8	4,4	4,7	5,2	5,5	5,7	6,1
OTHER SECTORS	11,2	11,6	12,0	13,0	13,9	14,7	15,5	16,7	17,4	17,3	18,0	18,7	19,2
TOTAL	9,6	9,9	10,3	11,4	12,1	12,8	13,6	14,7	15,4	15,5	16,2	16,9	17,5

24

Table 6: Highly educated, 1993 – 1999, Netherlands, LFS[13]

SECTOR	1993	1994	1995	1996	1997	1998	1999
OIL AND GAS	31,0 %	38,9 %	47,1 %	45,3 %	36,4 %	28,9 %	28,5 %
CHEMICALS& PHARMACEUTICAL	30,5 %	30,6 %	29,9 %	29,3 %	28,3 %	29,1 %	24,1 %
OFFICE/COMP	26,6 %	34,9 %	32,0 %	20,5 %	26,9 %	28,7 %	19,2 %
RADIO/TV/COMM	29,6 %	28,5 %	31,8 %	39,1 %	37,7 %	30,1 %	33,3 %
AEROSPACE& OTHER	19,2 %	15,5 %	17,2 %	20,2 %	11,5 %	7,6 %	13,5 %
TELECOM AND	21,3 %	21,4 %	21,6 %	23,6 %	26,2 %	22,2 %	23,8 %
COMPUTER	56,5 %	56,8 %	56,6 %	57,9 %	56,4 %	47,6 %	52,9 %
RESEARCH	63,6 %	64,3 %	63,8 %	61,6 %	66,3 %	62,5 %	62,2 %
OTHER MANUFACT.	11,3 %	10,6 %	10,9 %	11,0 %	12,7 %	11,8 %	12,7 %
OTHER SECTORS	24,3 %	25,1 %	24,8 %	25,9 %	26,7 %	25,0 %	25,3 %
ALL EMPLOYEES	22,9 %	23,5 %	23,2 %	24,3 %	25,4 %	23,6 %	24,2 %

Table 7: Highly educated, 1992 – 1999, UK, LFS

YEAR	1992	1993	1994	1995	1996	1997	1998	1999
AEROSPACE	32,8	32,5	24,6	29,9	28,6	29,8	34,8	32,8
OFFICE/ COMPUTER	40,4	39,8	38,0	39,4	40,6	37,5	39,2	38,8
RADIO/TV/ COMMS	48,7	38,9	29,3	29,2	27,3	29,5	27,0	29,0
PHARMA	36,9	41,9	34,5	36,6	42,9	42,6	44,1	42,5
TELECOMM	27,8	20,6	24,6	23,7	29,5	28,2	32,7	35,6
COMPUTER SERVICES	56,1	52,3	48,0	49,7	49,8	55,1	54,9	54,3
RESEARCH	65,3	61,0	62,9	58,5	63,8	70,7	66,5	63,5
ALL	22,9	22,2	22,2	19,3	19,8	20,3	24,8	22,1

Looking at the sectoral shares of highly educated in the three countries one has to keep in mind that the numbers cannot be directly compared. The educational classification in the Community LFS that the Dutch data are taken from changed from "old" to "new" classification in 1997. The group highly educated is constructed in order to make "old" and "new" educational data comparable. It is impossible to replicate without detailed knowledge of the Eurostat procedure. The Norwegian and UK data have a common, stricter definition of highly educated, namely the "old" ISCED groups 6 and 7. There is no general rising trend in the Dutch and UK data, even if we look at all employees. That is a bit surprising since the young generations generally have much higher average education – so that the educational level should rise. Maybe this tendency gets obscured by the change of classification in the Dutch case, in the UK case there is no obvious explanation.

[13] Shaded figures means that the estimates are not reliable due to small sample size.

25

When it comes to the sectoral differences, trends are rather similar, the same sectors have a high or low share. The very high share of computer services is noteworthy, being second only to the research sector. Telecommunications (not combined with Postal services) increases with respect to its share of the highly educated. This sector will be analysed in more detail below. The oil sector is one of the most education intensive sectors in both the Netherlands and in Norway.

Training

There is also quite uneven opportunity for training by sector. For example, computer services, which have a high level of stocks, have a relatively low level of training provision compared to, say, telecommunications in the UK. Since we can only look at the combined Post and Telecomms sector in Norway and Netherlands we cannot compare this directly. There are several possible explanations. One being that employees in computer services arrive already trained, while telecommunications workers are more likely to be continually upgrading or being re-trained. Or that upgrading skills is more a part of the job in computer services since there is a continuous stream of new hardware and software, while there are more distinct vintages in telecomms.

Table 8: Training, 1996-2000, LFS, Highly and low educated[14]

	NO	NO	NL	NL	UK	UK
	HIGH	LOW	HIGH	LOW	HIGH	ALL
1992					24,2	13,6
1993			22,0	26,1	23,6	13,6
1994			20,4	26,0	24,2	14,5
1995			22,4	26,6	22,8	13,4
1996	28	15	20,8	20,9	13,8	13,8
1997	27	15	20,5	22,3	22,2	14,3
1998	24	14	16,9	22,5	22,7	14,6
1999	24	14	19,3	23,0	23,3	14,9
2000	22	13				

The table 8 shows that in the UK and Norway knowledge workers and already qualified staff are more likely to get training than the overall worker. This suggests that there is the possibility of a polarisation of skills and knowledge taking place in certain sectors. This result is very clear in Norway and UK[15]. In the Netherlands we find the opposite on the level of the whole economy, the low educated get more training than the highly educated. If we look at the hi-tech sectors we get a more nuanced picture.

[14] Highly educated in the case of UK and Norway is ISCED-76, group 6 and 7 are roughly speaking those with fifteen or more years of education. The lower educated is ISCED-76, 1-5. In the Dutch case the high group should be roughly comparable, as it based on ISCED-76 and ISCED-97, the low group is split in medium and low. Consequently the lower educated have less education than in UK and Norway.

[15] For the UK we compare High with All employees, so the difference should be somewhat larger between low and highly educated.

Table 9: Training, sectoral average, in NL, 1993 – 1999 (shaded = uncertain figures)

SECTOR	HIGH	MEDIUM	LOW
OIL AND GAS	18 %	22 %	18 %
CHEMICALS&PHARMACEUTICALS	18 %	22 %	14 %
OFFICE/COMP EQUIPT	16 %	18 %	9 %
RADIO/TV/COMMS	16 %	19 %	14 %
AEROSPACE&OTHER TRANSPORT	14 %	13 %	9 %
TELECOM AND POST	31 %	28 %	17 %
COMPUTER SERVICES	25 %	28 %	31 %
RESEARCH	14 %	25 %	12 %
OTHER MANUFACT.	17 %	17 %	17 %
OTHER SECTORS	20 %	21 %	23 %

In most high-tech industries, staff with medium formal skills are more often trained than people with high or low formal skills. Highest propensity to training among medium-skilled persons is found in Telecommunications and Postal, Computer services and Research, with respectively 28, 28 and 25 percent of the staff getting trained.

Why the Netherlands are different from the UK and Norway is not obvious. This might be a result of the way education is classified, in three groups and not two as is the case in UK and Norway.

The data on training are a very valuable part of the LFS – and where the register data in the foreseeable future is no alternative[16]. In the national LFS there is more detail about the duration and kind of training received that has not been used in this study. These data ought to be of interest to researchers and policy makers concerned with life-long learning, human resources in the economy and related issues.

Flows – mobility rates

There are several ways in which mobility indicators can be constructed, i.e. which groups of persons to include in the numerator and denominator:

- Only those employed in two consecutive years or also include unemployed, new graduates and other not employed.
- To look at all changes of workplace (establishment) or only those that at the same time are a change of industrial sector.
- Look at inflow or outflow rates. Outflow rates use the number of employees in the year T, inflow rates the number in T+1 in the denominator.

There is no canonical way of calculating the mobility rate. The various calculation principles capture different aspects of mobility as a knowledge diffusion process. The data also sometimes limits what kind of mobility rates can be calculated.

[16] Since most training providers do have databases over their students they could technically report electronically to the education statistics in the same way as the higher educational institutions do, but this will be a major statistical project to implement.

The intrasectoral mobility says something with respect to the knowledge diffusion among sectors, about the relation of a certain industrial sector[17] to other sectors in the economy. If looking at all changes of workplace, including those internal to the chosen sector, that mobility rate will by definition be equal or higher. In most cases the mobility to firms in the same sector is a major part of all mobility pointing to the fact that peoples' skills are more useful in firms that are rather similar.

The age effect

When comparing the various types of mobility one must always be aware of the "age effect" caused by the fact that persons from 16 – 24 years old are very mobile. They are searching for the "right job", they have difficulties getting a permanent job, they are the first fired, they are in part-time jobs, they switch more often from being employed to other states (education, caring for children, unemployment etc.). In this 16 – 24 age group the mobility rate might be as high as 50% in some sectors. After 25 years of age the mobility rate falls significantly. Consequently, when comparing sectors that demand long education and sectors which do not, one has to take the age composition into consideration.

The dual nature of mobility

When comparing mobility rates one must avoid the temptation to think "the higher the better", because mobility clearly has a dual nature. On the one hand it is necessary for supplying firms with fresh people, new ideas, new network connections, otherwise the firms and the economy as a whole would stagnate. On the other hand too much mobility/turn-over of employees has well-known negative effects. Key persons leaving projects before they are finished, increased costs of constantly training new employees, sellers market for labour power = increasing wages with no corresponding increase in productivity.

The comparative results – the intersectoral rates

The comparative results in this study are limited due to data constraints. First of all the cell size problem occurs once more. In the Dutch case the guidelines of Eurostat make it difficult to make comparisons on a sectoral level. In the UK and Norwegian case there are no such guidelines actually prohibiting the publication of estimates which have a very large margin of error, but the problem does not of course disappear. But the Norwegian data are not – at the time of writing – structured in a way that allows for the calculation of outflow rates or intrasectoral rates, since the industrial classification of the previous workplace is not a variable in the LFS. The Norwegian register data can be used to calculate both outflow and intrasectoral rates. The consequence is that only the Norwegian register data and the UK LFS data – for the time being – are capable of being used to calculate intersectoral mobility rates.

[17] Defined as a set of industrial classification codes, in most cases more than one.

Table 10: Intersectoral mobility, 7 sectors, 1987 – 1999, highly educated, UK LFS, and Norwegian register data

HIGHLY		88	89	90	91	92	93	94	95	96	97	98	99
PHARMA	UK					3	6,7	7,3	3,3	2	9,7	14	8,8
PHARMA	NO	12,5	11,4	8,6	2,2	7,4	4,2	4,0	9,7	5,1	9,4	7,9	7,9
OFFICE&	UK					6,8	2,5	2,9	9,3	8	8,8	10,5	5,8
OFFICE&	NO	12,9	20,4	20,9	13,9	60,3	35,7	3,4	7,2	8,9	16,1	46,6	8,6
RADIO/TV/	UK					1,2	5,6	8,3	8,1	12,8	14	9,5	4,4
RADIO/TV/	NO	11,0	15,4	9,7	31,2	10,1	12,1	5,1	12,1	7,9	15,8	33,6	10,4
AIRCRAFT	UK					4,4	1,4	2,2	5,2	4,9	6,2	6,2	3,3
AIRCRAFT	NO	6,1	12,7	7,1	7,5	12,3	4,2	8,5	7,8	7,1	5,1	14,0	29,8
TELECOM.	UK					3,4	3,9	3,6	3,6	7,4	7,4	6,9	3,4
TELECOM.	NO	8,9	5,5	5,7	4,4	4,0	3,8	3,8	15,6	8,7	34,0	12,6	11,6
COMPUTER	UK					3,5	11	14,2	10,1	8,5	14,5	13,3	10,6
COMPUTER	NO	11,2	12,2	12,9	10,9	11,5	14,6	9,9	14,2	9,3	17,3	10,6	12,9
RESEARCH	UK					3,7	4,8	6,2	2,8	5,2	1,4	5,3	13,8
RESEARCH	NO	13,6	11,4	10,3	18,5	13,8	10,2	12,0	21,1	11,9	12,6	12,3	8,8

The % highly educated people moving into the sector as a % of the total number highly educated employees in the sector.

Table 11: Differences in intersectoral mobility, 7 sectors, 1992 – 1999, highly educated, UK LFS and Norwegian register data

	92	93	94	95	96	97	98	99
PHARMA	4,4	-2,5	-3,3	6,4	3,1	-0,3	-6,1	-0,9
OFFICE& COMPUTER	53,5	33,2	0,5	-2,1	0,9	7,3	36,1	2,8
RADIO/TV/	8,9	6,5	-3,2	4	-4,9	1,8	24,1	6
AIRCRAFT	7,9	2,8	6,3	2,6	2,2	-1,1	7,8	26,5
TELECOM.	0,6	-0,1	0,2	12	1,3	26,6	5,7	8,2
COMPUTER	8	3,6	-4,3	4,1	0,8	2,8	-2,7	2,3
RESEARCH	10,1	5,4	5,8	18,3	6,7	11,2	7	-5

There are several interesting aspects of a comparison like this. First of all the variations in the mobility rate in the register data are very great. In some years the mobility rate is over 50%. This is caused by entities being outsourced, bought etc. getting a new firm ID. In such cases the mobility rate of course get very high, although most probably it is the same people working together both years. From a knowledge diffusion perspective such high mobility rates are statistical artifacts, they do not measure any real mobility. This phenomenon is most visible in sectors with few employees and/or few firms (telecommunications). The rates in the UK vary but this is due to both real variations and the effects of few observations.

As can be seen from the table of differences the overall picture is that mobility is higher in Norway and this is also found in one other comparative study done by Eurostat.[18] where job-to-job mobility (not intersectoral) rates are calculated for the EU, the EFTA and the EU candidate countries.

[18] Lafia and Stimpson: Using the Community Labour Force Survey to develop mobility rates on human resources in science and technology, Eurostat 2001-06-15

A knowledge economy example: Comparing computer services with telecommunications in the UK.

As an example of how this type of analysis might be used within a specific systemic context consider that in the 'knowledge based' or 'new economy' two crucial sectors for progress are the telecommunications services (TS) and computer services (CS). If the state were to develop and implement a policy to enhance the knowledge driven economy based upon these two sectors then a "one size fits all" strategy would be rather inappropriate given the differences in mobility and human resource patterns in the two sectors. CS has very high stocks of educated workers and high training provision while TS has lower stocks and higher training than CS. The high stocks required by CS are already manifesting themselves to such a degree that getting qualified persons from other parts of the world is put on the agenda. The inflow rates are much higher than outflow rates showing that the sector is expanding.

In TS on the other hand inflow and outflow rates are more or less congruent, but on the increase throughout the 1990s. Therefore relatively speaking TS have more labour fluidity and more of a problem than CS in terms of retaining people. The TS training figures may reflect this fact plus the fact that the stocks are also lower. So in terms of policy, for telecommunications it would be more useful to introduce training programmes of a different type than for CS and also to attempt to reduce the outflows from TS, perhaps by offering programmes and incentives to telecommunication firms that help to retain staff.

Note that this analysis tells us nothing about mobility *within* the sector, which may be of crucial importance for individual enterprises. Whereas the computer services sector seems to be doing relatively well in terms of retaining highly skilled staff and having less fluidity this tells us nothing about the problems that individual firms within sectors may be having. Firms may still have difficulties with poaching or training employees who then leave to go to rival firms.

It seems on balance that if policy makers wanted to target training programmes or influence competitiveness in the knowledge based economy they would be better off devoting more resources to telecommunications than to computer services in terms of flexible labour market policies and training. On the other hand the high stocks in CS indicate that there is huge demand for qualified staff in CS. This suggests that provision of computer related HE courses must also be a priority. Recent employee based evidence from the UK also increasingly supports the need for computer based skills in general in any case (Green et al. 1999).

This kind of analysis could be done also in Netherlands and Norway. Not in the same way since the Dutch and Norwegian LFS only can treat Telecommunications together with Postal services. The combination of Norwegian register data clearly shows that the skill composition of Telecommunications is changing rapidly, most probably that is the case for Dutch telecommunications too. Consequently the same kind of policy challenges have to be addressed.

Conclusions

The very, very brief summary of the results of these three country studies is:

- Forecasting of skills is a useful exercise when done in an non-naïve way, but the data at hand are fraught with problems: changing classifications, small samples etc.
- The labour force survey is a limited data source for both stock and flow variables due to cell size problems. Register data is the only real data source for such data. The digitalisation of all kind of

31

employer – employee data in public registers makes this type of data potentially available. There is of course an ongoing debate on privacy.

- The weakness of the LFS, the only common data source, points to a need for considering if something could be done on a European scale for getting data sources that would be more adequate in relation to the ever increasing analytical and policy demands. Not only skill mismatches in high-tech sectors, but more generally the need for a more precise mapping of the human resources and their mobility in the new, 'knowledge-based' economy.
- Despite the weaknesses of the data the study of the dynamics regulating the stocks and flows of skills in the economy has shown itself to be a potentially rewarding approach. The rapid growth and high skill intensity of computer services is but one example of a stylised fact that other methods might not uncover. But sectoral stock and flow indicators will always have to be complementary to indicators based on special, qualitative surveys, counting of the number of vacancies in the sectors etc. Skill demand and supply is a multidimensional phenomenon and policy formulation has to rely on a larger set of indicators.

32

The supply and demand of high technology skills in the UK

Mark Tomlinson

CRIC, United Kingdom

Foreword

This report outlines a preliminary pilot study of possibilities in the under-explored area of labour mobility research and its relation to innovation and competitiveness in the UK. The report outlines possible data sources, other published sources, and case study material that can be used within a national systems framework for future work in the areas of mobility and human capital allocation and formation. It is not meant to be a definitive piece of work, but rather the beginnings of a possible future research programme analysing labour mobility and skills in knowledge based and high technology sectors.

The report is in 4 parts:

- Part 1: Introduction
- Part 2: Literature reviews
- Part 3: Potential data sources
- Part 4: Data results
- Appendix A: Data for the Chemical sector (which includes pharmaceuticals)

34

Part 1 Introduction

The report consists of the following further sections:

Part 2: Brief literature review

Some recent published documents of useful information/data are reviewed. This includes some useful case study material on skills shortages in high technology sectors as well as some published survey evidence among other things.

Part 3: Data sources

This comprises a review of the data sources already available in the UK from which studies of mobility and skills (including training) can and have been made. These include the UK Labour Force Survey, various panel surveys and other employment surveys etc. Many of these surveys are available to academics from the Data Archive at the University of Essex. Higher education statistics are also reviewed.

Part 4: Analysis of the UK Labour Force Survey

To measure the demand for skills we use the Labour Force Survey (LFS) and measure the number of qualified staff in different high technology and knowledge intensive sectoral categories . Using data going back to 1992 we can see how this is changing over time. We repeat this using broad occupational categories to examine the stocks of managers, professionals, and technicians.

We also examine some training variables in the LFS to assess changes in the formation of human capital within different sectors and occupations. This will also help to indicate in which sectors and occupations there is a growing demand for skills.

This evidence gives us an idea of the demand for skilled labour in the economy and how it is changing over time.

Turning to the supply side, the UK LFS asks people what jobs they are doing now and in which sector, and what they were doing 1 year previously. From these data we can calculate mobility rates. This gives us proxy measures for fluidity of labour supply at a sectoral level which we break down for high-skilled occupations and highly educated workers. We will look at how these measures change over time to see whether there are any increasing or decreasing trends in mobility rates.

Taking the results of the above analysis we attempt to identify trends in the supply and demand of skilled labour and attempt to identify mismatches. We show whether there is an increasing trend for educated workers or occupational types in certain sectors such as high tech sectors and knowledge based producer services and assess whether there will be adequate supply by examining the mobility indicators. This will be used (tentatively) to forecast where there will be problems in the future. This will be coupled with the data on training. If certain sectors are increasingly having to train their staff then this also might indicate that there will be problems in the future.

Drawing on the results of the single-country studies, some general conclusions will be outlined in a further synthesis report. Any similarities or differences in the trends between countries will be emphasised. Policy recommendations will be proposed with this in mind. This will take into consideration the similarities and differences between national systems. If there are common European strategies that can be suggested then this will be given priority. On the other hand nationally specific cases may require different strategies for each country with respect to the supply and demand of skilled labour.

Part 2

A review of recent policy literature on skills and mobility in the UK

A) PSI Skilltrends 2000 study - a general overview of skill trends in the UK

The Skilltrends 2000 study (PSI, 2000) is one of the most recent reports on skill trends and occupational mobility in the UK. According to the report the highest employment growth is in regions with high service sector concentration rather than traditional manufacturing industries. There is also an increasing diversity of labour required by the UK economy: different types of contract, working arrangements, skills etc.

The study found that skill requirements are increasing in the UK with new technologies, changing working practices and increased competition being the main reasons. Recruitment problems are rather severe with 23% of firms have hard to fill vacancies compounded by the fact that skills gaps are also reported by a significant number of employers (15%).

In terms of labour supply the labour force is expected to rise in the next decade, but employers are also reporting increasing skills shortages. However, educational participation is increasing which will help to offset this. There are also increased tendencies by employers and government to create a 'lifelong learning culture' for example the New Deal, Investors in People and other forms of employer best practice.

With respect to the demand for skills the main growth areas are in the service sectors and most prominently in the Banking and Finance sector. The report also states that the decline in employment in manufacturing is likely to be offset by increases in service sector employment. The authors note that employment flow research is currently a priority, but not yet completed or advanced in any way.

Around two thirds of employers thought skill needs were increasing. IT and computer technology has had a huge impact within the workplace for skills especially in large firms (this applies to both manufacturing and service firms). Demands for IT skills are also likely to increase in the future. The overall picture in the UK, then, is one of a continuous shift from manufacturing to services with the resultant flow of workers this entails. Skills are in short supply, but at least the labour force is expected to increase in the next few years. Skill gaps are not just associated with new technology, but also with changing working practices which require more interpersonal and social skills than previously needed. Employers appear to be worried that skill shortages are increasing.

B) The Skills Task Force and its programme at the Department for Education and Employment (DfEE)

A recent major attempt to study skills and training with respect to deficiencies and supply and demand factors in the UK has been undertaken by the skills taskforce

The skills task force was set up in 1997 in an attempt to deal with skills shortages in the UK economy. It was a venture proposed by David Blunkett, Minister for education in the labour government and financed by the DfEE. The members of the task force are academics and policy makers, industrialists and local government officials. Several papers have been published addressing the current shortages, supply and demand of skills in the UK economy. The following papers are available on their website:

Skills Task Force Research Papers published to date

ANTICIPATING FUTURE SKILL NEEDS: CAN IT BE DONE? DOES IT NEED TO BE DONE?

THE DYNAMICS OF DECISION MAKING IN THE SPHERE OF SKILLS' FORMATION

MANAGEMENT SKILLS

INTERMEDIATE LEVEL SKILLS - HOW ARE THEY CHANGING?

JUNGLE TREKKING: VOCATIONAL COURSES AND QUALIFICATIONS FOR YOUNG PEOPLE

THE LEISURE SECTOR

ENGINEERING SKILLS FORMATION IN BRITAIN: CYCLICAL AND STRUCTURAL ISSUES

THE MARKET VALUE OF GENERIC SKILLS

EMPLOYMENT PROSPECTS AND SKILL NEEDS IN THE BANKING, FINANCE AND INSURANCE SECTOR

NEW TECHNOLOGY INDUSTRIES

FUNDING SYSTEMS AND THEIR IMPACT ON SKILLS

SKILLS REQUIREMENTS IN THE CREATIVE INDUSTRIES

SKILLS ISSUES IN SMALL AND MEDIUM SIZED ENTERPRISES

SPATIAL SKILL VARIATIONS: THEIR EXTENT AND IMPLICATIONS

EMPLOYERS' ATTITUDE TO TRAINING

SKILLS ISSUES IN OTHER BUSINESS SERVICES - PROFESSIONAL SERVICES

SCIENCE SKILLS ISSUES

EMPIRICAL EVIDENCE OF MANAGEMENT SKILLS IN THE UK

MONITORING AND MEASURING OCCUPATIONAL CHANGE: THE DEVELOPMENT OF SOC2000

A summary of some of the findings of this research relevant to high technology and knowledge intensive sectors is now presented.

The possibility of forecasting skill trends

Haskel and Holt (1999) assess the efficacy of trying to measure and forecast skills and occupations. They find that the forecasts perform quite well at the occupational level and can be used to forecast qualifications and job opportunities at national and regional levels. They argue, however, that the major issue is whether such forecasts can pick up changing skill requirements. Multitasking and changing occupational characteristics make it much more difficult to perceive changes in the skills structure through looking at occupational trajectories.

In other words forecasting of occupations, say, should be supplemented with other studies that attempt to analyse the underlying changes going on within occupations etc. These studies combined are essential to understand and make allowances for skills shortages in the future as the market cannot adjust rapidly enough to changing demands in this area. The labour market and the education system need to be honed substantially for an economy to remain competitive.

Engineering skills formation

Within sectors there are several studies available that focus on skills and training deficiencies. For example, Geoff Mason (1999) of the National Institute of Economic and Social Research has explored recruitment difficulties and skill gaps among engineers in the UK. Engineering skills are a core competence required by high technology industries and require lengthy periods of education and training to produce. According to a survey carried out by the Engineering and Marine Training Authority (EMTA 1999) approximately half of the engineering establishments surveyed in 1998 had difficulties recruiting staff (of those that had vacancies to fill). This confirmed similar research done by the Confederation of British Industry using their industrial trends survey data.

The EMTA report also suggested which areas of skill deficiency were most prevalent. In high technology sectors such as aerospace, for example, practical skills were the highest reported skill gap (in around one half of all aerospace establishments). This was the case also for most other sectors in the survey. Other serious deficiencies included in the aerospace industry were computer literacy (38%), problem solving skills (38%), skilled crafts (35%), management skills (32%) and communication skills (29%). In other words around a third of companies in this high tech sector report serious deficiencies across a whole range of skills from practical to communication to managerial etc. a similar story emerged in other sectors such as electrical engineering and electronics.

Mason also noted the cyclical nature of skills shortages in the engineering industries. Engineering sectors tend to experience peaks and troughs with respect to the difficulties in recruitment which in turn affects production. Difficulties in recruitment correspond with intensifying existing recruitment practices rather than a willingness to take on less qualified staff or retrain existing staff (EMTA 1998). In fact the majority of firms surveyed by EMTA had not offered any on the job training in the previous 12 months to their employees. These factors represent serious deficiencies in the overall performance of engineering based sectors in the UK.

New technology industries

Hendry (1999) on the other hand, looks at new technology industries. The growing importance of knowledge based industries is his starting point. The definition of new technology industry incorporates mainly new scientific and highly advanced technological fields (quite often emerging from the fusion of other advanced areas – Cf. Kodama 1992) and which involve manipulation of materials at atomic or molecular levels. These include nanotechnology, advanced materials, biotechnology etc. They also include the development of information and communication technologies (ICTs).

This study explores five themes with respect to new technology industries: growth of these industries, the key types of skills required by them, how future skills can be identified, how to combine the talents of scientists and technicians with business and other types of skilled worker, and how the skills required are to be supplied (for example, by the education system).

The results of his study for 3 industries (advanced materials, biotechnology and opto-electronics) in the UK are shown in table 1.

Table 1: Skill problems by sector

	Advanced Materials	Biotechnology	Opto-electronics (Photonics)
Growth prospects	The UK is well placed to grow in this area	UK has the 2nd largest biotech industry. Strong growth forecast.	Rapid and continuous growth.
Key skills	Fundamental knowledge of materials; Support skills such as testing techniques, modelling and simulation; Project management skills.	Multidisciplinary skills; Strong science base; Entrepreneurial and management skills; Marketing skills; Alliance formation is crucial.	Diverse skills; Specialists within sub-sectors; Craft skills often important; Strong emphasis on learning from customers; Combination of science and business skills.
Skill gaps	Shortage of traditional materials graduates (esp. polymers, basic metals and ceramics); A mismatch between graduate and PhD competences and those demanded; Difficulty in predicting skill requirements.	Shortage of biochemical engineers; Separation of physical science and biology in the national curriculum a problem; Lack of suitable courses; Lack of commercial acumen and management skills (esp. by scientists); Brain drain (esp. to US) a serious problem.	Lack of technical skills; Lack of commercially aware science graduates; Lack of an organisation representing the industry and a lack of focus; Suggestions of brain drain.
Skill utilisation	A lack of supervisory skills, team work and management skills.	Problems translating university research out of the lab.	Lack of business acumen; In house development sophisticated.
Skill supply	PhD programmes; Industrial collaborations; Supply chain partnerships	Lots of professional bodies;Clustering used concentrate key players;	Lack of professional bodies;Clustering useful.

Clearly the results of Hendry's studies imply that in the high technology industries there are common themes and problems that need to be addressed. For example, a lack of commercial, managerial and business skills is a major handicap for all three of the sectors surveyed. There are problems getting scientists in universities to cope with the demands of commercialisation and marketing of new products and ideas. Geographical clustering seems to be a useful way of fostering a dynamic skills base, but on the other hand, there is a significant brain drain of skilled personnel especially to the United States where higher salaries are usually blamed for attracting UK employees abroad.

Business and professional services

Penn and Holt (1999) looked at business and professional services in a knowledge economy framework. These producer services are becoming increasingly important in fostering innovation, growth and competitiveness through their linkages with manufacturing sectors (see Tomlinson 2001). Penn and Holt look at three broad sectors within this area: management consultancy, advertising and market research.

In the management consultancy sector there is a polarisation between the actual consultants who are almost exclusively graduates (many with MBAs or accountancy qualifications) and an army of clerical workers and support staff. The graduates are usually recruited into professional or managerial occupations. Much of the knowledge these workers possess is acquired on the job or in large firms supplemented by in house training. New skills are beginning to emerge within the sector. No longer are these consultants brought in to just advise on cost reduction or downsizing strategies, but increasingly to offer advice on organisational issues, human resource practices, IT within firms etc. These multifaceted skills are currently in rather short supply as the PSI report noted above.

In the advertising industry the UK has a strong position in global the marketplace although its fortunes fluctuate widely along with the business cycle. Again there is a strong distinction between professional and non-professional staff. The professionals usually have degrees and acquire skills on the job. Senior professionals thus have the job of passing on knowledge to juniors. Because advertising is highly competitive agencies invest heavily in their own staff in order to remain ahead of the pack.

Finally, the market research sector has, like advertising, a strong tacit dimension. Most of the skills required are learned on the job although there is an increasing emphasis being placed on formal qualifications. There is also a growing demand in this sector for statistical and research credentials to cope with the massive increases and availability of market data. Training often now includes courses to assist in the dissemination of results and communication skills as well as the actual processing of data. New technology and ICTs in particular are having profound effects on the skills required. Serious skill shortages are prevalent in these areas and consequently high salaries are paid to workers with such skills. Clustering is also high with the vast majority of employment in this industry being located in London and the South East.

C) The recent research on skill demand[1] done by the Institute of Employment Research (IER).

The IER has recently reviewed the types of indicators that are postulated in the organisational performance literature and that might be used as indicators of skills demands (Bosworth (1999) and Bosworth and Wilson (1999)). This work has two main themes. Firstly a review of the literature on national and regional development and second the collection of statistical information relating to relevant national and regional indicators of skills. We review the limited information available. More detailed results are expected later this year. Interested parties should consult the skillsbase website for more details. The following is only a brief summary.

Review of the Literature

This work reviews the relevant regional and national literatures about developments which throw light on the future skills requirements. The authors note that this 'is a potentially enormous task'. The review is limited to key papers that relate to the types of variables deemed most useful for the present analysis.

In addition, the review covers some publications based upon unofficial data. There are several other surveys and other studies of R&D and innovation at the regional level that are relevant to the skills issue, such as the work of CURDS at Newcastle University. The aim is to report on relevant developments as perceived by each author, as well as to examine how the focus and concerns of the different publications has changed and is changing.

Indicators

IER note that it is possible to compile several statistical indicators at the national and regional levels that can be used for forecasting future skills developments. These indicators are not without their problems, but nevertheless they can provide an interesting picture of developments over time when used in combination. The range of indicators is somewhat more comprehensive at the national than the regional levels, but all of the national indicators can be reproduced for other countries. We focus only on the national indicators in this report as this is the focus of the later empirical work. The IER report also deals with regional indicators.

According to IER many studies point to the importance of indicators such as R&D expenditure or personnel levels and various intellectual property counts, such as patents, trademarks, etc. There are problems with using some of these indicators (especially for the service sector which does a great deal of research, but does not usually count it as 'R&D'. Services also tend not to issue patents; a traditional indicator of innovation or innovative potential in manufacturing sectors). R&D is a measure of input or effort in the inventive process, patents are often taken as a measure of industrial inventive output and trade (and service) marks have been argued to be a measure of product innovation activity. These are all available at the national level, and can also be broken down by sector.

Personnel measures are available from a number of different sources, including *Business Monitor, MA 14*, ONS and OECD, *Science and Technology Indicators*. In addition, *Science, Engineering and Technology Statistics*, ONS contains a compilation of R&D and other indicators. OECD 1999 (Benchmarking indicators for the knowledge based economy) also has data on levels of different

[1] available on the skillsbase website

types of skilled worker (for example, scientists and engineers etc.) in different categories and industries.

Other time series of indicators at national level include a wide range of science and technology indicators for most industrialised countries (such as OECD's *Science and Technology Indicators* and *Industrial and Technical Scoreboard of Indicators*). The author's also note that there are a number of other measures that may be useful, but that do not measure skills directly. One is foreign direct investment into the UK, which, at the national level, is available from a variety of sources (for example, OECD, *Reviews on FDI: the United* Kingdom). According to IER, FDI is an important form of job creation and led to the introduction of new technologies, training and new forms of management practice. Other measures that may be useful include general indicators of the numbers (or proportions) of individuals passing through the further and higher education systems. We review the data available from the Higher Education Statistics Association (HESA) below which covers this area.

The Extent, Causes, and Implications of Skill Deficiencies

Another IER report (Hogarth and Wilson, 2000) focuses on the implications of skills shortages in the UK. IER conducted research using employer survey data collected in 1999. This was conducted as part of a major project sponsored by the Department for Education and Employment and intended to meet the recommendations of the Skills Task Force 'about the need for a major reassessment of the *Extent, Causes and Implications of Skill Deficiencies* (ECISD)'. Further reports are expected which will provide more analysis and discussion of other elements of the ECISD project. This will include a series of in-depth case studies. None of these appear to be available at the time of writing. The survey work done so far focuses on the extent and nature of imbalances between skills supply and demand as reported by employers. This is precisely the area of interest of this report, but unfortunately only summary information of this project is available at present. Again later this year IER expect to publish more detailed results.

Skill Deficiencies

Two different kinds of skill deficiency have been identified in the UK. These confirm many of the results of the skills task force case studies discussed above:

- A. Recruitment difficulties, 'focusing in particular on hard to fill vacancies and what are referred to as *skill-shortage vacancies*, (external recruitment difficulties explicitly attributed to a lack of job applicants with the required skills, qualifications or work experience)'

- B. Internal skill gaps 'defined as occurring where a significant proportion of existing staff in a particular occupation lack full proficiency at their current jobs'

The authors state that recruitment difficulties are traditionally measured by vacancies. Based on their survey data, they estimated that the total number of vacancies reported by all the establishments in England was over half a million towards the end of 1999. They estimated also that the total number of 'hard to fill' vacancies was around a quarter of a million. Official government statistics suggest that there were only a quarter of a million total vacancies at the time of the survey. Thus the authors suggest that there is a serious underestimation of vacancies in the official statistics.

The survey evidence highlighted the following problems:

- Recruitment problems were widespread
- Over 30 per cent of all establishments reported vacancies
- 16 per cent reported hard-to-fill vacancies. (Of these, almost half were due to skill related problems.)
- Skill-shortage vacancies affected about one in twelve establishments. This represented about 43 per cent of all hard-to-fill vacancies.
- The main causes of other types of recruitment difficulty were a lack of interest in particular kinds of jobs and low numbers of applicants with the required personal attributes

In terms of occupation the survey found that occupations associated with skill-shortage vacancies were mainly associated with craft and skilled occupations followed by associate professional occupations. Sales and personal service occupations were also significant. In terms of industries, most affected were the craft-intensive construction and manufacturing sectors which makes sense in terms of the occupations discussed above; but also there were problems in the financial service industry and business services. We have already noted above that knowledge based services are becoming crucial drivers of growth in modern economies. Thus the fact that skill shortages are associated with these services as well as traditional manufacturing sectors is a cause for significant concern. The effects of this type of problem can be wide ranging. That is from product development and product quality all the way through to customer service provision.

Skill Gaps

With respect to skill gaps the survey found the following:

- skill gaps were recognised by employers in about one in five establishments.
- skill shortcomings had an impact on the performance of the establishment
- a significant proportion of establishments with skill shortcomings reported that this problem had led to a loss of business to competitors
- a significant proportion of establishments also stated that they anticipated skill gaps having an impact on their business in the future
- In contrast to skill shortage vacancies skill gaps tended to occur in less-skilled occupations
- Almost half of establishments with skill gaps acknowledged that these were at least in part due to their own failure to train and develop their employees
- The main factors increasing demand for skills were:

    1. the introduction of new working practices,
    2. the development of new products and
    3. the introduction of new technology.

It has already been noted that skill deficiencies were associated with poorer performance. The IER research went into more detail about this aspect of skill problems. Establishments suggested that their plans to improve their products and services required extensive skill changes. Much of the skill changes required were perceived to be generic rather than specific. Many involved interpersonal skills such as communication skills, team-working, and management, but also general problem solving skills.

The authors conclude that a shortage of skills amongst the existing workforce is a key factor in inhibiting firms from achieving their goals. Moreover, 'there is some evidence that this is only the tip of the iceberg. Unperceived, latent skill gaps could be at least as important. The implication is that there is considerable scope for further investment in skill acquisition if the ambition of securing a long-term improvement in economic performance is to be achieved'. Thus there are crucial messages for policy makers from this research effort in terms of human capital formation and improvement.

45

Part 3

Potential data sources for future research on skills and mobility in the UK

Many of these databases are freely available to academics in the UK upon application and are managed at the Data Archive at the University of Essex. Full details are available at http://dawww.essex.ac.uk. This list is not meant to be exhaustive.

The Labour Force Survey (LFS)

The Labour Force Survey has been carried out in the UK since 1973. From 1973 until 1983 the survey was carried out biennially, and from 1984 until 1991 it was conducted annually. In 1992 the quarterly LFS was introduced. The quarterly version had substantial revisions over the annual survey including a moving panel. In addition to the quarterly database, ONS now produce two databases for Unitary Authorities and Counties for Great Britain per quarter. This provides data at a more detailed local level than was previously available from the County indicator and for the first time makes available data for the current administrative areas. The Office for National Statistics (ONS) plan that these databases will be available for all quarters (from Spring 1992) as soon as possible.

Data include occupation, sector, training and education as well as some questions concerning job mobility. The sample includes unemployed and inactive respondents as well as employees. The sample size is quite large facilitating more detailed disaggregation than in most surveys (around 60000 employees and 140000 respondents in total). The data are also comparable with several European labour force surveys ánd a European database (the Community Labour Force Survey - CLFS) is created and maintained at Eurostat using these databases. The LFS data facilitated the bulk of the empirical work presented later in this report.

The British Household Panel Study (BHPS)

The British Household Panel Survey (BHPS) is an ongoing project carried out by the Institute for Social and Economic Research (incorporating the ESRC Research Centre on Micro-Social Change) at the University of Essex. The main objective of the survey is to further our understanding of social and economic change at the individual and household level in Britain, to identify, model and forecast such changes, their causes and consequences in relation to a range of socio-economic variables.

The BHPS is designed as a research resource for a wide range of social science disciplines and to support interdisciplinary research in many areas. The BHPS was designed as an annual survey of each adult (16+) member of a nationally representative sample of more than 5,000 households, making a total of approximately 10,000 individual interviews. The same individuals are re-interviewed in successive waves and, if they split-off from original households, all adult members of their new households are also interviewed. Children are interviewed once they reach the age of 16; there is also a special survey of 11-15 year old household members from Wave Four. Thus the sample should remain broadly representative of the population of Britain as it changes through the 1990s.

The BHPS collects extensive information on respondents' labour market status, (i) at the time of interview at each wave of the panel, (ii) through the period between 1st September a year before and the interview date, and (iii) retrospectively from first leaving full-time education. Thus several longitudinal studies of labour market mobility and the impact of training and education, say, could be carried out and followed up as more waves are added to the survey.

There are also several supplementary files available that have drawn together longitudinal and work history data for easier use. See Halpin, B. (1997) *Unified BHPS work-life histories: combining multiple sources into a user-friendly format*, Technical Papers of the ESRC Research Centre on Micro-Social Change, Technical Paper 13, Colchester: University of Essex. The Work-Life Histories data were first made available in November 1997, with a second version in February 2000, which included information for Waves 6 - 8.

The Workplace Employee Relations Survey (WERS) and the Workplace Industrial Relations Survey (WIRS)

The Workplace Employee Relations Survey (WERS) series began in 1980. It was previously known as the Workplace Industrial Relations Survey, or WIRS - the name was changed in 1998 to better reflect the present content of the survey. The primary aim of the survey series is to provide statistically reliable, nationally representative data on the current state of workplace relations and employment practices in Britain.

The WERS 98 Panel Survey dataset contains data from interviews conducted with management respondents at the same establishment in both 1990 and 1998. The 1990 interview data was collected as part of the 1990 WIRS. A random selection of establishments that took part in 1990 were re-interviewed in 1998, using a questionnaire designed to update the picture of employment relations in each establishment and investigate changes over the period.

Further information on the 1998 Workplace Employee Relations Survey data is also available from the ESRC-funded WERS98 Data Dissemination Service, which has been set up to provide expert advice about the survey and its analysis to both current and prospective users. The WERS98 Data Dissemination Service is located at the National Institute of Economic and Social Research; it is staffed by Neil Millward, John Forth and Simon Kirby. For further details, consult the Data Dissemination Service's web-site at: http://www.niesr.ac.uk/niesr/wers98.

The Community Innovation Survey CIS2

The 2nd Community Innovation Survey was conducted in 1997. It has firm level data on employment change and introduction of HRM practices from a nationally representative sample of around 2000 firms. This database is comparable with the other European community innovation surveys. The data is mainly concerned with innovation, but it would in principle be possible to look at the information of organisational change and the number of qualified staff within the responding firms and relate this to firm level performance. In fact some preliminary work was done in this respect which linked radical innovative performance with the proportion of qualified staff within the firm (Tomlinson and Miles 1999).

The National Child Development Study (NCDS)

The National Child Development Study (NCDS) is a continuing longitudinal study which is seeking to follow the lives of all those living in Great Britain who were born between 3rd and 9th

March, 1958. The aim of the study is to improve understanding of the factors affecting human development over the whole lifespan. To date there have been five attempts to trace all members of this cohort in order to monitor their physical, educational and social development including there occupational trajectories. The first four sweeps were carried out in 1965 (when they were aged 7), in 1969 (when they were aged 11), in 1974 (when they were aged 16) and in 1981 (when they were aged 23).

In addition, in 1978, contact was made with the schools attended by members of the birth cohort at the time of the third follow-up in 1974 in order to obtain details of public examination entry and performance. Similar details were also sought from sixth-form colleges and FE colleges, etc where these were identified by schools. The third follow-up assessed the progress of the children at age 16 and included medical history; IQ; medical and co-ordination tests; educational background; home environment; living conditions; ownership of consumer goods; relationship between child and parents; behavioural difficulties; educational expectations and aspirations; career expectations and aspirations; spare-time jobs held, spare time activities.

The fourth follow-up, carried out when the children were aged 23, covered the following topics: employment, unemployment and periods out of the labour force; participation in government special schemes; apprenticeship and training; post-school education; marriage, cohabitation and children; housing and household details; family income, savings and investment; respondent-reported health state and health related behaviour; voluntary activity and leisure. The fifth follow-up when the cohort group were aged 33 covered the following topics: education and training; employment history; housing history; partnership and family formation; income and wealth; health; health related behaviour; citizenship and participation; parenting; cognitive and behavioural development. Thus several variables based on childhood development and post childhood development (notably different training and educational experiences and career aspirations, unemployment and voluntary activities etc.) could be linked with actual careers and mobility patterns.

Further information about the NCDS can be found on the CLS website: http://cls.ioe.ac.uk/

Social Change and Economic Life Initiative (SCELI)

The questionnaire for this survey of around 6000 employees collected in 1986 in 6 different regions in the UK consisted of three sections: an interview schedule including questions to both respondents and their partners, a respondent's self-completion and partner's self-completion. These questionnaires include life history and work history data useful for analysing career and mobility patterns. The data also include several questions about the respondents' jobs and working lives.

Employment in Britain (EIB) 1992

In 1992 a survey of employed and unemployed people was undertaken in the UK partly based on the SCELI data. The project was performed under the guidance of Duncan Gallie of Nuffield College, Oxford, and Michael White of the Policy Studies Institute. Around 3800 employed and 1000 unemployed respondents were interviewed about their working lives and jobs. Complete work histories were collected for all respondents which can be used for longitudinal studies and mobility analysis. Results of this work were published in 1998 (Gallie et al. 1998). (NB this database is not yet in the Data Archive.)

The skills survey 1997

The Skills Survey undertaken in the UK in 1997 had the following objectives: to develop further the concept of and methodology for measuring different types of skills and to investigate the impact of various factors on skills and human capital, including personal characteristics and forms of education and training. Many of the questions on human capital in this survey are compatible with questions in SCELI and EIB noted above thus allowing some limited time series to be constructed mapping changes in the UK over a reasonably long period. The survey also aimed to investigate which particular skills were changing during the 1990s, and to what extent as well as investigating how skills were distributed among the employed population.

National adult learning survey

In autumn 1996, The Department for Education and Employment (DfEE) commissioned Social and Community Planning Research (SCPR) to carry out a survey of people's experiences of and attitudes towards learning.

This 1997 *National Adult Learning Survey (NALS)* was intended to collect data which would meet the information requirements of the Department regarding adult learning, and to provide a basis for future monitoring. In particular, the survey aimed to identify the extent to which people were taking part in different types of learning (both vocational and non-vocational), the costs, reasons and problems involved and the benefits of learning.

This dataset has extensive information about all aspects of education, training and learning based on interviews with more than 5,600 adults aged between 16-69 (both recent learners and non-learners) in England and Wales. Careers, education or training advice or guidance received in the past three years was also considered as well as the respondent's life event history - e.g. marriage, moving home, losing a job, birth of children. Thus some mobility data is available that can perhaps be related to learning.

Individual Commitment to Lifetime Learning: Individuals' Attitudes, 1993

The Employment Department commissioned three studies of attitudes to individual commitment to learning. Taken together, the three studies have been designed to produce an overall picture of attitudes to adult learning. The first in the series examined individuals' attitudes to learning. The aim of this study, the first in the series, was to increase understanding of vocational learning. There were around 1400 people in the sample.

Employers attitudes to learning 1994

The second study was concerned with employers' attitudes to learning. The aim of this study was to increase understanding of the employers' role in lifetime learning; how they contribute to learning, their attitudes towards learning and the factors which influence their policies and practices including such things as the type of training provided, human resource practices, training assessment, who pays for the training, training information and careers guidance. Around 580 firms were interviewed.

Providers attitudes to learning 1994

This study, the third in the series, aimed to explore the extent to which providers encouraged and supported commitment to adult learning, as well as identifying the factors which influenced their attitudes and helped shape their agenda. The study consisted of both quantitative and qualitative work with a sample of around 800 establishments.

Family and Working Lives Survey, 1994-1995

The aim of this study was to examine how different aspects of people's lives affect their working patterns in order to inform policy on equal opportunities and labour market flexibility. The study provides longitudinal information on the ways in which people participate in the labour market, and training, over the course of their lives. There are about 9000 respondents in the database.

HESA databases

The Higher Education Statistics Agency is the official body responsible for the collection and publication of statistical data about higher education. The Agency was set up in 1993 and began its data collection in the academic year 1994/95. Previously, a number of different organisations were involved in this work: publications previously issued by the Universities' Statistical Record are now available through HESA Services. For the future, all publications prepared by HESA are being marketed by HESA Services Ltd.

HESA also has a 'Data Provision Service' which aims to provide a customised data enquiry service to cover information which may not be available from existing HESA publications. This falls into 4 categories:

Data on students in Higher Education

Data on first destinations of graduates and leavers from Higher Education

Data on Staff in Higher Education

Data on financial aspects of Higher Education Institutions.

Published data include the following titles:

Higher Education Statistics for the UK

Data Report - Students in Higher Education Institutions

Statistics Focus

Reference Volume - Students in Higher Education Institutions

Reference Volume - Resources of Higher Education Institutions

Reference Volume - First Destinations of Students Leaving Higher Education Institutions

Higher Education Management Statistics - Sector Level

50

Higher Education Management Statistics - Institution Level

HE Finance Plus

HE Planning Plus

There are also a number of 'datapacks' available which provide tabulations of essential statistics for research into higher education (these are not free).

Research Datapack 1 - Ethnicity

Research Datapack 2 - Entry Qualifications in HE

Research Datapack 3 - Course results

Research Datapack 4 - First Destinations

Research Datapack 5 - Disability

Research Datapack 6 - Overseas Students

Research Datapack 7 - Regional Issues

Research Datapack 8 - Ethnicity in Higher Educations

Research Datapack 9 - Academic Staff in Higher Education

Research Datapack 10 - Non-credit-bearing Courses in Higher Education

Part 4

Results of using the UK Labour Force Survey to examine supply and demand for skills

The importance of studies of mobility and human resources and the methodology employed

There are at present few studies that link together the generation and movement of human resources within an innovation systems approach. Despite the fact that the mobility of knowledge is mainly facilitated by the movements of people, most studies of occupational mobility are done by sociologists who are on the whole interested in other matters. Attention is now beginning to turn to the mobility of people as it affects and is affected by science, technology, innovation and industrial change. For some early attempts at this see Tomlinson 1999, Miles and Tomlinson 1999, Akerblom 1999, and Ekeland 1998.

One of the first explicit recognitions of the importance of diffusion of knowledge through labour mobility was the OECD Canberra Manual (OECD 1995). This document explicitly focussed on human resources as they affect the workings of the science and technology system and contribute to national competitiveness. Stocks and flows of personnel were recognised as essential components and crucial objects of study for the analysis of economic systems. More recently the OECD has set up a focus group within the National Innovation Systems theme on human mobility which is for the first time attempting to produce comparable mobility data across countries. It is still too early to assess the success of this exercise.

In what follows we attempt to measure stocks and flows in specific sectors of the UK economy throughout the 1990s. the data employed are the Spring waves of the 1992-1999 UK Labour Force Survey (LFS). Each wave has around 60000 economically active people out of a total of around 140000 adults (the sampling unit is the household, hence there is information about non-employed people in the survey). The databases have information on mobility, training, education, job search patterns, occupation and sector etc. This allows us to break down data by sector or occupation and explore mobility patterns and training provision. Thus we can explore aspects of human resources within a stocks and flows framework and link it up to issues of supply and demand within a national innovation system.

As pointed out in the introduction we are interested in certain high technology manufacturing sectors (aerospace; the chemical industry as a whole; pharmaceuticals; the oil sector; radio/TV and communications equipment manufacture; office and computer equipment manufacture) and several knowledge intensive service sectors (telecommunications; computer services; the research and development service sector).

We explore three areas with respect to these sectors: **demand** for skilled workers, **supply** of skilled workers, and any **mismatches** that may be developing are isolated and assessed. Relevant policy conclusions will then be drawn.

The demand for skilled workers can be measured in two ways: by the number of highly qualified employees within the sector and also by the number of knowledge workers in the sector (knowledge workers are defined by occupations that are managerial or professional corresponding to the top 3 groups of the standard occupational classification). We also look at how high training provision is in each sector to assess the demand for increasing the knowledge and skills of employees. The survey asks whether any job related training was received within the last four weeks.

We estimate supply of skilled workers by looking at mobility rates. Inflow mobility (i.e. the number proportion of workers flowing into a sector) gives us some estimation of the availability and willingness to move from another sector into the sector under consideration. A broader definition can also take into account inflows from non-employment into employment. We can also balance the inflow rates with outflow rates (i.e. the proportion of employees in the sector who leave). The labour force survey has data on the positions of every employee in the sample and also information about what they were doing one year previously. It is using this time frame of one year that we estimate the mobility rates (this question is only asked in the Spring quarter hence all our figures refer to Spring of the respective years).

Once we have an idea of the demand and supply in the chosen sectors, we can make some tentative remarks about mismatches and potential problem areas by combining the analyses noted. This is the most interesting aspect of this work. Then policy conclusions can be drawn which may help to focus the development of human resource practices for these sectors. We now proceed to the analysis of the LFS data.

The demand for skilled labour

We have data on the number of highly qualified employees in each sector (defined as those with tertiary level education ISCED 6 and 7) and also the level of training that was available to different groups of workers. This is used to estimate demand for qualified employees on the one hand and the demand for human capital development on the other at sectoral level.

Table 2: Stocks of highly qualified workers by sector

YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMM	COMPUTER SERVICES	RESEARCH	ALL
1992	32.8	40.4	48.7	36.9	27.8	56.1	65.3	22.9
1993	32.5	39.8	38.9	41.9	20.6	52.3	61.0	22.2
1994	24.6	38.0	29.3	34.5	24.6	48.0	62.9	22.2
1995	29.9	39.4	29.2	36.6	23.7	49.7	58.5	19.3
1996	28.6	40.6	27.3	42.9	29.5	49.8	63.8	19.8
1997	29.8	37.5	29.5	42.6	28.2	55.1	70.7	20.3
1998	34.8	39.2	27.0	44.1	32.7	54.9	66.5	24.8
1999	32.8	38.8	29.0	42.5	35.6	54.3	63.5	22.1

This is the proportion of employees with tertiary education

Table 3: Training provision by sector

YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMM	COMPUTER SERVICES	RESEARCH	ALL
1992	16.4	16.3	15.7	24.0	23.0	16.0	23.8	13.6
1993	20.2	15.8	15.9	23.4	20.5	15.1	22.7	13.6
1994	19.5	17.3	15.0	21.1	15.6	17.1	17.6	14.5
1995	18.3	18.8	15.2	16.7	19.3	12.4	15.6	13.4
1996	17.5	14.4	16.8	18.8	16.8	16.4	12.9	13.8
1997	18.5	15.1	13.6	16.9	15.2	13.9	13.4	14.3
1998	17.8	14.2	14.2	22.1	19.2	16.3	20.0	14.6
1999	15.8	16.5	20.1	19.9	19.4	15.2	19.2	14.9

This is the proportion of employees who received training in the last 4 weeks

	TRAINING PROVISION BY SECTOR			KNOWLEDGE WORKERS (OCCUPATIONAL GROUPS 1,2,3)				
YEAR/QTR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMM	COMPUTER SERVICES	RESEARCH	ALL
1992	**17.9**	**16.6**	**19.6**	**31.7**	**24.2**	**17.4**	**24.7**	**19.6**
1993	**25.0**	**18.9**	**16.7**	**27.3**	**26.8**	**14.1**	**24.7**	**19.4**
1994	**19.4**	**18.5**	**22.0**	**25.4**	**13.6**	**18.6**	**17.6**	**20.2**
1995	**21.7**	**23.9**	**18.8**	**21.7**	**19.3**	**12.6**	**18.0**	**18.8**
1996	**20.7**	**16.7**	**21.3**	**19.5**	**16.7**	**15.7**	**13.5**	**18.9**
1997	**22.7**	**17.2**	**20.3**	**21.6**	**16.7**	**14.0**	**14.3**	**18.7**
1998	**22.9**	**17.6**	**21.7**	**28.7**	**18.8**	**16.4**	**19.8**	**19.2**
1999	**19.0**	**20.1**	**28.8**	**23.1**	**20.9**	**15.4**	**19.7**	**19.8**

This is the proportion of *knowledge workers* who received training in the last 4 weeks

	TRAINING PROVISION BY SECTOR			EDUCATED WORKERS (ISCED 6+7)				
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMM	COMPUTER SERVICES	RESEARCH	ALL
1992	**24.7**	**20.2**	**20.8**	**34.6**	**25.2**	**18.8**	**25.7**	**24.2**
1993	**28.8**	**18.0**	**12.7**	**29.4**	**24.3**	**13.2**	**24.8**	**23.6**
1994	**21.9**	**21.6**	**19.5**	**32.4**	**13.9**	**18.0**	**17.3**	**24.2**
1995	**17.3**	**23.0**	**16.0**	**25.8**	**21.8**	**13.4**	**20.3**	**22.8**
1996	**17.5**	**14.4**	**16.8**	**18.8**	**16.8**	**16.4**	**12.9**	**13.8**
1997	**19.8**	**19.7**	**19.6**	**20.3**	**16.2**	**13.4**	**13.5**	**22.2**
1998	**24.8**	**15.1**	**25.5**	**24.2**	**23.1**	**18.4**	**20.9**	**22.7**
1999	**23.3**	**20.5**	**36.2**	**20.3**	**22.3**	**16.0**	**20.0**	**23.3**

This is the proportion of *educated employees* who received training in the last 4 weeks

Some general conclusions from stocks and training data

Stocks of qualified personnel are very high in these sectors. The overall average for all sectors is about one fifth of employees having tertiary education, but the sectors under consideration in this study have substantially more stocks of qualified personnel. For instance, office and computer equipment manufacture and computer services have around 40-50% while the research sector has around two thirds. Stocks, however, are very unevenly distributed between these sectors (e.g., research and computer services are much higher than aerospace and telecommunications).

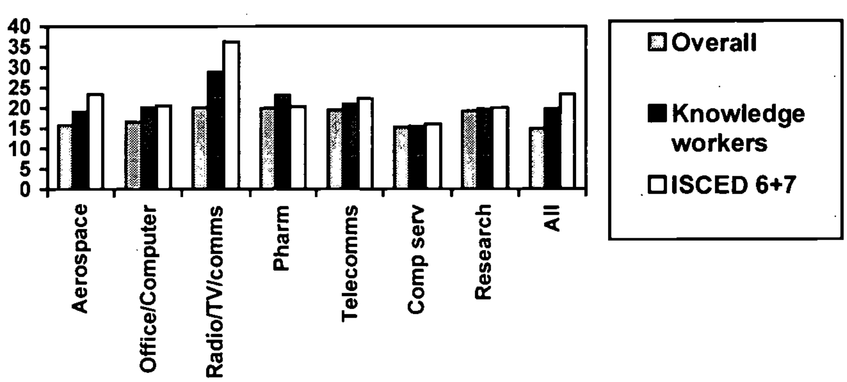
Although the figures fluctuate due to low numbers of cases in some instances, we can make some general statements about changes in the levels of stocks over the 1990s in these sectors. In some sectors stocks are generally falling (e.g., in Radio/TV/Communications equipment there appears to be a general decline from quite high levels to relatively low levels by 1999) while in most of the sectors stocks remain fairly constant or fluctuate in no particular direction (e.g., aerospace has around 30% for the whole period 1992-99; office and computer equipment and pharmaceuticals around 40%). Telecommunications appears to show a rise from around the low 20s to the around 30% in the later period.

Not only are stocks of qualified personnel high, but also training provision is generally high in these sectors also. This suggests that sectors that already have a high level of human capital are also keen on developing their human capital further. This suggests that demand for and maintenance of skill levels in high technology sectors and knowledge intensive services is of paramount importance.

There is also quite uneven opportunity for training by sector. For example, computer services, which have a high level of stocks, have a relatively low level of training provision compared to, say, telecommunications. This suggests that employees in computer services arrive already trained, while telecommunications workers are more likely to be continually upgrading or being re-trained. Other points to note are that in most sectors considered here knowledge workers and already qualified staff are more likely to get training than the overall worker. This suggests that there is the possibility of a polarisation of skills and knowledge taking place in certain sectors (see figure 1).

Figure 1

Training provision by sector



For example, based on 1999 figures, in computer services and research there appears to be a more equitable distribution of training than in radio/TV and communications equipment manufacture or aerospace. In the economy as a whole there also appears to be a sharp polarisation in human capital formation (14.9% of the whole sample received training in the last 4 weeks, compared with 23.3% of highly educated workers).

There is thus evidence of polarisation of human capital formation even in some high technology and knowledge intensive sectors (Cf. The OECD Jobs Strategy). This is a cause for concern. In a knowledge based economy it may not be wise to exacerbate differentials in this respect. It is generally accepted that an overall upskilling of the population is required to reap the benefits of IT and other new technologies. Giving significant advantages to those who are already ahead in the game seems to be counter to prevailing wisdom. This evidence is only sketchy, however, and further research would be needed to investigate this properly.

The other cause for concern is that it appears that most of these sectors show some decline (e.g., research, pharmaceuticals) or little change in overall training provision (e.g., in computer services) whereas for the economy as whole it has remained fairly constant. This must have consequences for national competitive advantage especially when many employers state that there are growing skill shortages. It must surely be significant that two key sectors of the UK economy are reducing their training provision, while very few are increasing it.

The supply side via mobility indicators

There are several ways in which mobility indicators can be constructed. The main differences are whether non-employed persons are allowed to enter the equation. For example, a broad definition of inflow mobility (i.e. the flow of workers into a sector as a proportion of the total employment in that sector) might include entrants from unemployment, the education system or other non-employed positions. Similarly outflows can include outflows to non-employed positions. A narrow definition might only include employees at both points in time (whether measuring inflow or outflow). There are advantages and disadvantages to both methods. For example a broad definition will give us more detail about the overall dynamics of an economy including the linkages between the education system or the take-up of unemployed people (for inflows) or the problems of labour scarcity due to retirements (for outflows). A narrow definition which only includes employees at both points in time gives a clearer picture of the dynamics of the more economically active population. This helps to understand the dynamics of employees knowledge flows rather than other types of knowledge flow. In what follows we concentrate on the narrow definitions of inflow and outflow mobility. (The UK LFS can also be used to calculate using broader definitions as it has non-employed and inactive members of the UK in its sampling frame at household level.)

The inflow and outflow rates give us some idea about the supply available to different sectors and an indication of the levels of labour turnover in specific sectors. In the next section we attempt to link together the supply indicators with the previously reported demand and training figures to form employment profiles of the industries concerned.

Table 4: Inflow and outflow mobility rates

	INFLOW MOBILITY RATES FOR HITECH SECTORS - EMPLOYEES AT TIME T AND T-1(%)						
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	**3.0**	**8.3**	**2.2**	**6.0**	**2.6**	**8.4**	**3.6**
1993	**1.2**	**7.9**	**5.2**	**5.4**	**3.1**	**9.9**	**4.4**
1994	**1.6**	**7.9**	**9.0**	**6.0**	**3.7**	**11.1**	**4.9**
1995	**2.2**	**13.2**	**12.1**	**4.5**	**5.0**	**11.4**	**6.5**
1996	**5.8**	**12.4**	**12.6**	**4.8**	**5.8**	**12.3**	**7.5**
1997	**6.8**	**10.8**	**9.9**	**8.2**	**9.2**	**13.3**	**3.8**
1998	**6.7**	**13.5**	**12.1**	**10.3**	**10.4**	**14.5**	**7.5**
1999	**4.9**	**11.8**	**9.7**	**8.7**	**12.5**	**10.9**	**12.9**

This is the proportion of *employees* in year t-1 moved into sector in year t (ie narrow definition)

	OUTFLOW MOBILITY RATES FOR HITECH SECTORS - ALL EMPLOYED AT TIME T AND T-1 (%)						
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/C OMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	**4.6**	**11.5**	**8.7**	**5.3**	**1.5**	**6.2**	**6.7**
1993	**4.1**	**6.9**	**3.7**	**4.3**	**5.8**	**7.2**	**5.8**
1994	**5.5**	**7.9**	**7.5**	**2.2**	**2.6**	**6.4**	**4.9**
1995	**5.9**	**8.3**	**6.4**	**8.3**	**6.6**	**6.7**	**3.8**
1996	**4.2**	**10.0**	**9.3**	**8.7**	**5.2**	**6.0**	**7.1**
1997	**5.3**	**9.6**	**8.8**	**2.8**	**5.7**	**5.7**	**6.0**
1998	**4.0**	**11.9**	**7.9**	**5.8**	**7.6**	**7.5**	**6.7**
1999	**3.9**	**9.8**	**12.1**	**5.9**	**9.4**	**6.3**	**8.8**

This is the proportion of *employees* in year t-1 moved out of sector but remained employed in year t (ie narrow definition)

	INFLOW MOBILITY RATES FOR HITECH SECTORS - EMPLOYED AT T-1 AND KNOWLEDGE WORKERS (SOC GROUPS 1-3) AT TIME T (%)						
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	1.2	5.5	0.0	0.9	4.0	4.1	2.2
1993	1.7	4.5	5.9	5.1	2.7	6.9	5.2
1994	2.2	4.9	10.6	5.4	1.8	11.0	4.0
1995	2.6	9.2	6.3	2.5	5.6	8.6	3.7
1996	1.8	9.9	13.8	3.3	5.3	9.1	5.9
1997	6.4	7.7	8.6	7.7	3.0	13.0	2.5
1998	6.7	11.4	3.2	9.2	9.0	12.5	4.7
1999	4.3	7.0	4.9	5.9	6.7	10.1	13.4

This is the proportion of *employees* in year t-1 moved into sector in year t (ie narrow definition)

	OUTFLOW MOBILITY RATES FOR HITECH SECTORS – KNOWLEDGE WORKERS AT TIME T (%)						
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	4.2	9.6	6.9	4.3	2.0	4.9	7.4
1993	5.5	7.0	4.0	5.1	4.7	3.8	4.6
1994	8.7	5.6	6.7	2.8	3.5	4.7	5.9
1995	4.2	6.8	1.7	7.1	8.6	4.0	2.7
1996	6.0	9.3	12.5	7.8	6.5	5.1	4.6
1997	4.1	7.7	3.6	3.2	3.5	4.2	2.5
1998	3.8	12.7	7.6	3.6	5.2	6.5	4.1
1999	4.3	8.3	7.9	3.8	10.8	4.5	8.4

This is the proportion of *employees* in year t-1 moved out of sector and employed in year t (ie narrow definition)

	INFLOW MOBILITY RATES FOR HITECH SECTORS - HIGH QUALIFIED WORKERS (ISCED 6+7) AT TIME T (%)						
	HI TECH SECTORS				KNOWLEDGE INTENSIVE SERVICES		
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	**4.4**	**6.8**	**1.2**	**3.0**	**3.4**	**3.5**	**3.7**
1993	**1.4**	**2.5**	**5.6**	**6.7**	**3.9**	**11.0**	**4.8**
1994	**2.2**	**2.9**	**8.3**	**7.3**	**3.6**	**14.2**	**6.2**
1995	**5.2**	**9.3**	**8.1**	**3.3**	**3.6**	**10.1**	**2.8**
1996	**4.9**	**8.0**	**12.8**	**2.0**	**7.4**	**8.5**	**5.2**
1997	**6.2**	**8.8**	**14.0**	**9.7**	**7.4**	**14.5**	**1.4**
1998	**6.2**	**10.5**	**9.5**	**14.0**	**6.9**	**13.3**	**5.3**
1999	**3.3**	**5.8**	**4.4**	**8.8**	**10.0**	**10.6**	**13.8**

This is the proportion of *employees* in year t-1 moved into sector in year t (ie narrow definition)

	OUTFLOW MOBILITY RATES FOR HITECH SECTORS - HIGH QUALIFIED AT TIME T (%)						
	HI TECH SECTORS				KNOWLEDGE INTENSIVE SERVICES		
YEAR	AEROSPACE	OFFICE/ COMPUTER	RADIO/TV/ COMMS	PHARMA	TELECOMMS	COMPUTER SERVICES	RESEARCH
1992	**2.3**	**11.7**	**6.6**	**3.0**	**1.4**	**3.5**	**7.1**
1993	**4.8**	**8.4**	**4.2**	**6.7**	**6.7**	**5.8**	**5.6**
1994	**9.0**	**5.7**	**5.7**	**3.3**	**3.6**	**4.5**	**7.0**
1995	**8.0**	**10.1**	**2.5**	**10.1**	**7.8**	**6.2**	**3.5**
1996	**2.5**	**8.0**	**14.6**	**6.8**	**5.0**	**6.2**	**3.8**
1997	**6.2**	**8.8**	**6.5**	**3.8**	**5.3**	**6.0**	**3.4**
1998	**2.8**	**13.0**	**13.6**	**3.9**	**9.4**	**7.0**	**7.1**
1999	**2.5**	**9.3**	**6.5**	**6.4**	**9.4**	**4.9**	**9.4**

This is the proportion of *employees* in year t-1 moved out of sector but still employed in year t (ie narrow definition)

General remarks concerning the mobility rates

Inflow mobility to the high technology sectors considered seems to be generally increasing throughout the 1990s, but this is tailing off for Radio/TV/Communications and Office and computer machinery manufacture. The inflow figures are generally high for Office and computer machinery manufacture, Radio/TV/Communications equipment and Pharmaceuticals relative to Aerospace.

Inflow mobility to knowledge based services is also generally increasing. Inflow mobility of Computer services has been the highest throughout the 1990s, but now Research and Telecommunications has caught up with it.

Outflow mobility is far less clear, but it is generally lower in the service sectors considered here. Outflow mobility is also generally increasing in these services (except for computer services). It also appears to be increasing in office/computer equipment manufacture and radio/TV and communications equipment manufacture, while in aerospace it has remained fairly constant and any trend is rather unclear in pharmaceuticals

Synthesis of the results by sector - combining the demand and supply figures

The following graphs plot the results for the various sectors. They show the stocks of educated personnel in each sector, the overall training provision for each sector and the inflow and outflow mobility rates of knowledge workers in each sector. This combination of figures gives us a useful profile of each industry from a human capital supply and demand perspective which can be used to assess potential problems and highlight differences between sectors at the national level. The results are summarised in table 5 and discussed in the next section.

Manufacturing sectors:

Figure 2

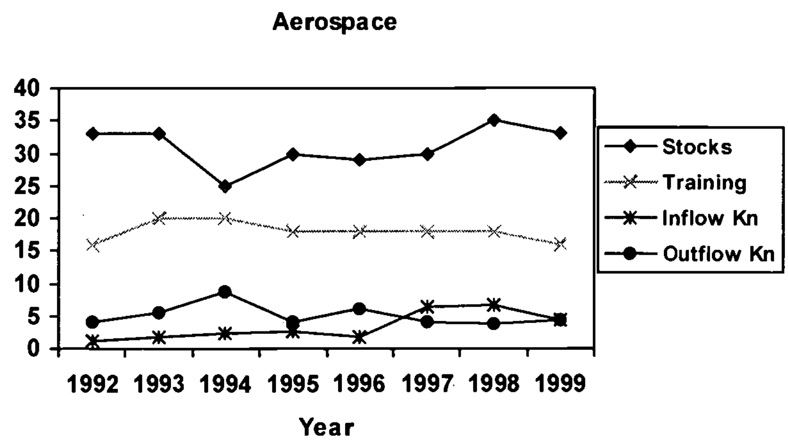


Figure 3

Pharmaceuticals

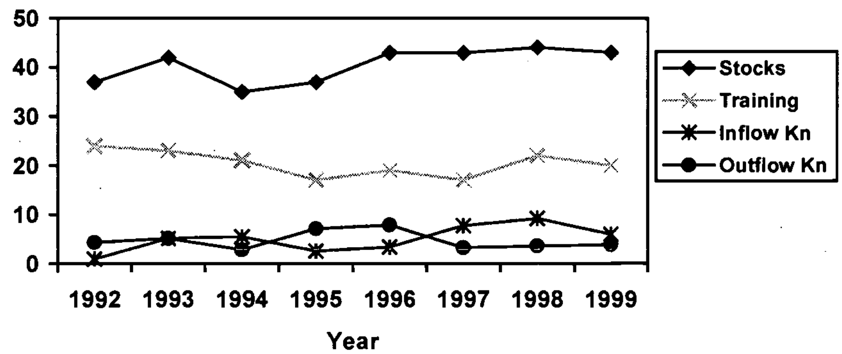


Figure 4

Office and computer equipment manufacture

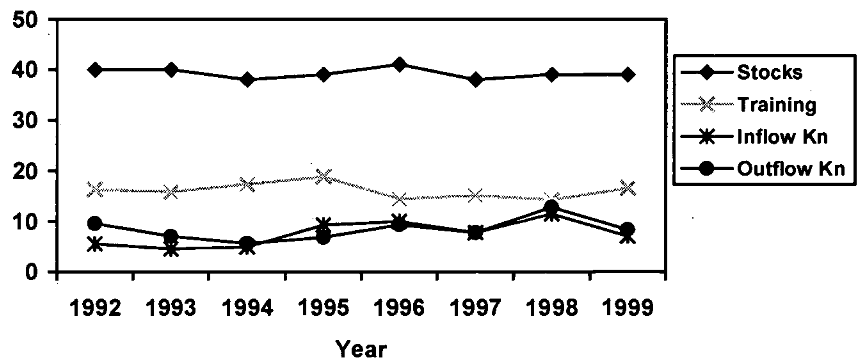
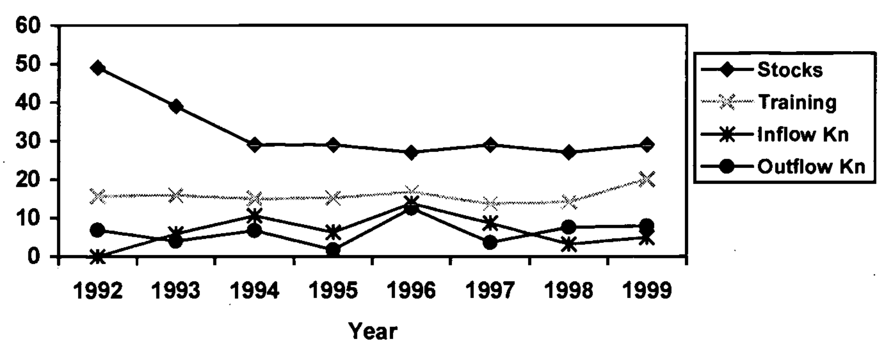


Figure 5

Radio/TV/Communications equipt. manufacture



60

Knowledge intensive Services:

Figure 6

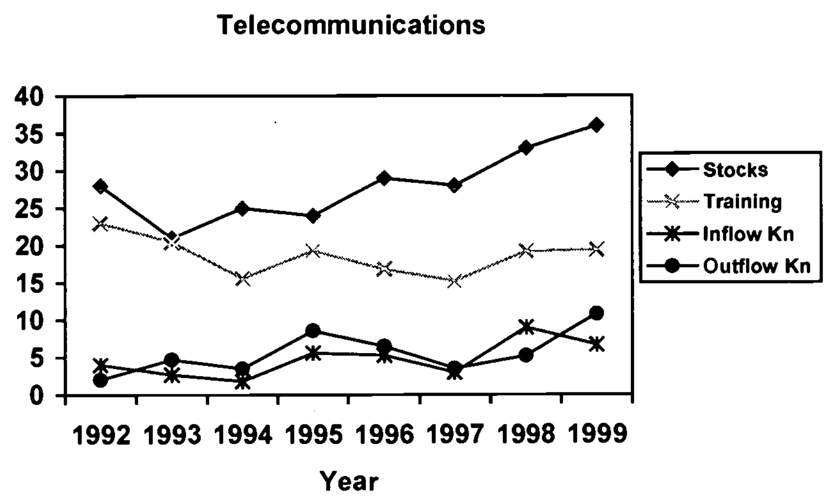


Figure 7

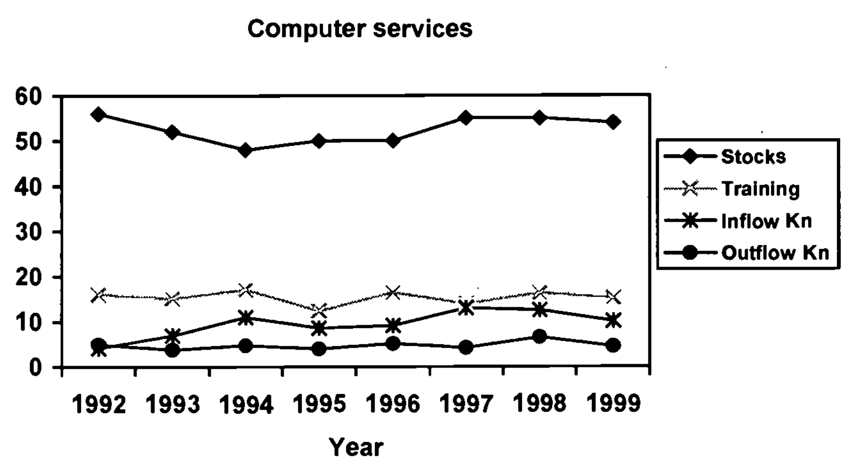


Figure 8

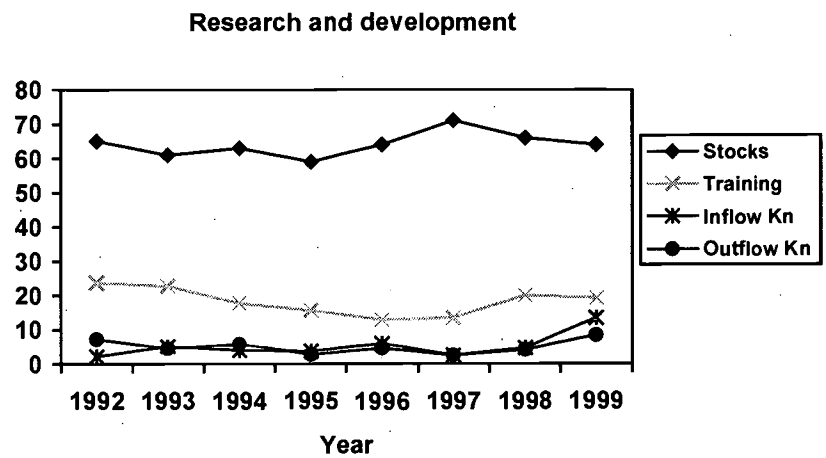


Table 5: Summary table of the supply versus demand by sector

	STOCKS	TRAINING	INFLOW	OUTFLOW
AEROSPACE	GENERALLY STABLE AT AROUND 30%	FAIRLY STABLE AROUND 20%, POSSIBLY SLOW DECLINE	GENERALLY VERY LOW	USUALLY HIGHER THAN INFLOW, BUT CONVERGING
OFFICE/COMPUTER/EQUIPT.	VERY HIGH AROUND 40%, STABLE	FAIRLY STABLE AT AROUND 17%	QUITE HIGH AT AROUND 10%	QUITE HIGH AT AROUND 10%, GENERALLY FOLLOWS INFLOW
RADIO/TV/COMMS. EQUIPT.	DECLINED FROM A HIGH OF 50% IN 1992, NOW STABLE AT 30%	FAIRLY STABLE AT 15%	APPEARS ERRATIC (LOW NUMBER OF CASES)	APPEARS ERRATIC (LOW NUMBER OF CASES)
PHARMACEUTICALS	HIGH AT AROUND 40%	APPEARS TO BE SLOWLY DECLINING TO AROUND 20%, BUT WITH SOME SIGN OF RECOVERY 1999	GRADUALLY INCREASING, BUT LOW	ERRATIC. APPEARS TO BE LOWER THAN INFLOW 1997-99.
TELECOMMUNICATION	INCREASING RAPIDLY TO AROUND 33%	FLUCTUATES AROUND 16% FROM A HIGH OF 23% IN 1992	INCREASING TREND	INCREASING TREND
COMPUTER SERVICES	VERY HIGH AT AROUND 55%	RELATIVELY LOW AT AROUND 16%	INCREASING TREND. GREATER THAN OUTFLOW.	LOW AND STABLE AT AROUND 4%
RESEARCH	HIGHEST AROUND 65%, ALSO SEEM TO HAVE AN UPWARD TREND	HAS DECLINED, BUT SIGNS OF RECOVERY	FAIRLY STABLE, SIGNS OF INCREASE TOWARDS 1999	FAIRLY STABLE, SIGNS OF INCREASE TOWARDS 1999

62

Discussion and conclusions

Table 5 which summarises the results of the synthesis shows that the sectors with the highest stocks are Office and computer machinery manufacturing, computer services, pharmaceuticals and research and development. This suggests that demand for graduates and highly qualified people will especially be in these sector. This suggests considerable investment might be made in higher education and shifts in provision of courses oriented towards these sectors might be prioritised. Furthermore there has been a significant growth in demand for skills in telecommunications towards the end of the 1990s. Again provision of training and education oriented towards this sector should be considered as essential (especially as training provision within this sector appears to have declined).

Deficiencies in training provision are apparent in computer services, although this must be offset by the fact that this sector has extremely high stocks of qualified personnel. Pharmaceuticals and research and development also show a decline in provision which is potentially worrying. The other sectors appear to have fairly stable training provision. In any case it must be borne in mind that provision of training is higher in these sectors than the average for the whole economy.

In terms of mobility the sectors that appears to have high fluidity in terms of inflow and outflow are telecommunications and office and computer equipment. Again steps could be taken to reduce the outflow rates from these sectors if this seemed appropriate. Computer services and pharmaceuticals appear not to suffer from this problem having higher inflows than outflows. This appears set to continue.

The general impression of skill problems in the UK economy from the literature review point to the need for the government to focus on several key areas:

- Fostering more management skills among skilled employees
- Fostering a more business like orientation and entrepreneurial style among professionals
- Promoting multidisciplinarity
- Reducing brain drain especially to the US in key sectors
- Promotion of clusters of high technology industries
- Encourage the creation of professional bodies for new high technology industries such as photonics

The first three points could be addressed at university level. If more graduates are trained or given the opportunity to undertake some management courses and focus on courses with multidisciplinary awareness this could reduce problems experienced by many high technology and knowledge based firms. The last three points suggest a focus on creation and maintenance of a suitable infrastructure for certain key sectors. This would involve the maintenance of, say, science parks, regional developments and grants for specific industrial clusters and the fostering of dynamic local labour markets which reduce the level of brain drain. We end the report with an example of how the type of data generated above might be used in a more systematic way and with a warning as to how different sectors require quite different strategic policies in order to maintain competitiveness.

63

A knowledge economy example: Comparing computer services with telecommunications in the UK

As an example of how this type of analysis might be used within a specific systemic context consider that in the 'knowledge based' or 'new economy' two crucial sectors for progress are the telecommunications services (TS) and computer services (CS). Two sectors which have been analysed above with respect to the supply and demand of human resources in the UK. If the state were to implement a strategy to bolster the knowledge driven economy based upon a focus on these two sectors then a common strategy between the sectors would be rather inappropriate given the differences in mobility and human resource patterns in the 2 sectors.

For example, CS has very high stocks of educated workers and high training provision while TS has low stocks and higher training than CS. The high stocks required by CS are already manifesting themselves in the UK. Immigration controls are being relaxed in order to allow IT qualified graduates from abroad to work in the country. The figures on mobility show that there is no problem keeping such workers in the industry once they enter in (inflow rates are much higher than outflow rates).

In TS on the other hand inflow and outflow rates are more or less congruent, but on the increase throughout the 1990s. This is the case whether we look at overall mobility or just knowledge workers (i.e. professionals and managers). Therefore relatively speaking TS have more labour fluidity and more of a problem than CS in terms of retaining people. The TS training figures may reflect this fact plus the fact that the stocks are also lower. So in terms of policy, for telecommunications it would be more useful to introduce training programmes of a different type than for CS and also to attempt to reduce the outflows from TS, perhaps by offering programmes and incentives to telecommunication firms that help to retain staff.

Note that this analysis tells us nothing about mobility *within* the sector which may be of crucial importance for individual enterprises. Whereas the computer services sector seems to be doing relatively well in terms of retaining highly skilled staff and having less fluidity this tells us nothing about the problems that individual firms within sectors may be having. Firms may have extreme difficulties with poaching or training employees who then leave to go to rival firms.

It seems on balance that if policy makers wanted to target training programmes or influence competitiveness in the knowledge based economy they would be better off devoting more resources to telecommunications than to computer services in terms of flexible labour market policies and training. On the other hand the high stocks in CS indicate that there is huge demand for qualified staff in CS. This suggests that provision of computer related HE courses must also be a priority. Recent employee based evidence also increasingly supports the need for computer based skills in general in any case (Green et al. 1999).

There was also evidence of polarisation of training provision in TS, but not CS perhaps indicating an area to be addressed also. It may be better to encourage telecommunications firms to train their less skilled staff as well as their knowledge workers. While in CS there may be a more democratic system in place. This quantitative evidence would need further investigation to be conclusive and perhaps some qualitative work would help to shed more light on these results.

References

Åkerblom, M. (1999) Mobility of highly qualified manpower, a feasibility study on the possibilities to construct internationally comparable indicators. Report for Camire (Eurostat) and OECD. Statistics Finland, 14th December.

Bosworth, D.L. (1986). *Intellectual Property Statistics*, Oxford: Pergamon Press.

Bosworth, D.L. (1999). "National and Regional Indicators of Skill Demands", Institute for Employment Research, University of Warwick: Coventry

Bosworth, D.L. and R.A. Wilson(1999). "Skills and Performance: a Review of the Literature". Part of a Report by Cambridge Econometrics, prepared for the London TEC Council

Ekeland, A. (1998) 'Indicators for human resources and mobility', IDEA Paper No.9, STEP Group, Oslo.

EMTA (1999) *Labour Market Survey of the Engineering Industry in Britain*, Watford: Engineering and Marine Training Authority

Gallie, D., M. White, Y. Cheng and M. Tomlinson (1998), *Restructuring the Employment Relationship*, Oxford: Oxford University Press.

Green, F., Felstead, A. and Gallie, D. (1999) *Computers are even more important than you thought: an analysis of the changing skill-intensity of jobs.* Paper presented to EEEG Annual Conference, July 1999

Haskel, J. and Holt, J. (1999) Anticipating future skill needs: Can it be done? Does it need to be done? National Skills Task Force Research Paper 1, DfEE.

Hendry, C. (1999) *New Technology Industries.* National Skills Task Force Research Paper 10, DfEE.

Kahn J. A. and Jong-Soo L. 1998, 'Skilled Labour Augmenting Technical Progress in US Manufacturing', in *Quarterly Journal of Economics*, 113(4), pp. 1245-1280.

Mason, G. (1999) *Engineering skills formation in Britain: cyclical and structural issues.* National Skills Task Force Research Paper 7, DfEE.

OECD (1999) *Science and Technology Industry Scoreboard*, Paris: OECD.

OECD (1995) *Canberra Manual*, Paris: OECD.

Penn, R. and Holt, R. (1999) Skills Issues in Other Business Services - Professional Services, National Skills Task Force Research Paper 16, DfEE.

PSI (2000) *Labour market and skill trends 2000*, London: Policy Studies Institute (for the DfEE Skills Task Force).

65

Tomlinson, M. (2001), 'A new role for business services in economic growth', in Archibugie, D. and Lundvall, B-Å. (eds.), *The globalising learning economy: major socio-economic trends and European innovation policy.* Oxford: Oxford University Press.

Tomlinson, M. (1999), 'The learning economy and embodied knowledge flows in Great Britain', *Journal of Evolutionary Economics,* Vol.9, No.4, pp.431-451.

Tomlinson, M. and Miles, I. (1999), 'The career trajectories of knowledge workers', in *Mobilising human resources for innovation: Proceedings from the OECD workshop on science and technology labour markets,* DSTI/STP/TIP(99)2/FINAL, OECD: Paris.

Appendix A: Data for the Chemical sector (which includes pharmaceuticals)

	1992	1993	1994	1995	1996	1997	1998	1999
INFLOW	**5.3**	**4.6**	**5.2**	**6.0**	**4.5**	**5.7**	**8.0**	**7.2**
OUTFLOW	**7.3**	**5.3**	**4.2**	**7.8**	**7.8**	**4.5**	**7.4**	**8.1**
KNOWLEDGE WORKERS:								
INFLOW	**2.0**	**3.4**	**4.3**	**4.3**	**2.0**	**5.1**	**6.4**	**5.0**
OUTFLOW	**5.2**	**5.4**	**4.0**	**6.7**	**6.4**	**4.2**	**5.2**	**5.9**
TERTIARY EDUCATION:								
INFLOW	**4.0**	**4.0**	**5.5**	**5.6**	**2.1**	**4.8**	**9.2**	**8.1**
OUTFLOW	**4.0**	**7.6**	**4.1**	**9.7**	**8.4**	**4.1**	**3.4**	**8.1**
STOCKS	**30.8**	**30.0**	**28.5**	**28.4**	**31.6**	**31.0**	**33.9**	**34.6**
TRAINING	**18.6**	**18.1**	**19.6**	**17.3**	**17.3**	**16.9**	**20.4**	**16.7**

The supply and demand of high technology skills in Norway

Anders Ekeland

STEP group, Norway

Introduction

This report is one of three country studies in a pilot project looking at the supply and demand of high technology skills. The other two country reports are from the UK and the Netherlands. In our study of supply and demand for high technology skills, we are going to take a closer look at skills in the high-tech sectors of the Norwegian economy. High-tech sectors are characterised by requiring advanced skills, they are often R&D intensive and they often experience rapid changes in products and technology. These factors make these industries particularly interesting and important when trying to study the problems of skill mismatch. In addition, these sectors are often regarded as potential growth sectors. For policy makers concerned with economic development, knowledge flows and technical change these sectors are often regarded as the most interesting.

The actual choice of sectors to be defined as high-tech is based on the UK country study that in many ways has functioned as "template". We will in this study also to a certain extent discuss that choice. Too often certain sectors are regarded as high-tech without much critical reflection on what that actually means, running the danger of restricting analysis of high-tech skills to certain sectors that are in fashion. And as we all know – fashion is a volatile phenomenon.

The following analysis has two main aims: First, to study the development of high-tech sectors in terms of labour mobility and supply of training. Such a study is important for the very simple reason that we are talking about very skill-intensive industries. Secondly, Norway has both register data[1] and Labour Force Survey (LFS) data that can be used whereas most countries only have LFS data. We will use both data sources and discuss their strengths and weaknesses.

The report consists of the following sections:

Part1: Literature review

Part2: Analysis of national data

1 Register data is based on various public administrative registers.

Part 1 The Norwegian literature on skill mismatches

There exists a considerable literature in Norway on skill mismatches and the forecasting of future skill needs. The literature may roughly be divided into three according to the methods and data used:

- Direct indicators (registers of vacancies, surveys of employers and employees)
- Empirical demographic/economic forecasting models
- Macro economic econometric models

It is of course impossible to summarise this vast literature, written over the last four decades in just a few pages. For the issues focused on in this report we think that there are a few topics that are of special interest to the present study:

- are we able to forecast the future need for skills - and if so - to what degree of detail - and by which methods?
- if we are able to foresee the need for skills - are the political systems willing to try to implement the necessary policies?
- if the political system is willing - will the implemented policy deliver the result
- and if one misses - what are the costs of substituting and training?

The basic need for forecasting the output of various types of skills cannot be denied on a general level. It takes several years to educate a highly skilled person, so to avoid bottlenecks in the near future one has to be proactive. And very often it takes more years to expand the staff, move to or build new buildings. All kinds of mundane tasks that require time if one must expand more than marginally an existing field. Even more difficult and time consuming is to build an entirely new field - the prime example in the last three decades is of course ICT.

A basic problem is of course *who* ought to formulate the needs for the expansion of existing skills, and especially difficult is the creation of entirely new fields of education? General answers like "the public" or "the market" only raise further questions, because there are many questions to deal with before one is down to an operative level. The public sector is a complex system of actors, parliament, government, different levels and institutions.

The parliament is not going to make detailed decisions - at least not without expert advice - and if expert advice is given are the parliament to overrule the expertise? The problem of policy versus expertise is repeated at various levels in the governmental apparatus. It is no easier to decide who is going to be the voice of the "market", especially concerning long-term issues like supplying skills for markets that do not exist, but that will emerge due to the future development of various technologies.

In addition comes of course that the last four decades have seen an unprecedented expansion of higher education, first during the sixties, for some periods the growth has slowed down a little, but the secular trend has been very clearly expansive. But let us try to go through these questions one by one - although they are highly interrelated.

To describe how national educational systems as a whole and the various subsystems are regulated one can use a model with three principal types of authority[2]:

- Public authorities – various levels, both politicians and various types of expertise
- Markets – the demand for education from new generations and the demand for generic and specific skills from employers.
- Academic and professional bodies

Every national system of skill production – and its various subsystems – is of course not governed by only one of these types of authority. They are the result of the relations between these three types of authority.

Are we able to foresee the future need for skills?

Before one starts to summarise the track record of the efforts in Norway, one might ask the more general question - are we able to satisfy today's need for skills? Because one should by no means take for granted that we are in an optimal situation now, and that the only task at hand is to take into consideration the unknown and/or uncertain challenges of the future. There is always a discussion how well adapted different types of education are to the multiple needs of contemporary society. An eternal discussion of what those needs are and how well they are met.

Different political, professional and pedagogical views structure this debate. Even very homogenous interest groups might have different strategic and tactical points of view of what is actually needed. Should education be more general, focusing on "eternal" elements of skill or should is be very closely adapted to the technologies actually used. To take an example: a university level study of economics - how well is that actually suited to the needs of those employers that employ economists? These are not simple questions, and they get worse by an order of magnitude when confronted with different emerging technologies.

Forecasting the dimensions of different fields of education

The track record of forecasting the future need for specific skills – either existing sets of skills or new skills is not the best one, but of course there is not a single cause for that. Because if the model were that simple then the forecasters would have corrected that a long time ago. Most forecasts have of course not missed the general need for more highly educated people. At times since the Second World War there were more or less strong voices warning that there would be an overproduction of highly educated people. But today that is not regarded as a very important issue. Experience shows that all the educational capacity that has been built is mostly used, no matter what the specific content. The education institutions that experience less demand for their services in most cases manage to adapt to new needs – so there has been no chronic oversupply of specific types of skills.

[2] The model is taken from Burton Clarke (1983). This section draws heavily on Aamodt (1999) where Burton Clarke's model is used in analysing the regulation of higher education in Sweden, UK and USA.

The last four decades has witnessed a "massification" of higher education. This process will probably not stop before having at least 15-16 years of education becomes the general norm, as seven and nine years of education has been the norm earlier. To have at least twelve years is rapidly becoming the norm in Norway *today*.

But in case one fears that such a massification of education would result in an overproduction - who is going to decide when enough is enough? There has up to now – as mentioned above - been an insatiable demand for higher education in general. This demand is in our opinion to a large extent not motivated by short term economic motives or accurate calculation of "net present value of future income streams", but by more strategic concerns of a social and political kind by broad layers of society[3]. Knowledge, education implies social recognition, feeling less inferior to various elites, mostly a decent income, an escape from hard and/or routinised work etc.

There are in the literature clearly two different worldviews. On the one hand the "particularists" – those who believe that various technologies demand a very specific set of skills. The particularists often see skill mismatch as a technical problem in a "production function" framework. On the other there are the "generalists", who emphasise the general "ability-building" aspects of education. The generalists tend to believe that an important element of any higher education is the ability of problem solving, the self-confidence needed to take difficult decisions etc. The generalists argue that a lot of education for example in the humanities and social sciences is not directly useful in a narrow technical sense and that also technical education becomes more useful when it is aware of the "other" aspects of technology – understanding the needs of the end-users of technology, understanding economics, entrepreneurship, team-work etc. The "generalists" are in addition as a rule more open to consider the social, cultural, political/democratic dimensions of education.

The problems of skill mismatches – different approaches

There are as mentioned above three main approaches to skill mismatches:

- using "direct" indicators like vacancies and queues
- empirical, demographic forecasting models
- econometric models

Of course there is considerable overlap between these approaches. The use of direct indicators of course is based on a more or less explicit model of how labour markets function. The empirical/demographic models likewise have to model how supply and demand for skills/education and the econometric models uses as data indicators of vacancies and demographic data, but still we think this typology is useful.

[3] Cf. Aamodt (1999) and Skoie and Aamodt (1991)

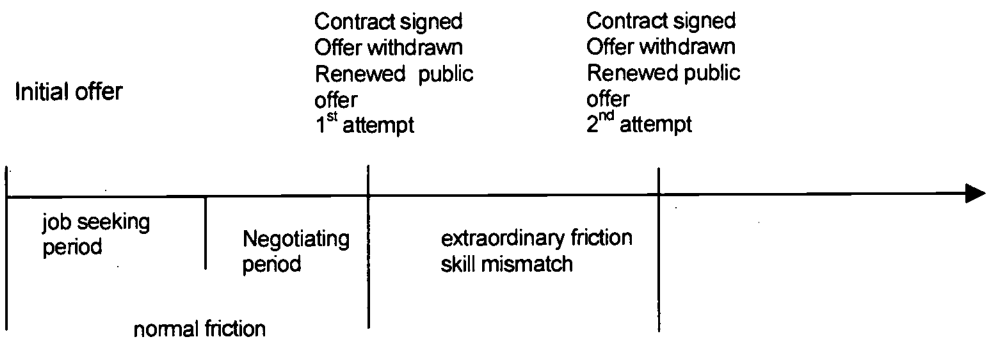
Direct indicators – using registers and surveys

The Nordic comparative study – Tema Nord 1995

One way of dealing with the problem of measuring skill mismatches is to try to study in detail the matching process on the labour markets. One seeks to construct indicators for the mismatch between the skills of persons seeking new jobs and the kind of skills in demand by employers. This is done in a comparative Nordic study from 1995[4].

The study starts by ordering the different phases and events on the labour market

Figure 1: Friction and mismatch on the labour market



In order to define an indicator of skill mismatch one must first of all one has to draw a line between normal friction in the labour markets from various degrees of extraordinary friction/skill mismatch. There are of course a lot of factors influencing the degree of friction, like attitudes to geographical mobility, wages, reaching all potential job-seekers in a labour market segment with the job offer. But even if we assume that these factors are constant, it is a complex task to use the available data about vacant jobs, number of people applying for specific jobs etc. to get a good, pure indicator for skill mismatch. One gets for example different estimates for the number of job seekers using the register for the total number of job seekers than the Labour Force Survey –due to different definitions.

The study defines four different measures of skill mismatch and estimates them by using register data. The estimates are for different geographical units like municipalities and counties. There are also estimates on the need for geographical mobility, the lack of/need for more work experience and further education to reduce the mismatch. The study also looks at the occupations and/or branches of industry with the greatest disproportion between the number of jobs offered and the number of job seekers. In Norway the sectors in 1993 with the greatest need for more people was clearly education due to the baby boom in the late eighties and early nineties and health. The next group comprises various services, including IT.

In addition to the estimates based on register data the study reports on a series of surveys done in Norway where a sample of employers announcing jobs of more than a weeks duration were asked about what would be the *best* qualification for this specific job. It is *not* asked only what the employer realistically thinks they can get on the labour market today, what the firm regards as sufficient. The employer is asked to disregard the different wages for kind of skills – to

[4] Larsen, Eriksen and Devold (1995)

hypothetically regard the wage as fixed to try to single out the importance of education and previous work experience. The employer is also asked to give the person who finally was employed in the job a questionnaire in order to get information about their background and map the job seeking efforts of the employee.

Such surveys with two questionnaires have been done in 1989, 1990, 1991 and 1993 in Norway and in 1991 in Sweden. The categories of jobs are rather broad so the branches focused in this study are not identifiable, but the methodology used is interesting and could be used also for more specific branches and skills.

There are of course problematic aspects of this method connected with the fact that the employers might be rather myopic – even if they are able to disregard wage differentials etc. and actually tell what would be the best set of skills for the job. It is an open question how good such a method is for forecasting their needs some years ahead due to technological (and other) changes in society.

Since doing this kind of measurement exercise is rather costly - those who believe that a great deal of substitution and/or retraining can take place would not see detailed measurement of skill mismatches using this kind of survey as being worthwhile.

Empirical forecasting models

There is a large literature on forecasting the needs for various occupational groups, the need for recruitment to the universities and research institutes[5]. Such studies are done continuously, In some countries this is part of a tradition of public planning and policy intervention, in others they are presented more as analyses of specific markets. As mentioned above, the track record of such forecasts is not that impressive, so today they are used as one piece of information to fit into a broader picture. Often it is useful to make such an estimate, because one forces oneself to try to single out the most important determinants for the demand for skills and possible skill mismatches – and to learn from the mistaken estimate what factors/mechanisms were poorly understood. But it is also important to realise that even if the estimates for the future demand are sufficiently correct, it is by no means given what policy conclusions should be drawn.

Estimates and policy – the case of primary school teachers[6]

Often one can hear in public debate around problems on the labour market that it is strange that one cannot estimate correctly the number of teachers since we know at least six years in advance how many children will start school, how many teachers that go into retirement etc. There are more volatile factors influencing the demand for teachers and many of the estimates

[5] A large part of this literature comes from the Norwegian institute of research on research and education, Norwegian abbreviation is NIFU, but also other Norwegian research institutions have contributed considerably to this field. The institute was set up in the sixties when the optimism regarding the possibilities for planning and controlling the long-term supply of skills and academic training was greater than it is today.

[6] The case is discussed in Aamodt (1999), a Pro Memoria written by Lars Brandell in the Swedish National Agency for Higher Education is printed as an appendix. Brandell deals with this issue in great detail and illustrates the great variations in cohorts and the resulting consequences for the demand for teachers.

made for the demand for teachers have not been very close. But there is an aspect of this that is often overlooked: namely that the number of children vary considerably due to considerable changes in fertility. These variations are so great – the number of graduated teachers needed on the top of the boom might be the double of the number needed when the small cohorts are at school age. The variations happen within a decade or less so that it is simply impossible for the education system to build up/reduce the capacity for graduating teachers accordingly. That means that in the boom years people who are not qualified teachers are employed and one might not want – or for legal reasons be able to dismiss – them rapidly enough. In addition comes the question of the individuals right to become a teacher personally taking the risk that the labour market might be adverse in a period after examination.

Estimates and policy – the case of IT-skills

In most countries one is experiencing a lack of ICT skills in the late nineties. It is generally believed that ICT skills are vital in the development of key sectors of the economy and will be so for a good number of years, due to the generic, pervasive character of this set of technologies. The ICT skills are interesting since they pose all the classical questions of how to minimise skill mismatches.

- were different institutions able to foresee the demand for ICT skills - and the kind of skills needed?
- And if so - did the authorities take the necessary steps to meet the correctly estimated need for ICT skills?
- And if they did not - why - and have they learned anything from these experiences?

The ability to forecast the need for ICT skills

In Norway one can roughly divide the period after WWII in an early period – until the mid-seventies when one underestimated the potential of – and consequently the use of computers. But with the advent of mini-computers from firms like DEC[7] and Norsk Data in the late seventies and even more with the introduction of personal computers, "everybody" realised in the mid-eighties that a major new technology shaping our lives in various ways had arrived.

At that time the employer organisation Confederation of Norwegian Industry (Norges Industriforbund) had their yearly conference "Industrial forum" (Industriforum), a meeting place for top leaders of industry and the political establishment – from the ministers of trade, industry and top civil servants to the leaders of the political youth organisations. The universities and research institutes were also well represented. This was an important and representative forum. In the opening speech, the president of the Confederation said:

> There has always been a gap between the needs of industry and the capacity of the educational system, this problem is now becoming more serious than ever ...Especially we lack persons with IT-skills and there is also a lack of people with education in various other fields of technology.

This opening speech was followed up by the Vice President of the Confederation providing a much more detailed analysis of the needs of industry and the bottlenecks it was facing. It

[7] Digital Equipment Corporation, well know for machines like PDP11 and VAX.

launched a ten year plan with very specific targets, being very outspoken about the lack of response from the political establishment to the very clear signals of bottlenecks. Underlining that there was no lack of students or forecasts demanding a radical increase in the number of graduates in key fields of science.

In the aftermath of the conference a special study was published by the Confederation specifically on this topic. In this study a ten-year plan with detailed quantitative targets was set out. These targets were controversial. The leading experts – the institute for research on research and education held that lower numbers of engineers and ICT persons were needed.

A very precise forecast of technological development

Several other attempts were done at quantifying the need both for technological skills in general and ICT skills in particular. NIFU made a study with the title "The need for IT-education" ("Behovet for datautdanning") in 1985[8]. This is a rather remarkable study because it focused a great deal on discussing in detail both the possible technological scenarios – *and* the corresponding educational needs. The study described the typical computer in 1974, 1984 - the year of the study – and ten years ahead to 1994 – and they were remarkably clairvoyant about the typical computer in 1994 on parameters like:

- type and speed of processor
- amount of RAM
- size of hard-disk, development of other storage media
- other related technologies (fiber-optics, e-mail, Local Area Networks etc.)

This was not pure luck or a stroke of genius, but reflected that the development of computers, i.e. PCs at that time was on a certain technological trajectory that made it possible to foresee further developments with a sufficient degree of accuracy for the purpose of estimating the need for ICT skills.

The expansion in the late eighties

The demands both from the private sector and researchers probably led to an expansion of IT-education in Norway, mainly as a part of the "National Action Plan for IT". This expansion might have continued into the nineties if the business cycle had not changed rapidly from late 1986. At that time the locomotive of the Norwegian IT industry, Norsk Data began to have serious problems and the oil price plunged from above $30 a barrel to just above $10. The banks – a very big employer of IT-skills were in crisis and had to be rescued by the state. The oil industry also had to be much more careful about costs, starting big new IT-projects is not the thing you do in such a business climate. This meant that the very optimistic forecasts from the mid-eighties seemed to be refuted by actual events. An indication of this is the unemployment rates for various groups of highly skilled IT-engineers.

[8] NIFU/Jahnsen (1985)

TABLE 1: UNEMPLOYMENT RATES 6 MONTHS AFTER GRADUATION*, 1987 - 1997

EDUCATION	1987	1989	1991	1993	1995	1996
CAND. SCENT FROM UNIVERSITY	0,0	10,0	7,5	8,1	7,8	2,4
CIVIL ENGINEERS, TECH. UNIV.	..	..	3,3	3,3	6,6	1,6
ENGINEERING SCHOOLS (2-3 YEARS)	..	..	13,6	..	27,9	..
OTHER HIGH SCHOOLS, 3 YEARS	0,0	11,8	..	12,2	..	..
ALL HIGHER EDUCATED	3,2	5,7	6,8	9,2	12,4	10,3

* The rates are for those who graduated in the Spring, for the Technical University in Trondheim the majority graduates in the autumn, but one claims that the numbers are indicating the trend correctly.
Source: NIFU (1997), the survey of graduates (Kandidatundersøkelsen)

The table clearly shows the rapid adverse change in labour market conditions for the newly graduated. There is no reason to think that there was any significant long-term unemployment, but probably many had to take jobs that they were overqualified for.

One aspect studied when looking at the post-graduates 6 months after graduation is their subjective feeling of the relevance of their education to the job they have got (Arnesen 1996). There are clear differences between the rate of unemployment and the "rate of relevance". The data seems to support the hypotheses that accepting jobs that are seen as less relevant are more frequent when unemployment is high.

There are market differences between social scientists and natural scientists. But one should not jump to quick conclusions from this, for several reasons all of them related to the mechanisms using certain types of education in new contexts, branches. The humanities, social scientists and partly law have always been more "generalist", while other educational branches have been more narrowly used. Since the mid-nineties was the first period where the highly educated experienced some major problems on the labour market there are reasons to believe that this "shock" made the various professions more open minded about what could be seen as areas where their skills could be used. Another finding is that there is not a simple relationship either between the number of graduates, or the growth in the number of candidates, and the unemployment rate. This is not surprising since there are various processes that interact: the business cycle, search/matching and learning processes by both employers and job seekers. One cannot take for granted that the level of job satisfaction has some natural level, it might increase in a period of rapid technological change, not because the graduates take jobs they are overqualified for, but simply because the content of the curriculum is lagging behind and consequently they feel that it is less relevant.

The data covers the years 1989, 1991, 1993 and 1995. It would have been interesting to have a full cycle – that is from the boom year 1987 to the next boom in 1997 - to see if the feeling of match between education and job content stabilises again. If one could get data for the same persons over several years that would have been very interesting.

The case of ICT skills – the late nineties

It is symptomatic that it is hard to find any forecasts from either industry or research of ICT skills in particular between the late eighties and the late nineties. First when the up-turn started in 1995, after the highest rate of unemployment since WWII, the question of sufficient IT-skills again came on the agenda. There were published official documents in 1998, like the Government white paper on IT-skills in a regional perspective (Stortingsmelding 38/98) and a green paper: "IT-plan for 1998 – 2001 for private sector").

Recently the question of the lack of ICT competent personnel has been raised with full force again since on top of the general spread of ICT in society came the very proactive attitude of firms in the light of the coming development of Internet computing. Only the making of home pages and the setting up of web services increased the demand for ICT skills even more. One clear indicator of this is the fact that the public sector – not having the possibility to match the wage offers from the private sector was losing key personnel. Not only that: different parts of public administration started to overbid each other, with various fringe benefits, in order to get the human resources needed. As a consequence of this difficult situation there were launched a series of studies with the aim of forecasting the need for ICT skills in the central state apparatus. The main method used for the quantitative part was looking at the share of ICT persons in the different departments and institutions, making some estimate of the employment growth/decline – and the necessary number of ICT persons followed deterministically[9].

Other methods like counting the number of advertisements for ICT skills were also used. Early in 1997 there were 100 advertisements per week in the major Norwegian newspaper Aftenposten. Of these 40% asked explicitly for high university level education, the total number of candidates in Norway at that time equalled 7 per week[10].

Since 1997 the extraordinary high demand for ICT competence has drawn university teachers to the private sector and students into industry before graduating – no wonder, being offered very high wages and many other benefits. This of course makes it difficult to increase the supply of ICT graduates – there were at the time 30 vacant university jobs out of 130[11]. The fact that students do not graduate, do not finish their theses means less research and there is less research experience being accumulated since efforts are directed towards solving the short term needs of private sector – and not their long term needs.

It is of course not only a question of ICT skills in general, what was really in demand in recent years was the communication part, TCP/IP, HTML, XML, web-design etc. This shortage of very special ICT skill points to the problem of proactively preventing skill mismatches on such a detailed level. There were established special arrangements to catch up in this field in 1996-97[12], but that was several years after the first graphical Internet browser Mozilla had made the potential of the Internet pretty clear. But this is a question of whether it is possible – in advance – to reform the curriculum, change the resource allocation from one sub-field of Computer Science to another. Who are going to make such decisions?

---

[9] Statskonsult (1999a, 1999b, 1999c), ECON (1999) and Ekeland (1999)

[10] Fløisbonn and Liestøl (1997)

[11] NIFU (1997) quoting a survey done by Prof. Conradi at the University of Trondheim

[12] A short memorandum written by administrative director of the Faculty of Mathematics and Natural Sciences at the University of Oslo, Rune Fløisbonn and Prof. in Informatics, Knut Liestøl gives a valuable overview over the situation in 1996/1997. (Informasjons- og kommunikasjonsteknologi (IKT) – behov og potensiale for opptrapping av utdanningskapasiteten.

Econometric studies of skill mismatch

This literature uses mainly unemployment rates for specific groups and wages to construct indicators for skill mismatch. The line of argument is that if wages were flexible, then they would react to skill mismatches with lowering of the wages of those who's skills are facing a negative demand change, and rising wages for those who are much in demand. Since wages in Norway is generally considered to be rigid, due to unionisation, central bargaining etc. a skill mismatch would mean increasing unemployment for those groups with the wrong skills[13].

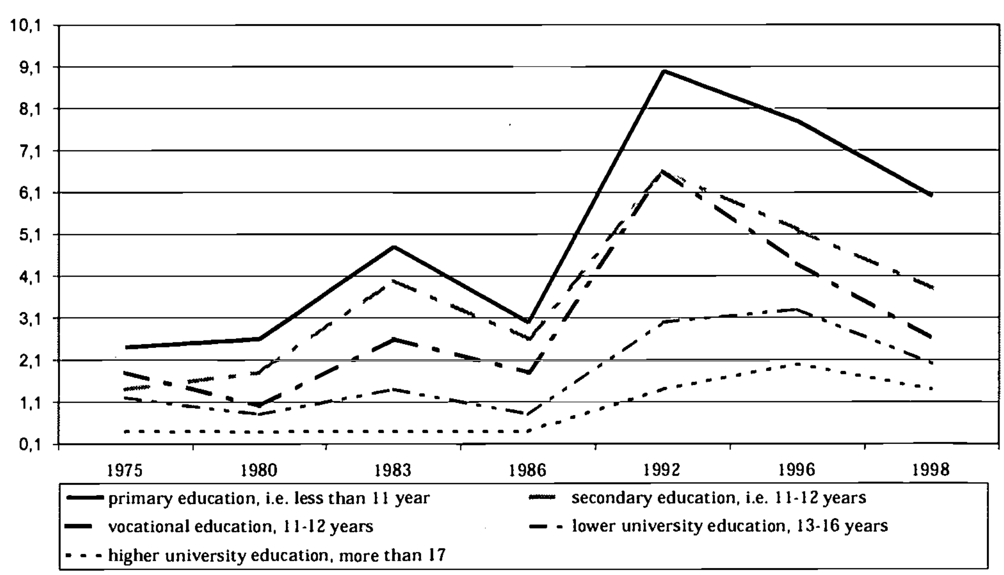
One recent study of this kind is "The Effects of Skill Mismatch on Wages in a small open Economy with Centralised Wage Setting: The Norwegian Case", Bjørnstad (2000). The study uses high-technology imports/exports as a proxy for rapid technological change. It then looks at the development of the unemployment rates for workers with:

- primary education, i.e. less than 11 year
- secondary education, i.e. 11-12 years
- vocational education, also 11-12 years
- lower university education, 13-16 years
- higher university education, more than 17 years

The unemployment rates for these groups have the following pattern: the higher the education, the lower the unemployment

Figure 2:

Unemployment rates, five educational categories, 1975 - 1998, Norway



Source : Bjørnstad (2000), Statistics Norway

The stylised picture is clear, the lower the education the higher the unemployment, and also the more variation in the unemployment. The persons with university education are much less

[13] See Krugman (1994) for a more detailed analysis of these phenomena.

influenced by the business cycle than the lower educated. In addition there is often a tendency that in those groups with high unemployment more workers are withdrawing from the labour market, so that the unemployment rates are biased downwards.

If wages were sufficiently flexible the labour markets should always clear and unemployment rates should be close to "normal friction unemployment", that is not more than 1- 2 percentage points.

This way of looking at skill mismatch could of course try to find data for unemployment among more specialised educational categories since the register of job seekers and/or receivers of unemployment benefit do have individual data on education. As mentioned above there are regular surveys of newly graduated persons done to map when they get their first regular job – and the corresponding rate of unemployment.

But there are some points that need to be addressed before such an exercise is started. First of all it is hard to tell whether the higher rates of unemployment for the lower educated is really because they do not have the necessary skills. Many employers would – when they can choose – take the ones with the highest education available, even though those with lower education do have the skills needed for the time being.

Even though increasing your skills by getting more formal education will increase your individual chances of getting a job, in a recession you might just crowd-out someone with less – but sufficient education for the job.

Since the level of education has been rapidly rising – one has to look at the same age groups with the same education. But this does not solve the problem, since in the younger generations where at least 12 years of education have become the norm, having less than 11 is in a way stigmatised. Those with less than 11 years of education are overwhelmingly more than fifty years old, so they would be harder to reemploy if they became unemployed, and consequently have higher unemployment.

It is also difficult to separate the effects of the business cycle from the effect of new technology generating a skill mismatch. When the economy is booming – everybody is employed – but that does not mean that there is no skill mismatch. When the economy is sluggish, different groups are hit by unemployment – both unskilled workers and architects. In the case of the architects there is no case of skill mismatch even though they are unemployed. It is just a consequence of construction being a very cyclical branch of the economy.

Data

Labour force survey

The most established and authoritative data source is the Labour force survey, even in Norway where public register data is available. The total number of employed people and other important macro aspects of the Norwegian labour force are estimated by using the Labour force survey.

There has been an ongoing process of development of the Norwegian LFS, so in order to generate long time-series it is a considerable effort to prepare the data for analysis. There was a major change in the LFS in 1996 when the Norwegian LFS was made to conform much more with the EU standard for LFS, the so-called Community Labour Force Survey.

The Norwegian LFS is since 1996 a quarterly sample, people being questioned 8 times, with partial renewal of the sample each quarter. The LFS has all the "usual" variables about the present employment, including training. There was a national occupational code that has been replaced by the ISCO-88 standard from year 2000.

The LFS also contains the key questions for mobility studies "when did your present job start", and "when did your last job end". Of course there is a problem how these questions are interpreted. Do the respondents regard it as a new job when they rise in the hierarchy, when they move between different establishments in the same enterprise etc.? Since the respondents are in the sample for 8 quarters one can also calculate the mobility between industrial sectors on a yearly basis by looking at the NACE code of the present job between quarters.

Since the persons interviewed are asked for their personal identification number it is possible to link the LFS to the registers, this is partially done today in order to get a consistent sectoral classification. But there are many other potential benefits of using the LFS in combination with the registers. One of them is that using the registers one can analyse the respondent's career before being interviewed by the LFS and later. Of great importance is to try to get information about those who "drop-out" of the LFS for some reason or another.

Regular surveys

Other data are based on surveys with coverage and cycles varying from full censuses, like the population census each decade or so, to samples like the annual industrial and biannual R&D statistics. The latter often have a census of large firms, a sample of small and medium sized firms. Statistics Norway is conducting these surveys.

Statistics Norway is making forecasts of the need for different skill categories based on their large, empirical, macro-economic models.

The Labour market authorities also publish regular reports on the labour market and the demand for particular educational groups.

Register data

Beside the LFS the register data, parallel to those found in the other Nordic countries, are the most important source of knowledge about the labour market. It is a widespread misunderstanding that there is something inherently centralist about the register data. Even the Canberra Manual[14] writes that these countries "have a tradition of centrally co-ordinated registration of characteristics of individuals". But this is not correct - there has in fact been no centrally co-ordinated registration of characteristics of individuals: what there has been is a *unique identification number for each person* since the late sixties. In the various parts of public administration, and in the banking system, and many other firms and institutions – databases have been made using this unique identification number. This was of course not part in some "Big brother is watching you" plan from the Norwegian authorities. The main reason was that the personal identification number cut through the problem of identical names, name changes, address changes etc.

Even if we only look at the public sector, there was no co-ordination of which characteristics to collect about individuals, definitions used, coding rules etc. were *not* co-ordinated. But the unique number makes it possible to compare/merge/supplement/verify information from various registers even if this was *not the intention* when the particular register was built up. It is a well-known fact among those who have worked with data based on these registers, that there is contradictory information in the various systems, for example the industrial classification is not fully harmonised – although it could (and should be). It happens that persons are registered as employed and seeking employment at the same time, they have two full jobs at the same time, that firms have different industrial classifications in the different registers etc. These problems are not major ones, the overall quality of the registers is very good, but there is room for improvement. The task of harmonising the registers, i.e. to agree on definitions and maintenance rules and how to eliminate existing contradictions is a task which has yet to be undertaken.

Although there is no centrally co-ordinated registration, the unique person number makes the use of all register data possible. The data set used for research purposes is actually a merging[15] of information from uncoordinated registers such as the educational register and the social security register. In actual fact the authorities have what in database jargon is called "a virtual distributed database". It is "distributed" because the administration of content and physical handling of the database is done in different locations. It is "virtual" - or more precisely "potential" - because the various registers are not yet interconnected. But this is technically quite feasible using existing database- and network technology.

> The conclusion is that *if* one has various indicators for skill mismatch in a database using the personal identification number one can get - in a very cost efficient way – these skill mismatch data analysed with a rich set of other personal characteristics over time. Incomes, career, family, further education and so on.

[14] The OECD manual for classifying HRST (Human Resources in Science and Technology), made in Canberra, Canada in 1995.

[15] In database language this is called "a join"

Future development of data sources on skill-mismatch

The general trend in Norway and the other Nordic countries is to try to base more and more of the official statistics on registers, by using, modifying and extending already existing private and public digital data sources. The reason is of course that registers are very cost efficient, and when using person and firm identificators can be matched with a lot of other data.

Probably this will also influence the regular surveys like the LFS. A lot of the information collected by the LFS could be extracted from the registers, and the LFS could concentrate on that kind of information that is not in the registers – like peoples judgement as to what degree their education and skills match their present job.

But before there are going to be any major developments when it comes to measure skill mismatches, one has to decide if such an exercise is worthwhile – and not the least on the level of detail and how to use the results. As the parameter for regulating access and funds to higher education – or as just one piece of information in a much larger picture.

References

Arnesen, Clara Åse and Brandt, Ellen and Hovland, Grethe. 1997. IT-utdanning: kapasitetsbehov og utbyggingsplaner (IT-education: needed capacity and plans for further expansion). NIFU skriftserie 25/97. Oslo: NIFU

Fløisbonn, Rune and Liestøl, Knut 1997. Informasjons og kommunikasjonsteknologi (IKT) – Behov og potensiale for opptrapping av utdanningskapasiteten. (Information and communication technology. The need and potential for expanding the capacity). Internal Memo, University of Oslo

Aamodt, Per O. 1994. Valg og gjennomstrømning i utdanningsystemet (Choices and Through-put in the Educational System). in Lauglo (1994)

Aamodt, Per O. 1999. Dimensjonering av høyere utdanning. Et komparativt perspektiv med særlig vekt på Storbritania, Sverige og USA (The Scale of Higher Education. A Comparative perspective with special emphasis on the UK, Sweden and the USA), NIFU Report 3/99. Oslo: NIFU

Adolfsen, Kari Anne and Gunnar E. Christensen, 1994, IT-utdanninger i Norge. Rapport fra et kartleggingsprosjekt for Den norske dataforening. (IT-education in Norway, Report from a mapping project on for the Norwegian Computing Association, Oslo, DND

Bjørnstad, Roger. 2000, The Effect of Skill Mismatch on Wages in a small open Economy with Centralized Wage Setting: The Norwegian Case. Discussion paper No 270, Oslo:Statistics Norway

Cappelen, Ådne og Nils Martin Stølen. 1994. Forecasting Labour Marked Imbalances, Economic Survey" 4/94. Oslo: Statistics Norway

ECON. 1999. Behovet for IT-kompetanse i staten (The need for IT-skills in the State administration. Report 57/99. Oslo: ECON, Center for economic analysis

Eikeland, Ole Johan and Olav Tvede. 1998. Rekrutteringsbehov i naturvitskaplege og teknologiske fag: Status i 1997. Prognosar mot 2015 (The need for recruitment in Natural Science- and Technological Subjects: Status in 1997. Forcasts to 2015). NIFU Report 20/98. Oslo: NIFU

Ekeland, Anders and Braadland, Thor Egil. 1999. Staten og IT-kompetansen: Offer eller aktivist? (The State and the IT-skilled: Victim or Activist?). Working Paper 9-1999. Oslo: STEP group

Hatlevik, Ida K. R. 2000. Styring og regulering av sykepleier-, lærer- og ingeniørutdanningen i fire land. En sammenlignende studie av Norge, England, Finland og Nederland. (Management and regulation of Nurse-, Teacher- and Egnineering Education in Four Countries. A Comparative Study of Norway, England, Finland and the Netherlands). NIFU Report 4/2000. Oslo:NIFU

Norges industriforbund. 1986. Økt kunnskap og kompetanse (Increased knowledge and skills) Debatt og studie hefte nr. 68. Oslo: Norges industriforbund.

Norges industriforbund. 1986. Industriforum 1986. (Industrial Forum 1986) Debatt og studie hefte nr. 66. Oslo: Norges industriforbund

Larsen, Knut Aril. 1982. Høyere utdanning og arbeidsmarkedet mot år 2000. (Higher Education and the Labour Market towards Year 2000) in Forskning og høgre utdanning, Årbok 1982. Oslo: Universitetsforlaget

Larsen, Knut Arild and Devold, Edvard and Eriksen, John. 1995. Mistilpassning på arbeidsmarkedet (Mismatch on the Labour Market). TemaNord 1995/505. København: Nordisk Ministerråd

Lauglo, Jon (ed.), 1994, Norsk forskning om utdanning. Perspektiver og veivalg (Norwegain Research on Education. Perspectives and Options??), Oslo: ad Notam Gyldendal

Lindquist, K-G. and Skjerpen, T. 2000, Explaining the Cahnge in Skill Structure of Labour Demand in Norwegian Manufacturing Industries. Discussion Paper (forthcomming), Oslo: Statistics Norway

Nærings- og Handelsdepartementet. 1998. Næringsrettet IT-plan for perioden 1998-2001 (Ministry of Trade and Industry: IT-plan for 1998 – 2001 for private sector). Oslo: Nærings- og Handelsdepartementet

Næss, Terje and Ramberg Inge. (eds.) 1996. Utdanning og arbeidsmarked. (Education and Labour Marked 1996). Oslo: NIFU

NIFU/Jahnsen, Torleiv. 1985. Behovet for datautdanning. Noen aktuelle problemstillinger (The need for IT-education. Some recent challenges). NIFU Notat 1/85. Oslo: NAVF's utredningsinstitutt

Skoie, Hans and Aamodt, Per O. (eds.) 1991. Sykelys på høyere utdanning i Norge. En del utviklingstrekk med vekt på 1980-tallet. (Focus on Higher Education in Norway. Some trends with emphais on the eighties) NAVF Report 3/91, NAVFs utredningsinstitutt

Statskonsult. 1999a. Intervjuer om IT og IT-kompetanse (Interviews about IT and IT-skills). Notat 1999:6. Oslo Statskonsult

Statskonsult. 1999b. IT-personell, behov og tilgang (IT-skilled persons, demand and supply. Notat 1999:11. Oslo Statskonsult

Statskonsult. 1999c. Staten og nerdene (The State and the Nerds). Notat 1999:5. Oslo Statskonsult

Stortingsmelding 38 (1998). IT-kompetanse i et regionalt perspektiv (IT-skills in a regional perspective), Oslo: Norwegian Ministry of Trade and Industry

Terje Næss og Inge Ramberg, 1996, Utdanning og arbeidsmarked, NIFU, Oslo, TANO

Labour Force Survey (LFS)

The Norwegian LFS started in 1975, but the number and type of questions have changed several times as in most other countries. Norway did not start to implement the new features of the 1992 Community Labour Force Survey before 1995-96. This means that we cannot get long time series based on LFS in Norway[16].

Education

The educational classification is basically a national standard, but there is an official mapping of national codes to ISCED which for the ISCED-76 is straightforward.

Industrial classification

The NACE classification was implemented from 1995, and so far there has been no conversion from ISIC to NACE for earlier years.

Mobility

The so called retrospective questions were first introduced in 1997. At the time of writing only the 1996-2000 Norwegian LFS contains the retrospective question needed for calculating mobility rates.

Occupational classification

Occupational classification has been used, but according to a national standard. A recoding to ISCO-88 has been done for the years 1996 – 2000 and that will be the period of study of LFS data.

LFS vs. register data

Register data

The Norwegian register data that makes a matching of employers and employees is available for the period from 1986 - 1999. The data used here are the so-called" employment files"[17]. As is the case with the LFS data, the educational classification is a national system with a direct mapping to the international standard, ISCED-76. There is no occupational classification in the register data.

16 Using the register data to supplement the LFS one could construct the required data, but this is a demanding task and as far as we know there are no plans to do this in the near future

17 For a more detailed description, see Ekeland (1998)

Industrial classification

NACE was implemented from 1995 in the Norwegian statistical system. To make it possible to have time series with the register data an ad hoc recoding from ISIC to NACE had been done by the STEP group for the years 1986 - 1994. The principle being – besides the trivial cases of a one-to-one correspondence – to take advantage of the data at firm level. We take as our starting point the year of classification change, in this case, 1995. This is the year when both standards are used. We then "write back" as far as possible for all firms existing in 1995 using the firm identification number as many years as possible. For those firms that "died" before 1995 we have used the most frequent of the possible ISIC-NACE combinations. That means that some of the potential variation in the NACE codes is lost and consequently that the intersectoral mobility estimates are biased. But it is hard to tell which way they are biased, since this depends on the complex relation between ISIC and NACE. Since this study is done mainly on a two digit level we do not think this will influence the estimates in a way that would alter the main results. The only real solution to this problem would be a very detailed study of the firms. In practice that would amount to a new (re)classification from ISIC to NACE of the "dead" firms on an individual basis.

Industrial classification - the relation between LFS and register data

The high-tech industries are defined in the "template" UK study as a mix of two and three digit NACE codes. However, it is not possible to get data for employment and education from the Norwegian LFS on such a detailed level. When it comes to register data we will use both the "common denominator", i.e. a two-digit level and various more detailed breakdowns.

Table 2: Industrial sectors - preferred break down

NACE	3-DIGIT	TITLE
110		EXTRACTION OF CRUDE PETROLEUM AND NATURAL GAS; RELATED SERVICES, EXCLUDING SURVEYING
244	X	MANUFACTURE OF PHARMACEUTICALS, MEDICINAL CHEMICALS AND BOTANICAL PRODUCTS
300		MANUFACTURE OF OFFICE MACHINERY AND COMPUTERS
320		MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS
353	X	MANUFACTURE OF AIRCRAFT AND SPACECRAFT
642	X	TELECOMMUNICATIONS
720		COMPUTERS AND RELATED ACTIVITIES
730		RESEARCH AND DEVELOPMENT

Table 3: Industrial sectors the actual break down LFS

11	Extraction of crude petroleum and natural gas; related services, excluding surveying
24	Chemicals&pharmaceuticals
30	Manufacture of office machinery and computers
32	Manufacture of radio, television and communication equipment and apparatus
35	Aerospace & other transport
64	Telecom and post
72	Computers and related activities
73	Research and development

Using the 2-digit industry level is slightly problematic for our purpose, as we now cover broader activities than what are generally regarded as high-tech activities. For example, we wanted to study pharmaceuticals, but end up looking at both chemicals *and* pharmaceuticals. We cannot single out Aerospace, but have to look at "Aerospace" *and* "Other transport". We wanted Telecommunications, but can only get Telecommunications *and* Postal services together. This might not look like a very dramatic change, but as we will see below the size of the sector increases threefold as a result of these minor changes in the Norwegian case. We will take a more detailed look at the consequences of using a the 2-digit level in all sectors instead of the 3-digit preferred breakdown in some of the sectors.

Table 4: Relative employment growth, three 2-digit ,1987 – 1999, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
PHARMA+ CHEM.	100 %	95 %	90 %	90 %	91 %	90 %	94 %	91 %	92 %	94 %	97 %	94 %	91 %
TANSP+AIR	100 %	90 %	88 %	80 %	83 %	87 %	90 %	89 %	88 %	93 %	96 %	97 %	102 %
TELECOM +POST	100 %	103 %	105 %	98 %	104 %	104 %	103 %	107 %	105 %	98 %	94 %	77 %	84 %

We start by looking at the development of employment of the three 2-digit sectors. The number of employees in Transport + Aircraft goes down and then up. This is mainly caused by the business cycle. The employment in the other two sectors declines in relation to 1987.

Table 5: The 3 digit breakdown of 2 digit sectors, 1987-1999, all employees, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
CHEM, NON-PHARMA.	15381	14573	13735	13539	13354	13042	13569	12849	12782	12754	12998	12663	12165
PHARMACEUTICALS	1149	1116	1212	1297	1762	1813	1891	2267	2372	2811	2970	2915	2927
TRANSPORT (NON-AIR)	35979	32590	31069	28347	29095	30783	31964	31780	31427	33141	34392	34822	36161
AIRCRAFT	1952	1584	2140	2105	2206	2213	2053	2030	1932	1996	2051	2100	2516
POST, NON-TELECOM	28672	30918	33863	31235	34005	34609	34153	35664	34935	33692	32839	29299	30368
TELECOMMS	19349	18669	16413	15930	15937	15476	15229	15890	15517	13558	12418	7442	9842
CHEM, NON-PHARMA.	100 %	95 %	89 %	88 %	87 %	85 %	88 %	84 %	83 %	83 %	85 %	82 %	79 %
PHARMACEUTICALS	100 %	97 %	105 %	113 %	153 %	158 %	165 %	197 %	206 %	245 %	258 %	254 %	255 %
TRANSPORT(NON-AIR)	100 %	91 %	86 %	79 %	81 %	86 %	89 %	88 %	87 %	92 %	96 %	97 %	101 %
AIRCRAFT	100 %	81 %	110 %	108 %	113 %	113 %	105 %	104 %	99 %	102 %	105 %	108 %	129 %
POST, NON-TELECOM	100 %	108 %	118 %	109 %	119 %	121 %	119 %	124 %	122 %	118 %	115 %	102 %	106 %
TELECOMMS	100 %	96 %	85 %	82 %	82 %	80 %	79 %	82 %	80 %	70 %	64 %	38 %	51 %

If we look at the 3-digit sector we want to study and the residual of the 2-digit sector we get another story. Non-pharmaceutical Chemicals declines steadily, and pharmaceuticals more than doubles its number of employees. Since the Non-pharmaceutical part of the sector is much bigger, the 2-digit sector employment declines. Telecommunications also have quite a different trajectory than Postal services. Post is stable, in Telecom. employment is halved from 1987 to 1999. Non-Aircraft and Aircraft are not that different in this period, so here the employment development of the 2-digit sector is roughly the same as the 3-digit hi-tech sector. But this is accidental because the size of Aircraft is roughly 5% of the combined sector, so it is the rest of the sector that is decisive for the development of employment in the 2-digit sector.

Table 6: The three sectors as percentage of 2-digit sector, all employees, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
PHARMA.	7 %	7 %	8 %	9 %	12 %	12 %	12 %	15 %	16 %	18 %	19 %	19 %	19 %
AIRCRAFT	5 %	5 %	6 %	7 %	7 %	7 %	6 %	6 %	6 %	6 %	6 %	6 %	7 %
TELECOM.	40 %	38 %	33 %	34 %	32 %	31 %	31 %	31 %	31 %	29 %	27 %	20 %	24 %

Pharmaceuticals and Aircraft are clearly small in relation to the rest of the actual 2-digit sector. Telecommunications start out in 1987 at 40%, but its share declines continuously. The conclusion is that in the three cases where we want to study the 3-digit sector, but where the LFS only allows us to study the aggregated 2-digit sector, the development of employment in this 2-digit sector is not even a rough indicator of what is happening in the 3-digit sector since the hi-tech sector is not in any of the cases more than a quarter of the 2-digit sector. The development of employment is actually quite different in two of the sectors.

The highly educated – and the question of 2- and 3-digit sectors

With rapid technological change leading to demand for new types of skill there is reason to believe that the share of highly educated employees should develop differently from the overall trends in employment.

Table 7: The 3 digit breakdown of 2 digit sectors, 1987-1999, highly educated, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
CHEM, NON-PHARMA.	983	927	759	868	900	1001	1276	1354	1369	1439	1602	1597	1517
PHARMACEUTICALS	277	267	282	338	431	454	468	568	654	741	772	764	790
TRANSPORT(NON-AIR)	638	585	642	763	850	925	978	1275	1443	1800	1892	2182	2445
AIRCRAFT	36	33	58	58	70	76	76	85	81	87	108	125	159
POST, NON-TELECOM	227	246	288	302	412	462	538	658	711	618	639	581	718
TELECOMMUNICATIONS	661	766	872	990	1107	1196	1231	1478	1686	1923	2154	1782	2390
CHEM, NON-PHARMA.	100%	94%	77%	88%	92%	102%	130%	138%	139%	146%	163%	162%	154%
PHARMACEUTICALS	100%	96%	102%	122%	156%	164%	169%	205%	236%	268%	279%	276%	285%
TRANSPORT(NON-AIR)	100%	92%	101%	120%	133%	145%	153%	200%	226%	282%	297%	342%	383%
AIRCRAFT	100%	92%	161%	161%	194%	211%	211%	236%	225%	242%	300%	347%	442%
POST, NON-TELECOM	100%	108%	127%	133%	181%	204%	237%	290%	313%	272%	281%	256%	316%
TELECOMMUNICATIONS	100%	116%	132%	150%	167%	181%	186%	224%	255%	291%	326%	270%	362%

If we compare the employment of the highly educated with the overall employment it is very clear that there is a change in the educational composition of the workforce in these sectors. Some of it is of course caused by the general rise in educational level. The table shows that all sectors have a rapid growth in their share of the highly educated, but the difference between the 3-digit hi-tech sector and the residual is most marked between Chemicals and Pharmaceuticals, but the trend is the same in all three cases.

Table 8: Three digit sectors, percentage of 2-digit sector, highly educated , register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
PHARMACEUTICALS	22 %	22 %	27 %	28 %	32 %	31 %	27 %	30 %	32 %	34 %	33 %	32 %	34 %
AIRCRAFT	5 %	5 %	8 %	7 %	8 %	8 %	7 %	6 %	5 %	5 %	5 %	5 %	6 %
TELECOMS.	74 %	76 %	75 %	77 %	73 %	72 %	70 %	69 %	70 %	76 %	77 %	75 %	77 %

The share of highly educated in the 3-digit sectors of the highly educated in the 2-digit sector is about the same in Aircraft as in the 2-digit sector. The two other sectors differ radically. If we compare with **Table 6**, Pharmaceuticals have more of the highly educated, and for Telecommunications the picture is radically altered. The highly educated are in Telecommunications, not in Postal services!

Conclusion – LFS not suitable for studying the chosen hi-tech sectors

The clear – and not surprising conclusion – is that one cannot use the 2-digit breakdown found in the European Union Labour Force Survey to study a 3-digit sector like telecommunications. One is only able to study this sector together with postal services, and these behave very differently in most cases. This is of course very regrettable because making a comparative study of telecommunications might be of great policy interest. It is a sector that is heavily influenced by public (de)regulation and of vital importance for the diffusion of various ICTs.

General trends in employment according to LFS and registers

In the period of study employment is influenced by the business cycle and a secular trend of increasing female participation. From 1987 to 1997 Norway went through a full business cycle. Starting with the last boom year of the previous cycle1987 with no unemployment and surplus demand for labour, especially highly educated in the big cities. Then going down to the bottom in the early nineties, 1992 and 1993. The upturn started slowly, but took off from 1996 onwards, levelling out in late 1999.

Table 9: Active population and employment, 1987 – 1999, comparing LFS data and register data

YEAR	ACTIVE	IN % OF 87	EMPLOYED REG. DATA	IN % OF 87 REG. DATA	EMPL. SHARE NACE	EMPL. SHARE FIRM ID	EMPL. SHARE LFS	EMPLOYED LFS
87	3047419	100 %	1701051	100 %	55,8 %	56,9 %	71,2 %	2 171 000
88	3072498	101 %	1723773	101 %	56,1 %	57,2 %	71,0 %	2 183 000
89	3091150	101 %	1678527	99 %	54,3 %	54,7 %	69,6 %	2 151 000
90	3097819	102 %	1668969	98 %	53,9 %	54,1 %	69,1 %	2 142 000
91	3106601	102 %	16F62767	98 %	53,5 %	53,6 %	68,4 %	2 126 000
92	3115802	102 %	1675168	98 %	53,8 %	52,6 %	68,4 %	2 130 000
93	3125572	103 %	1687756	99 %	54,0 %	52,9 %	68,2 %	2 131 000
94	3138100	103 %	1710916	101 %	54,5 %	53,1 %	68,5 %	2 151 000
95*	3135972	103 %	1945951	114 %	62,1 %	53,6 %	69,7 %	2 186 000
96	3142404	103 %	1985543	117 %	63,2 %	56,1 %	71,3 %	2 240 000
97	3151702	103 %	2032761	120 %	64,5 %	57,5 %	72,6 %	2 288 000
98	3165952	104 %	2080662	122 %	65,7 %	58,7 %	73,4 %	2 323 000
99	3183534	104 %	2093796	123 %	65,8 %	60,9 %	73,3 %	2 333 000

The active population, all those from 16 years to 70 years old that are able to work is growing from 1987 – 1999. Since there is an secular trend of higher participation rates of women, the share of employed persons of the active population is growing.

The downturn – and for Norway a high rate of unemployment - in the early nineties only meant that the share of employed persons stagnated between 1990 and 1995, rising as the economy recovered - if we include the self-employed. If we measure this by those that work in a firm with a firm identification number – including one-person firms – the employment share goes down from around 57% in 1987/88 to around 53% in 1992-1993, rising to 60% in 1999.

If we compare the share of employed in the LFS with the register data it is about 13 – 15 percentage points lower in the registers than in the LFS.

There are two main reasons why the register data has fewer employees than the LFS. First of all the register data has in practice a more restrictive definition of being employed than the LFS. The firms do not manage to get the temporary, accidental workers into their records – and some of the ad hoc jobs are for firms that the statistical office do not get data from due to the temporary, seasonal existence of some of these firms. This bias in the registers is reflected in that the employment share based on register data goes down while the LFS rate only stagnates.

Secondly there was less coverage in the sectors with a lot of self-employment (farming, fishing, lawyers etc.). In these sectors the registers have been improving, especially from the change in the system of firm identification numbers in 1995, and consequently more employment is registered.

There is a break in the series in1995 with the number of employees increasing by over 235.000 from 1994. The break in the time series is mainly caused by the fact that a lot of one-man firms were given a NACE classification as a part of the transition from ISIC to NACE. Also some persons that were not traditionally regarded as one man firms like farmers were given a NACE code. So measured by those with NACE codes the registers increased their coverage from 1995 onwards. This increased NACE coverage makes the definition of being employed more equal in the registers and in the LFS. But the number of people that were employed in firms (including one man firms) that got an establishment ID did not rise very dramatically so the number of employed measured by firm ID is still considerably lower

Employment in the hi-tech sectors

We now turn to the sectors of interest for this analysis, the high-tech sectors. But as explained above, we can either look at the preferred break-down, or the LFS "combined" sectors. First the pure high-tech sectors.

Table 10: Employment shares, 1987 – 1999, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
HI-TECH, 3 DIGIT	2,7	2,6	2,5	2,5	2,6	2,6	2,6	2,7	2,8	2,4	2,4	2,4	2,7
HI-TECH, 2 DIGIT	13,5	13,2	13,1	12,8	13,1	13,1	13,0	12,8	12,5	10,9	10,8	10,4	10,8
OTHER	15,2	15,0	14,6	14,0	13,8	13,5	12,9	12,6	12,5	11,7	11,9	11,9	11,7
OTHER SECTORS	71,3	71,8	72,3	73,2	73,2	73,4	74,1	74,6	74,9	77,4	77,4	77,7	77,6

Table 11: Employment shares, 1996– 2000, LFS

	1996	1997	1998	1999	2000
HI-TECH 2-DIGIT	10,8 %	10,9 %	10,7 %	11,0 %	10,5 %
OTHER MANUFACT.	12,1 %	12,0 %	11,8 %	11,2 %	10,8 %
OTHER SECTORS	77,1 %	77,2 %	77,6 %	77,8 %	78,7 %

The first table shows that the hi-tech sectors defined on a 3 digit level have a small, stable, 2,7% share of employment. When we are speaking of employment growth these hi-tech sectors do not seem to have much potential – at least not in Norway. As source of innovative knowledge, diffused to other sectors as products/services and by human mobility, they are of course much more important. But as we know – how much more is difficult to measure.

When we use a 2-digit level, i.e. the breakdown that is the common denominator on a European level we are talking about quite another animal, four times the size of the hi-tech sectors we wanted to study. And this 2-digit hi-tech sector has about the same share of the employment in Norway as in the Netherlands. Actually it is three or four percentage points higher. The size of the 2-digit hi-tech sectors are practically the same in the LFS and in the register data.

The overall trends are well-known: traditional manufacturing sectors declining and services growing. We shall not here enter the debate about how much of this that is "real" and how much that is caused by our concepts of what "manufacturing" is and how we measure it, other than noting that this is a very interesting debate both conceptually and when it comes to measurement methods. It is important for an empirical based debate about the "information society", "knowledge-based" economy etc. that one avoids taking the standard industrial classification as a given.

Table 12: Relative employment shares, nine sectors, 1987 – 1999, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
OIL AND GAS	1,1	1,1	1,1	1,1	1,2	1,2	1,4	1,4	1,4	1,2	1,2	1,2	1,3
CHEMICALS& PHARMACEUTICALS	1,0	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,8	0,8	0,8	0,7
OFFICE/COMP EQUIPT	0,2	0,2	0,2	0,2	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,1	0,0
RADIO/TV/COMMS	0,4	0,4	0,4	0,3	0,3	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3
AEROSPACE& OTHER TRANSPORT	2,3	2,0	1,9	1,8	1,9	2,0	2,0	2,0	1,9	1,9	1,9	1,9	1,9
TELECOM AND POST	7,3	7,4	7,4	7,2	7,3	7,2	6,9	6,8	6,7	5,8	5,6	5,0	5,1
COMPUTER SERVICES	0,6	0,6	0,6	0,6	0,6	0,7	0,7	0,7	0,7	0,7	0,8	0,9	1,1
RESEARCH	0,6	0,6	0,6	0,6	0,7	0,7	0,7	0,7	0,7	0,6	0,5	0,6	0,5
OTHER MANUFACT.	15,2	15,0	14,6	14,0	13,8	13,5	12,9	12,6	12,5	12,0	12,1	12,1	11,9
OTHER SECTORS	71,3	71,8	72,3	73,2	73,2	73,4	74,1	74,6	74,9	76,8	76,8	77,2	77,1
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Also on this detailed level the overall picture is one of remarkably stability. The only clear trends among the hi-tech sectors are oil and computer services (CS) increasing; and Post&Telecom decreasing.

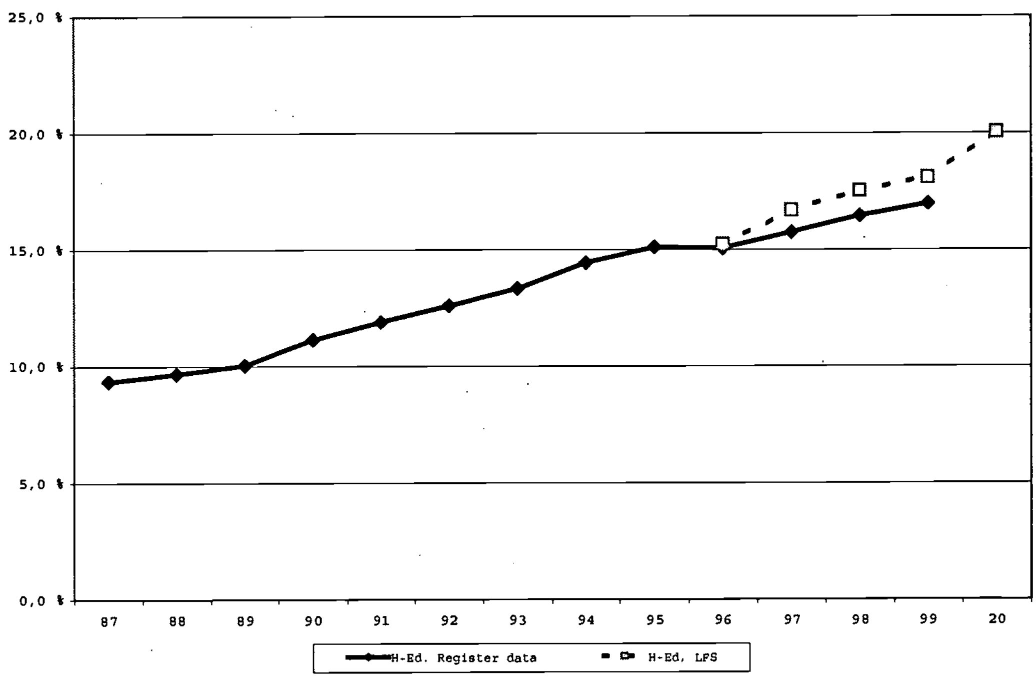
Table 13: Relative employment shares, highly educated, nine sectors, 1987 – 1999, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
OIL AND GAS	2,3	2,2	2,1	2,1	2,1	2,2	2,3	2,3	2,2	1,8	1,7	1,7	1,7
CHEMICALS& PHARMACEUTICALS	0,8	0,7	0,6	0,6	0,7	0,7	0,8	0,8	0,8	0,8	0,8	0,7	0,7
OFFICE/COMP EQUIPT	0,4	0,3	0,3	0,3	0,2	0,2	0,1	0,1	0,1	0,1	0,0	0,1	0,0
RADIO/TV/COMMS	0,3	0,3	0,4	0,4	0,4	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,3
AEROSPACE&OTHER TRANSPORT	0,4	0,4	0,4	0,4	0,5	0,5	0,5	0,6	0,6	0,7	0,7	0,7	0,7
TELECOM AND POST	4,1	4,3	4,3	4,2	4,1	4,0	3,8	3,7	3,8	3,6	3,6	3,3	3,7
COMPUTER SERVICES	1,0	1,1	1,2	1,1	1,1	1,3	1,3	1,3	1,3	1,4	1,6	1,9	2,3
RESEARCH	2,8	2,8	2,8	2,8	3,2	2,8	2,7	2,6	2,4	1,9	1,7	1,8	1,7
OTHER MANUFACT.	4,0	4,0	4,0	3,9	3,9	3,9	3,7	3,8	3,8	4,0	4,1	4,1	4,1
OTHER SECTORS	83,9	83,9	83,9	84,1	83,8	84,2	84,6	84,7	84,7	85,4	85,4	85,3	84,6
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Again, the overall picture is one of remarkably stability. The only clear trends among the hi-tech sectors are Oil whose relative share is declining. The oil sector had from the start a high share of highly educated, and has become a mature sector, not expanding so rapidly any longer, and not recruiting as many highly educated as before. But this treats all highly educated as equal, if we had looked at fields of study the oil sector is one of the 2-digit sectors with the highest share of engineers.

Stocks of highly educated and knowledge workers

Figure 3: Share of highly educated, 1987-1999, register data and LFS



The figure shows the rapid increase in the share of highly educated in the workforce. It is the continuation of a trend that took off in the mid-sixties. In a historical perspective this will turn the former elite in society having the highest education into a substantial group. We compare the register data and the LFS for the last years. Again they are in general agreement. The small difference in level is probably mainly the result that in the register data there is a time lag in the education information used in relation to the LFS.

Table 14: The educational composition, 1987 –1999, register data

	ISCED 1-5	87=100	ISCED 6+7	87=100
1987	1467679	100 %	155179	100 %
1988	1497039	102 %	164601	106 %
1989	1506711	103 %	173044	112 %
1990	1460243	99 %	187054	121 %
1991	1441421	98 %	198598	128 %
1992	1424597	97 %	209523	135 %
1993	1421876	97 %	223400	144 %
1994	1417633	97 %	243791	157 %
1995	1423916	97 %	258413	167 %
1996	1617209	110 %	293042	189 %
1997	1633898	111 %	312611	201 %
1998	1653783	113 %	334397	215 %
1999	1675924	114 %	353284	228 %

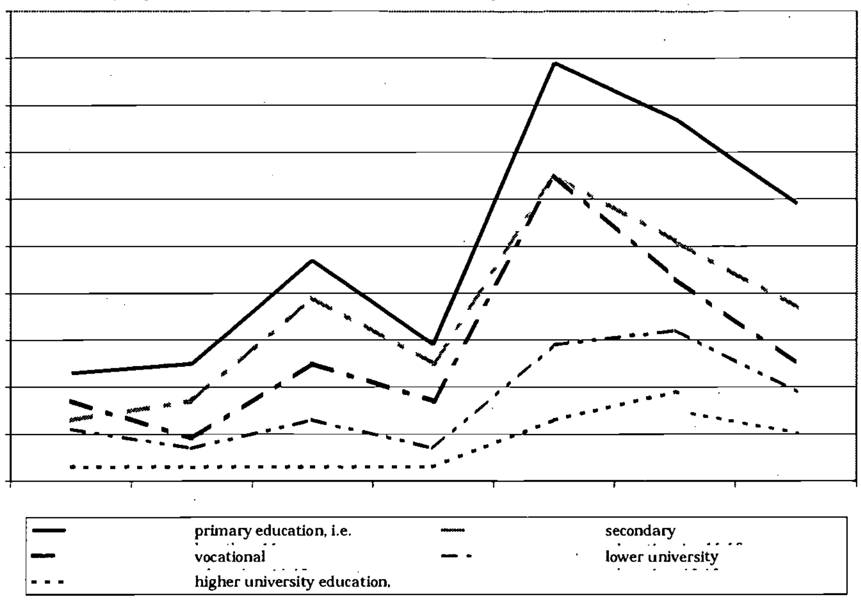
The table shows that the absolute number of ISCED 1-5 (lower educated) is fairly stable, the variations in the share of number of employed is caused by the business cycle. The jump between 1995-1996 is just a reflection of the increased coverage of the registers resulting in more than a 10% increase. On the contrary all the entrants to the labour market – that is in practice young people with higher education, many of them have at least 15-16 years of education, and many of them will be classified in ISCED 6 or higher. To a certain extent this is the question of "inflation". Some major educational fields like health and engineering have changed from taking 2-years to 3-years and consequently moving from ISCED 5 to ISCED 6 so there is a certain "inflation" in the numbers.

Table 15: Sectoral shares of highly educated, 1997 – 1999, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
OIL AND GAS	21,9	21,4	20,6	21,8	22,4	23,3	23,0	24,3	24,5	25,1	24,3	23,8	23,8
CHEMICALS& PHARMACEUTICALS	7,8	7,8	7,1	8,3	9,0	10,0	11,5	13,0	13,6	14,3	15,2	15,5	15,6
OFFICE/COMP EQUIPT	20,3	19,8	19,5	18,9	19,0	19,6	16,1	19,6	17,7	16,6	19,0	27,4	21,2
RADIO/TV/COMMS	7,2	7,7	10,4	12,2	13,5	14,9	16,7	19,5	21,8	23,3	25,3	24,8	20,4
AEROSPACE& OTHER TRANSPORT	1,8	1,9	2,2	2,7	3,0	3,1	3,1	4,1	4,6	5,5	5,6	6,4	6,9
TELECOM AND POST	5,3	5,7	5,9	6,5	6,7	7,0	7,3	7,9	8,6	9,5	10,3	11,3	12,5
COMPUTER SERVICES	17,2	17,5	19,2	20,3	21,7	23,3	24,6	27,2	29,9	32,3	33,2	34,9	36,7
RESEARCH	43,7	45,5	47,0	50,3	53,1	51,5	52,1	52,9	54,5	53,2	53,5	55,5	56,7
OTHER MANUFACT.	2,5	2,7	2,8	3,2	3,5	3,7	3,8	4,4	4,7	5,2	5,5	5,7	6,1
OTHER SECTORS	11,2	11,6	12,0	13,0	13,9	14,7	15,5	16,7	17,4	17,3	18,0	18,7	19,2
TOTAL	9,6	9,9	10,3	11,4	12,1	12,8	13,6	14,7	15,4	15,5	16,2	16,9	17,5

This table gives an overview of the share of highly educated. There are no great surprises, but it is worth noting that Oil and Gas – an extraction sector – has the third highest share of the highly educated. Research is first, followed by Computer services. But again one should be aware of the consequences of the division of labour in society. If research was done – not in a specialised public/semi-public institute but in firms "closer" to production of marketable products/services, then one would not have a share of higher educated of 50%, but more like Computer services and Oil.

Figure 4: Unemployment rates, five educational categories, 1975 - 1998



The figure shows the unemployment rates of five different educational groups. In 1975 Norway was practically speaking in a full employment situation. As unemployment came with the stagnating growth of the economy the lower educated were hit more by unemployment than the highly educated. There are many possible explanations for this. The level of wages for the lower educated might mean that they are not competitive at the going wage. Some economists would argue that if the less educated just lowered their reservation wage – they would be employed. Others would argue that if you cannot handle computers and other new technologies, then you will be unemployed no matter how low the wages you are willing to work for[18]. One gets the combined effect that there are just fewer jobs that do not demand education – and that even in those jobs employers prefer the highest possible education.

18 One might also argue – inspired by Keynes – that the consequences for aggregate demand might just start a downward spiral that does not stop before you fix wages, increase government spending etc.

Training

The information on training is only available from the Norwegian LFS. But before we start analysing the provision of training it is necessary to get a an overview with respect to the distribution of the three "top" occupational groups Managers, Professionals and Technicians.

Table 16: Stocks of knowledge workers (ISCO 1,2,3 Managers, Prof. and Technicians), 1996-2000, LFS

SECTOR	1996	1997	1998	1999	2000
OIL AND GAS	58 %	51 %	50 %	61 %	60 %
CHEMICALS& PHARMACEUTICALS	35 %	37 %	33 %	35 %	37 %
OFFICE/COMP EQUIPT	63 %	62 %	100 %	76 %	34 %
RADIO/TV/COMMS	57 %	55 %	53 %	45 %	38 %
AEROSPACE&OTHER TRANSPORT	18 %	21 %	19 %	24 %	30 %
TELECOM AND POST	50 %	52 %	53 %	56 %	62 %
COMPUTER SERVICES	81 %	87 %	91 %	90 %	88 %
RESEARCH	73 %	76 %	78 %	78 %	92 %
OTHER MANUFACT.	23 %	22 %	22 %	23 %	25 %
OTHER SECTORS	37 %	37 %	38 %	39 %	40 %
ALL	36 %	37 %	37 %	39 %	41 %

The very high share of knowledge workers in all the hi-tech sectors and the rest of the economy only shows that the classification of occupations – as the ISCO-88 standard does it – in our opinion is not well adapted to a society with a general high level of formal education. The use of both educational criteria and job content criteria make some of the ISCO groups very inclusive. It makes it hard to use ISCO to tell what people actually are doing and what their position in the workplace hierarchy is. It is not possible to decide if engineers are doing more engineering or administrative work, and how that is changing.

Table 17: The amount of training last four weeks, 1996-2000, LFS, all employees

SECTOR	1996	1997	1998	1999	2000
OIL AND GAS	22 %	24 %	25 %	22 %	15 %
CHEMICALS& PHARMACEUTICALS	15 %	22 %	16 %	20 %	13 %
OFFICE/COMP EQUIPT	0 %	0 %	27 %	0 %	0 %
RADIO/TV/COMMS	8 %	24 %	17 %	11 %	2 %
AEROSPACE&OTHER TRANSPORT	12 %	12 %	13 %	15 %	15 %
TELECOM AND POST	22 %	22 %	20 %	21 %	17 %
COMPUTER SERVICES	23 %	16 %	18 %	22 %	14 %
RESEARCH	21 %	14 %	14 %	15 %	19 %
OTHER MANUFACT.	11 %	12 %	10 %	10 %	9 %
OTHER SECTORS	17 %	17 %	16 %	16 %	15 %
ALL	17 %	17 %	16 %	15 %	15 %

In the sectors with few employees the numbers are very unreliable. The extreme case is of course "Office and computer equipment" that has zero observations of people that have received training in four of five years, but also "Radio/tv/comms" are too small to get reliable estimates. In the sectors with more reliable estimates there are some differences. "Other Manufacturing" has a low share. On the opposite side, "Telecom and Post" are among the highest. This is probably due to the long and strong traditions of "internal" training to cover the need for specialised, practical skills not traditionally supplied by the educational system.

Table 18: The amount of training last four weeks, 1996-2000, LFS, Knowledge workers versus other occupations

SECTOR	1996	1996	1997	1997	1998	1998	1999	1999	2000	2000
	K-	OTHER	K-	OTHER	K-	OTHER	K-	OTHER	K-	OTHER
OIL AND GAS	27 %	15 %	30 %	19 %	21 %	28 %	20 %	24 %	16 %	13 %
CHEM. AND PHARMA.	19 %	12 %	33 %	16 %	25 %	12 %	36 %	12 %	14 %	13 %
OFFICE/COMP EQUIPT	0 %	0 %	0 %	0 %	27 %	0%	0 %	0 %	0 %	0 %
RADIO/TV/COMMS	10 %	5 %	39 %	5 %	29 %	3 %	15 %	8 %	5 %	0 %
AEROSPACE& OTHER TRANSPORT	23 %	9 %	20 %	10 %	19 %	11 %	16 %	15 %	14 %	15 %
TELECOM AND POST	30 %	15 %	28 %	16 %	24 %	16 %	24 %	16 %	20 %	11 %
COMPUTER SERVICES	27 %	5 %	18 %	8 %	19 %	4 %	21 %	31 %	14 %	11 %
RESEARCH	25 %	12 %	12 %	22 %	16 %	4 %	13 %	22 %	19 %	14 %
OTHER MANUFACT.	17 %	10 %	18 %	10 %	13 %	10 %	16 %	9 %	12 %	8 %
OTHER SECTORS	24 %	13 %	25 %	13 %	23 %	12 %	21 %	12 %	21 %	12 %
ALL	24 %	13 %	24 %	13 %	22 %	12 %	21 %	12 %	20 %	11 %

Although there are cases where the other occupations have received more training, the clear tendency, both in the hi-tech sectors and for the economy as a whole, is that the knowledge workers get significantly more training. The difference is almost 10 percentage points for the economy as a whole. One might think that the other occupations in the hi-tech branches did get relatively more training, being after all part of sectors marked by rapid technological change. The numbers do not give much support for this hypothesis. There are of course problems with small numbers of observations. One example being Computer Services, where 80-90 % are "knowledge workers", the non-knowledge workers become a very marginal group and the estimates for "Other" (occupations) become very unreliable.

Table 19: The amount of training last four weeks, 1996-2000, LFS, Highly educated and lower educated

	1996		1997		1998		1999		2000	2000
	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
OIL AND GAS	21 %	23 %	24 %	25 %	16 %	28 %	18 %	23 %	10 %	16 %
CHEM. AND PHARMA.	21 %	13 %	36 %	20 %	10 %	18 %	28 %	19 %	12 %	14 %
OFFICE/COMP EQUIPT	0 %	0 %	0 %	0 %	28 %	26 %	0 %	0 %	0 %	0 %
RADIO/TV/COMMS	19 %	5 %	41 %	20 %	10 %	18 %	6 %	12 %	10 %	0 %
AEROSPACE&OTHER TRANSPORT	31 %	11 %	35 %	10 %	20 %	12 %	16 %	14 %	7 %	16 %
TELECOM AND POST	36 %	20 %	27 %	22 %	23 %	20 %	27 %	19 %	25 %	15 %
COMPUTER SERVICES	42 %	13 %	13 %	18 %	24 %	13 %	23 %	22 %	16 %	13 %
RESEARCH	16 %	24 %	11 %	18 %	16 %	10 %	11 %	19 %	17 %	22 %
OTHER MANUFACT.	15 %	11 %	19 %	11 %	22 %	9 %	23 %	10 %	15 %	8 %
OTHER SECTORS	28 %	15 %	28 %	15 %	25 %	14 %	24 %	14 %	23 %	13 %
ALL	28 %	15 %	27 %	15 %	24 %	14 %	24 %	14 %	22 %	13 %

The overall picture is the same for the highly educated versus the lower educated. There is a declining rate of training, the highly educated get more training than the lower educated, but in one sector – "oil and gas" the relationship is reversed. Also in the research sector the lower gets more training, except for one year. But the problem of small sample sizes makes it hard be 100% sure whether this is really so, or just a consequence of the "cell-size" problem. But since the lower educated in Oil and Research is a substantial part of the sectors, 75 – 50%, this is probably the case. One possible explanation might be that researchers and engineers in the Oil sector in a certain sense are continuously trained, working with new and challenging projects, conferences and seminars being a "natural part" of the projects. This is in contrast to lower educated that are more explicitly taken away from routine work to get training.

Mobility according to the LFS

These are "job to job" mobility rates. That is the rate of those being employed in year T and T+1 and changing "job", meaning workplace. It is of course impossible to know exactly how the respondents understand the questions: "When did your last job start" and "Have you been in this job more than a year", which are the two questions concerning mobility in the Norwegian LFS. But the way questions are formulated (in Norwegian) the most common interpretation would be a change of establishment/workplace. Since these are the "job to job" (j2j) mobility rates they are not comparable with the UK rates. The UK rates are the intersectoral rates, i.e. only those changing from one industrial sector to another are considered mobile.

The intersectoral rates can in principle be calculated since people are interviewed eight quarters in a row. But regrettably the data was not yet at the time of writing prepared as panel data that would make possible the computation of the intersectoral rates from the LFS.

Table 20: Mobility, 1996-2000, LFS, all employees, job to job, inflow mobility rate

SECTOR	1996	1997	1998	1999	2000
OIL AND GAS	8,6 %	11,9 %	16,6 %	8,7 %	8,0 %
CHEMICALS& PHARMACEUTICALS	8,4 %	12,0 %	12,1 %	8,4 %	7,7 %
OFFICE/COMP EQUIPT	0,0 %	23,8 %	0,0 %	0,0 %	50,9 %
RADIO/TV/COMMS	29,6 %	12,2 %	6,6 %	19,8 %	8,0 %
AEROSPACE&OTHER TRANSPORT	12,7 %	12,7 %	12,1 %	12,7 %	10,6 %
TELECOM AND POST	12,0 %	13,1 %	16,5 %	14,1 %	15,1 %
COMPUTER SERVICES	18,8 %	22,8 %	31,5 %	31,0 %	23,6 %
RESEARCH	17,1 %	15,9 %	13,5 %	12,9 %	11,9 %
OTHER MANUFACT.	15,5 %	16,7 %	16,3 %	14,0 %	13,6 %
OTHER SECTORS	18,5 %	18,3 %	19,3 %	18,0 %	18,1 %
ALL	17,5 %	17,7 %	18,6 %	17,3 %	17,2 %

This table shows that the hi-tech sectors do not have a higher mobility than the rest of the economy. This is to a large extent an age effect. Since sectors with a higher portion of highly educated will – on average – have persons who are older before they start working – and since mobility declines rapidly and monotonically with rising age. On the other hand, people with higher education are slightly more mobile than persons of the same age with less education. In "Computer services" where the employees are young and well educated the mobility rate is consequently the highest.

Table 21: Mobility, j2j, 1996-2000, LFS, all employees, three age groups

	16 - 24	25 -54	OVER 55
OIL AND GAS	46,8 %	9,9 %	2,5 %
CHEMICALS& PHARMACEUTICALS	54,2 %	8,1 %	2,4 %
OFFICE/COMP EQUIPT	72,7 %	7,0 %	0,0 %
RADIO/TV/COMMS	90,2 %	13,7 %	5,6 %
AEROSPACE&OTHER TRANSPORT	42,7 %	9,8 %	4,6 %
TELECOM AND POST	52,7 %	12,4 %	3,1 %
COMPUTER SERVICES	70,7 %	24,3 %	10,2 %
RESEARCH	58,6 %	15,4 %	4,1 %
OTHER MANUFACT.	48,7 %	11,9 %	3,6 %
OTHER SECTORS	51,9 %	15,7 %	4,8 %
ALL EMPLOYEES	51,6 %	15,0 %	4,6 %

The table shows the radical difference in mobility between young and older generations, but still the sector specific mobility is clearly visible. Computer services is most mobile in all age groups. This high mobility clearly shows the high rate of technical development in this sector. It reflects the hectic "buy-up needed competence" strategy that is common in this sector. In addition the high rate also reflects too strong competition for competent persons that in lead the "dot-com" years employers to overbid each other. The employees, of course, took advantage of this "sellers market". Such high mobility is a way of diffusing competence rapidly, but it also has well-known negative consequences: Projects suffering from key persons (the most competent) leaving before they are finished, increased wage costs with no corresponding increase in productivity.

Table 22: Age composition, LFS, all employees, three age groups

	16 - 24	25 -54	OVER 55
OIL AND GAS	3,8 %	88,6 %	7,5 %
CHEMICALS& PHARMACEUTICALS	5,8 %	78,5 %	15,7 %
OFFICE/COMP EQUIPT	12,8 %	80,3 %	6,8 %
RADIO/TV/COMMS	3,9 %	84,2 %	11,9 %
AEROSPACE&OTHER TRANSPORT	9,0 %	80,8 %	10,2 %
TELECOM AND POST	7,8 %	78,2 %	14,0 %
COMPUTER SERVICES	6,0 %	88,8 %	5,2 %
RESEARCH	3,9 %	79,8 %	16,2 %
OTHER MANUFACT.	12,6 %	73,4 %	14,0 %
OTHER SECTORS	12,5 %	73,2 %	14,4 %
ALL EMPLOYEES	11,9 %	74,0 %	14,1 %

The table shows as expected that the hi-tech sectors have less young employees since they require more people with long education. The "young" branches like "Oil" and CS have less over 55s, whereas an established sector like "Research" has more.

Table 23: Mobility, j2j, 1996-2000, LFS, Educational groups

	HIGHLY EDUCATED					LOWER EDUCATED				
YEAR	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000
OIL AND GAS	9 %	18 %	11 %	9 %	17 %	9 %	9 %	19 %	8 %	5 %
CHEMICALS& PHARMACEUTICALS	7 %	19 %	26 %	10 %	17 %	9 %	11 %	9 %	8 %	6 %
OFFICE/COMP EQUIPT	0 %	0 %	0 %	0 %	0 %	0 %	27 %	0 %	0 %	60 %
RADIO/TV/COMMS	24 %	35 %	0 %	22 %	0 %	31 %	8 %	8 %	19 %	10 %
AEROSPACE& OTHER TRANSPORT	25 %	18 %	17 %	22 %	12 %	12 %	12 %	12 %	11 %	10 %
TELECOM AND POST	31 %	23 %	23 %	20 %	22 %	10 %	12 %	15 %	13 %	14 %
COMPUTER SERVICES	16 %	29 %	36 %	29 %	20 %	20 %	20 %	29 %	32 %	26 %
RESEARCH	18 %	10 %	19 %	13 %	7 %	19 %	22 %	6 %	12 %	29 %
OTHER MANUFACT.	17 %	19 %	31 %	24 %	20 %	15 %	16 %	15 %	13 %	13 %
OTHER SECTORS	17 %	19 %	20 %	18 %	16 %	19 %	18 %	19 %	18 %	19 %
ALL	17 %	19 %	21 %	18 %	17 %	17 %	17 %	18 %	17 %	17 %

If we look at the mobility rate for all highly educated employees it rises from 17% to 21% and falls back to 17%. One hypothesis is that as everybody realises that the good times are back again in 1996-1998, there are accumulated needs for job changes. Firms expand, fuse etc. when we are in these "dot-com" years. After the first rush, things slow down a little. The tendency is that the highly educated are more mobile.

Table 24: Mobility, j2j, 1996-2000, LFS, Occupational groups

	MANAG., PROF.&TECH					OTHER OCCUPATIONS				
YEAR	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000
OIL AND GAS	7 %	12 %	17 %	9 %	9 %	11 %	12 %	16 %	8 %	7 %
CHEMICALS&PHARMACEUTICALS	2 %	10 %	8 %	9 %	5 %	12 %	13 %	14 %	8 %	10 %
OFFICE/COMP EQUIPT	0 %	0 %	0 %	0 %	0 %	0 %	63 %	0%	0 %	78 %
RADIO/TV/COMMS	20 %	14 %	0 %	27 %	0 %	43 %	10 %	14 %	14 %	13 %
AEROSPACE&OTHER TRANSPORT	6 %	9 %	9 %	7 %	7 %	14 %	14 %	13 %	14 %	12 %
TELECOM AND POST	12 %	11 %	13 %	11 %	14 %	12 %	16 %	20 %	18 %	18 %
COMPUTER SERVICES	19 %	21 %	32 %	30 %	25 %	16 %	35 %	34 %	43 %	20 %
RESEARCH	22 %	13 %	16 %	9 %	15 %	9 %	25 %	4 %	25 %	23 %
OTHER MANUFACT.	10 %	13 %	12 %	12 %	13 %	17 %	18 %	18 %	15 %	14 %
OTHER SECTORS	15 %	15 %	16 %	14 %	13 %	21 %	21 %	22 %	21 %	22 %
	14 %	14 %	16 %	14 %	13 %	20 %	20 %	21 %	19 %	20 %

Despite the fact that the definition of occupation builds on education the pattern of mobility is not just a question of small variations. The mobility of "Other occupations" is markedly higher than for than Managers, Professionals & Technicians. Why this is so is not obvious and it is beyond the scope of this project to try to find out. But one hypothesis is that since there are many small firms in Norway the managers of these small firms will be classified as top managers despite the fact that they have just a few persons below them. The directors of these firms are classified as managers, and they are relatively stable since they are often the backbone of the firm. In each of the hi-tech sectors the age composition is important. It is clear that if a large part of the employees are educated, they are older – and the young ones, less than 30 years, are very mobile.

Mobility – register data

Since the main data source for the country studies of UK and Netherlands is the LFS we are just going to look at some of the mobility rates that one can calculate with the register data. The aim is to discuss the LFS-mobility rates data in order to compare levels and patterns.

In this part we will take a look at the difference between the total job-to-job and intersectoral mobility. The total j2j mobility is every shift of job – also between firms in the same sector. Intersectoral mobility disregards the mobility internal to the sector. The reason for looking at intersectoral mobility is to focus on the spread of knowledge/human resources *between* sectors. By definition the intersectoral mobility rates will be lower than the overall mobility rates[19]. This reduction of course will be stronger if the skills a person possesses are more or mostly useful in the sector. The way the sector is defined also plays a great role in this. It is beyond the scope of this study to discuss how the current industrial classification was constructed. But the ISIC and NACE classifications are historical products, in many respect compromises between conflicting needs. Consequently the various sectors are very heterogeneous when it comes to size both generally and in each country. The technologies used and the skills needed in a NACE sector might be few or it might be very many. If the sector has a lot of job opportunities – then internal mobility in the sector will be high, and the intersectoral mobility consequently lower.

Table 25: Intersectoral mobility, 9 sectors, 1987 – 1999, all employees, register data

	OIL AND GAS	CHEM& PHARMA	OFFICE/ COMP EQUIPT	RADIO/ TV/ COMMS	AEROSPACE& OTHER TRANSPORT	TELE COM & POST	COMP. SERV	RESEARCH	OTHER MANUF.	OTHER SECTORS
87	10,0 %	12,1 %	9,5 %	11,7 %	17,6 %	6,4 %	16,6 %	10,7 %	8,7 %	2,8 %
88	4,7 %	10,9 %	10,6 %	12,9 %	14,6 %	7,6 %	13,0 %	11,6 %	9,1 %	2,6 %
89	5,4 %	3,9 %	14,8 %	12,3 %	10,3 %	7,5 %	11,3 %	10,4 %	6,7 %	2,0 %
90	3,3 %	3,6 %	16,8 %	9,2 %	8,7 %	5,4 %	12,3 %	8,5 %	5,8 %	2,1 %
91	3,2 %	5,5 %	13,5 %	28,4 %	6,7 %	5,0 %	10,4 %	13,3 %	5,5 %	1,8 %
92	4,9 %	5,1 %	54,5 %	10,7 %	7,0 %	5,1 %	10,2 %	11,1 %	5,8 %	1,6 %
93	4,5 %	4,4 %	41,5 %	8,1 %	7,6 %	5,6 %	12,7 %	7,7 %	4,7 %	1,5 %
94	4,3 %	3,4 %	9,0 %	3,9 %	7,1 %	4,6 %	9,8 %	10,3 %	5,2 %	1,4 %
95	10,5 %	4,9 %	5,6 %	8,5 %	10,1 %	10,1 %	13,7 %	15,6 %	8,0 %	2,4 %
96	6,4 %	3,6 %	14,9 %	9,6 %	10,1 %	7,9 %	10,0 %	17,3 %	7,0 %	2,3 %
97	8,4 %	8,9 %	7,9 %	12,0 %	12,4 %	15,6 %	19,3 %	12,1 %	9,6 %	2,6 %
98	4,8 %	6,4 %	35,9 %	22,1 %	11,3 %	10,6 %	12,1 %	11,6 %	9,4 %	2,7 %
99	10,7 %	9,0 %	12,0 %	26,7 %	18,6 %	9,3 %	14,0 %	9,2 %	9,2 %	2,5 %

19 If we presuppose that there is no change of NACE classification of the firms from one year to the next. But this is in practice not the case. Firms change and their NACE classification changes too. But in large sectors this phenomenon is dwarfed by the mobility internal to the sector.

The table shows first of all the consequence of a definition of sectors. The residual group "Other sectors" has a very low mobility – not because people change workplace less, but because most of the mobility is internal to this very residual "sector". In the extreme case when the whole economy is defined as one sector there will be no mobility at all. What this low rate shows is the mobility between "the rest of the economy" and some very specific hi-tech sectors. In contrast the other, but much smaller residual group "Other Manufacturing" has a level of mobility that is of the same order of magnitude as the high-tech sectors. That shows that people changing jobs in the "Other manufacturing" sector change as much to the rest of the economy as the much more narrowly defined high-tech sectors. A little surprising is the low mobility from "Post and Telecom". This might be because Telecommunications are dominated by the deregulated former public telecom company, the Postal service is still a public company. Both are scattered all over Norway and they are marked by formal rules and traditions ensure that people who must or want change place, are employed somewhere else in the company, if possible. Computer services is a thoroughly dynamic sector with a high internal and intersectoral mobility.

Table 26: Intersectoral mobility, 9 sectors, 1987 – 1999, highly educated, register data

	OIL AND GAS	CHEM & PHARMA	OFFICE/ COMP EQUIPT	RADIO/ TV/ COMMS	AEROSPACE& OTHER TRANSPORT	TELE COM AND POST	COMP. SERV	RESEARCH	OTHER MANUF.	OTHER SECTORS
87	10,8 %	18,8 %	12,2 %	18,3 %	24,5 %	8,7 %	19,9 %	12,4 %	11,6 %	2,0 %
88	4,9 %	24,5 %	13,1 %	11,0 %	18,7 %	10,7 %	11,9 %	13,7 %	13,5 %	1,8 %
89	6,9 %	8,0 %	20,4 %	15,4 %	15,8 %	8,6 %	12,2 %	11,5 %	10,5 %	1,5 %
90	4,4 %	6,5 %	20,9 %	10,0 %	12,5 %	7,8 %	13,0 %	10,3 %	10,6 %	1,8 %
91	3,7 %	6,7 %	17,3 %	34,3 %	13,4 %	8,0 %	11,4 %	18,6 %	9,4 %	1,5 %
92	4,6 %	10,2 %	62,3 %	11,9 %	17,9 %	8,2 %	12,0 %	13,8 %	13,8 %	1,3 %
93	5,0 %	7,8 %	38,1 %	12,1 %	10,9 %	8,9 %	14,8 %	10,4 %	8,3 %	1,2 %
94	4,1 %	5,6 %	10,3 %	5,1 %	11,3 %	6,9 %	10,0 %	12,0 %	8,5 %	1,2 %
95	7,9 %	10,3 %	7,2 %	12,1 %	14,1 %	13,0 %	14,3 %	21,2 %	13,1 %	2,1 %
96	7,4 %	5,3 %	8,9 %	10,3 %	16,6 %	9,8 %	10,5 %	19,5 %	11,3 %	1,6 %
97	11,0 %	12,7 %	16,1 %	16,1 %	18,5 %	16,4 %	18,4 %	14,6 %	16,5 %	2,0 %
98	6,3 %	9,0 %	52,8 %	34,5 %	17,4 %	11,0 %	11,2 %	12,7 %	13,7 %	2,2 %
99	8,2 %	11,1 %	14,8 %	16,2 %	19,6 %	10,2 %	13,0 %	10,0 %	13,7 %	2,0 %

The table shows the highly educated (ISCED 6+7). If we compare with all employees we get the well know result that the highly educated are more intersectorally mobile – as can be seen from the table below.

Table 27: The difference in intersectoral mobility between all employees and the highly educated, register data

	87	88	89	90	91	92	93	94	95	96	97	98	99
OIL AND GAS	-0,80	-0,20	-1,40	-1,10	-0,50	0,30	-0,60	0,20	2,60	-0,90	-2,60	-1,50	2,50
CHEMICALS& PHARMACEUTICALS	-6,70	-13,60	-4,10	-3,00	-1,30	-5,10	-3,40	-2,20	-5,40	-1,70	-3,80	-2,60	-2,10
OFFICE/COMP EQUIPT	-2,70	-2,50	-5,50	-4,10	-3,80	-7,80	3,40	-1,30	-1,60	6,00	-8,10	-16,90	-2,80
RADIO/TV/COMMS	-6,70	2,00	-3,10	-0,90	-5,90	-1,20	-4,00	-1,20	-3,60	-0,60	-4,20	-12,40	10,50
AEROSPACE& OTHER TRANSPORT	-6,90	-4,10	-5,60	-3,90	-6,70	-10,90	-3,30	-4,20	-4,00	-6,50	-6,10	-6,10	-1,00
TELECOM AND POST	-2,30	-3,10	-1,00	-2,50	-3,00	-3,10	-3,30	-2,30	-2,90	-1,80	-0,80	-0,40	-0,90
COMPUTER SERVICES	-3,30	1,10	-0,90	-0,70	-0,90	-1,80	-2,00	-0,20	-0,70	-0,50	0,90	0,90	0,90
RESEARCH	-1,60	-2,00	-1,00	-1,80	-5,30	-2,70	-2,70	-1,70	-5,60	-2,10	-2,50	-1,00	-0,90
OTHER MANUFACT.	-2,90	-4,40	-3,80	-4,80	-3,90	-7,90	-3,60	-3,30	-5,10	-4,30	-6,90	-4,40	-4,50
OTHER SECTORS	0,80	0,80	0,50	0,40	0,30	0,30	0,30	0,30	0,40	0,70	0,60	0,50	0,40

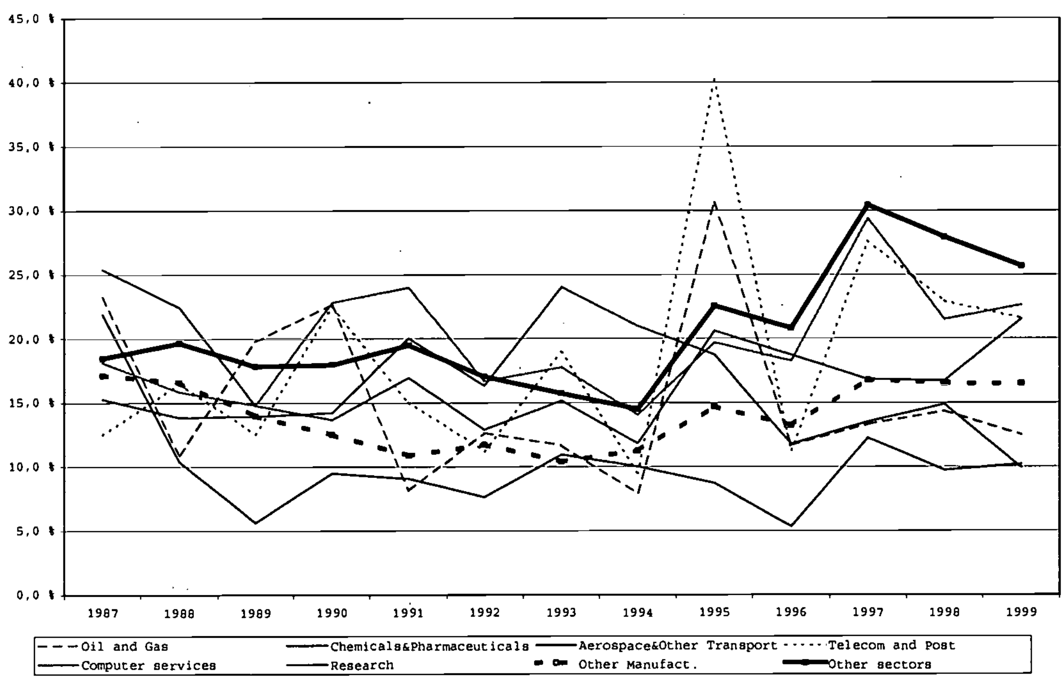
The greyed cells are those where mobility rate for the highly educated is higher than for all employees. This is mostly the case. There is only one exception to this rule – that is "other sectors". The reason is strange is that it includes large groups of highly educated in health, education and public administration in general. The highly educated are more *internal* to this part of the economy than people with less education, who might take "manual" jobs just as well in the manufacturing and hi-tech branches.

TABLE 28: MOBILITY RATES, J2J, 1987-1999, REGISTER DATA

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OIL AND GAS	23,2	10,9	19,8	22,7	8,2	12,6	11,7	7,9	30,6	11,7	13,3	14,3	12,5
CHEMICALS&PHARMACEUTICA	21,9	10,4	5,6	9,5	9,1	7,6	10,9	10,0	8,7	5,3	12,3	9,7	10,2
OFFICE/COMP EQUIPT	8,9	10,5	15,6	27,2	14,1	73,0	78,3	5,5	6,8	67,4	23,7	37,9	10,7
RADIO/TV/COMMS	14,5	39,0	21,5	20,4	28,1	10,1	8,5	5,8	10,7	8,4	22,4	34,2	21,0
AEROSPACE&OTHER	25,4	22,4	14,8	13,7	16,9	12,9	15,1	11,8	20,6	18,7	16,8	16,7	21,5
TELECOM AND POST	12,5	16,5	12,5	22,4	15,0	11,2	18,9	9,5	40,2	11,2	27,6	22,9	21,6
COMPUTER SERVICES	18,1	15,8	14,8	22,8	24,0	16,7	17,8	14,1	19,7	18,2	29,4	21,5	22,6
RESEARCH	15,3	13,8	13,9	14,2	20,0	16,3	24,0	21,0	18,7	11,8	13,5	14,9	9,9
OTHER MANUFACT.	17,1	16,6	14,0	12,5	10,9	11,7	10,4	11,2	14,7	13,2	16,8	16,6	16,5
OTHER SECTORS	18,5	19,6	17,8	18,0	19,5	17,0	15,7	14,5	22,6	20,8	30,4	27,9	25,7

This table shows all mobility between workplaces – not only that between sectors. The general trends in the table have been commented on earlier and will not be repeated. But if one looks closely at Telecom and Post one will see that in several branches the rates fluctuate 10-20 percentage points. So that even when we do not have a problem of cell size, when a sector becomes small, the numbers will be jumpy: both because there are stochastic elements, localised business cycles, but also due to the importance of "firm demography". In "Oil" the rate changes several times more than 10 percentage points. Some of this is the result of hiring/firing – huge contracts lost or won, but also mergers and split-ups will "artificially" influence the mobility rates. Take for example telecoms & post, that has great variations from 1994 onwards. Typically (like in oil&gas) there are a few big firms in these sectors and when there are organisational changes, this will give high mobility rates without actually implying any increased transfer of knowledge from one group of workers to another. The high rates are in a certain sense statistical artefacts.

Figure 5: Mobility rates, j2j, 1987-1999, register data



The very volatile behaviour from 1994 onwards also reflects, as mentioned before, that there was a change in the firm ID system that, together with the Social Security Authority having less resources for quality checking of the data, has made the numbers less reliable. Hopefully these deficiencies will be amended in the future.

BEST COPY AVAILABLE

Table 29: Mobility from Computer Services to other sectors, highly educated

	87	88	89	90	91	92	93	94	95	96	97	98	99	TOTAL
OIL AND GAS	2,5	2,0	1,2	1,7	3,0	4,5	1,4	1,9	0,0	1,6	0,8	1,9	0,4	1,4
CHEMICALS &PHARM.	0,0	1,2	0,6	0,0	0,6	0,8	0,2	0,2	0,9	0,4	0,1	0,4	0,6	0,5
OFFICE/COMP EQUIPT	1,4	0,4	11,9	0,2	0,4	0,0	0,2	1,2	0,3	0,4	6,5	0,1	0,2	1,6
RADIO/TV/COMMS	1,4	0,4	1,5	0,4	1,1	0,8	1,6	6,8	2,2	1,5	0,9	1,2	1,8	1,6
AEROSPACE& TRANSPORT	0,0	0,0	0,0	0,2	0,4	0,6	0,2	0,2	0,7	0,3	0,4	0,6	0,5	0,4
TELECOM AND POST	10,1	8,4	7,3	8,4	5,3	3,9	4,7	6,3	7,7	8,5	6,8	6,2	3,8	6,2
COMPUTER SERVICES	22,5	25,1	29,4	44,3	51,5	39,8	31,0	32,1	35,6	47,5	37,0	54,2	41,4	40,8
RESEARCH	2,9	1,6	4,3	3,2	1,3	2,7	1,7	1,9	1,6	1,5	2,2	1,0	1,9	1,9
OTHER MANUFACT.	7,6	6,8	2,8	7,7	3,4	4,7	4,1	6,1	6,2	4,5	5,2	5,0	22,8	8,5
OTHER SECTORS	51,4	54,2	41,0	33,8	33,0	42,1	55,0	43,3	44,8	33,6	40,2	29,2	26,6	37,0
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

The table shows that persons from Computer Services move to the other knowledge and intensive branches in greater proportion than the size of these sectors. There is a slight declining trend for Oil and Research which might be explained by these sectors having established systems and consequently have moved from an intensive development phase into a more mature operating phase. It might also be that they are buying more competence, instead of doing in-house development.

Table 30: Mobility from Computer Services to other sectors, less educated

	89	90	91	92	93	94	95	96	97	98	99	TOTAL	TOTAL
OIL AND GAS	1,7	0,6	0,8	1,6	0,7	0,5	0,1	0,8	0,3	0,9	0,1	0,7	1,4
CHEMICALS&PHARM.	0,4	0,4	0,1	0,6	0,4	0,2	0,1	0,1	0,1	0,2	0,2	0,2	0,5
OFFICE/COMP EQUIPT	7,5	0,3	0,7	0,0	0,0	0,6	1,8	0,3	1,0	0,0	0,0	0,8	1,6
RADIO/TV/COMMS	0,4	0,0	0,2	1,1	0,4	0,8	0,1	0,5	0,2	9,3	0,7	1,3	1,6
AEROSPACE&TRANSP	0,8	1,1	0,2	0,2	0,2	0,3	0,3	0,4	0,5	0,5	0,3	0,5	0,4
TELECOM AND POST	7,2	11,6	6,0	6,9	9,8	5,1	6,7	5,8	4,8	5,3	4,1	6,6	6,2
COMPUTER SERVICES	22,0	47,5	60,0	42,1	27,8	32,9	28,7	53,0	38,0	41,9	38,3	38,4	40,8
RESEARCH	0,0	0,2	0,3	0,8	0,4	0,2	0,4	0,3	0,4	0,2	1,4	0,5	1,9
OTHER MANUFACT.	6,4	8,8	2,8	4,4	3,6	8,3	5,4	3,3	3,2	4,8	23,3	8,0	8,5
OTHER SECTORS	53,7	29,4	29,1	42,2	56,7	51,3	56,5	35,5	51,6	37,0	31,7	43,0	37,0
TOTAL	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

The mobility patterns for those with less education are similar, as expected there are fewer going to Research and Oil, and more going to "Other sectors". For both groups there is an outlier in 1999 when "Other manufacturing" suddenly gets more than 20%. This is probably a result of the change of NACE code in one of the major Computer service firms, being reclassified into "Manufacturing".

Summary

The main findings in this part are on two levels:

1) The substantial results concerning the demand and supply for skills in high-tech sectors.

2) The usefulness of the two data sources, the Norwegian LFS and the register data.

Substantial findings

The high-tech sectors have a small but stable share of overall employment, about 2,75% of total employment.

In the high-tech sectors the share of highly educated is rising, more than for the rest of the economy, but the variations are great and substantial.

Computer services is the only sector that shows a rapid growth in employment. The sector has also very high mobility. Both indicators reveal a great demand for such skills and a lack of them.

Telecommunication goes through a change in its skill structure firing the lower skilled and rapidly increasing the share of highly skilled. This reflects the technological changes in all parts of telecommunications, from an analogue/mechanical technological base to a digital/computerised base.

Data sources

The Labour Force survey has notorious problems when analysing particular sectors and subdividing according to education and occupation. In this case the Norwegian LFS – following the EU-standard – does not have the level of detail as the UK LFS. Three sectors, Aerospace, Pharmaceuticals and Telecommunications cannot be analysed using the LFS. These 3-digit sectors cannot be analysed on a two digit level, that is together with the other 3-digit sectors in the same 2-digit group. The 2-digit sector is too heterogeneous. This is shown by using the register data to analyse all the 3-digit sectors.

The LFS does have a lot of information on training but besides the eternal problem of cell size (few observations of sub-groups) it is not as well suited to analyse skill mismatches as it should be.

The LFS also has occupational classification, but since the current standard, the ISCO-88, uses education as one of its criteria, it does not give as much information about job content – and consequently on skills needed, as it could. One work-around would be to use the detailed occupational classification, but then we meet the problem of cell size again.

The register data are a very valuable source of information, but they lack occupational data. When it comes to mobility rates, they are very sensitive to the way the firm identification number system handles such phenomena as, splits, mergers and change of NACE group.

References

Ekeland, A. (1998) 'Indicators for human resources and mobility', IDEA Paper No.9, STEP Group, Oslo.

Braadland, Thor Egil, Ekeland, Anders, (2001), "The mapping of IT-competencies", STEP working paper

OECD (1995) *Canberra Manual*, Paris: OECD.

Nås, Svein Olav, Anders Ekeland, Eric J. Iversen, Mikael Åkerblom, Markku Virtaharju, Christian Svanfeldt, Johnny Ullström, 1998, *Formal competencies in the innovation systems of the Nordic countries: An analysis based on register data*, STEP report 6-98.

Rosenberg, Mikael, 1998, "An Inventory of National Priorities and availability of data in OECD Countries to Quantify Science and Technology Personnel Mobility Patterns", Room Document No.2, joint NESTI/TIP/GSS workshop, 17. June 1998, OECD.

Stimpson, Alex. (2001) (forthcoming) Preliminary Results from the HRST Mobility analysis, Procedings from OECDs Focus Group on Human Mobility, Camire Luxemburg.

Åkerblom, M. (1999) Mobility of highly qualified manpower, a feasibility study on the possibilities to construct internationally comparable indicators. Report for Camire (Eurostat) and OECD. Statistics Finland, 14th December.

The supply and demand of high technology skills in the Netherlands

Anders Ekeland*, Sami Mahroum** and Thor Egil Braadland***

*Anders Ekeland

STEP group, Norway

**Sami Mahroum

TNO, Netherlands

***Thor Egil Braadland

STEP group, Norway

Introduction

In our study of supply and demand for high technology skills, we are going to take a closer look at skills in the high-tech sectors of the Dutch economy. High-tech sectors are recognised by requiring advanced skills, they are often R&D intensive and they often experience rapid changes in products and technology. These factors make these industries particularly interesting for a more detailed skills study. In addition, these sectors are often regarded as potential growth sectors. This make this study important for policy makers concerned with economic development, knowledge flows and technical change.

The following analysis has two main aims: First, to study the development of high-tech sectors in terms of labour mobility and supply of training. Such a study is important for the very simple reason that we are talking about very skill-intensive industries. Secondly, since this is one of the first studies of its kind based on Dutch mobility data, the quality of the data is a major concern. A central question is if the existing data give reliable and/or reasonable results.

The study is divided in four. After a literature review, we look at trends in the economy as a whole in order to delineate more general trends in the Dutch economy from the more specific development of the chosen high-tech sectors. Thirdly, we look at the distribution of training in the Dutch labour market. Fourthly, we look at mobility of highly skilled persons in the Dutch economy.

Literature review:

The structure of employment in the Netherlands

The Netherlands have an active working population of 6.6 million people, a number which continues to rise. Although, the number of jobs grew in virtually every sector since 1997, it was the services sector, which was largely responsible for the 30% rise in the demand for labour. In 1999, unemployment fell below the 5%. Much of the increased demand for labour came from the private sector with the number of vacancies rising in that sector from 55000 in 1995 to 158000 in 1999. Vacancies in the public sector, however, have risen from 8000 in 1995 to 14000 in 1999. The greatest portion of these vacancies was in the education sector and in local government. The structure of employment in the Dutch labour market has changed radically in the last two decades. The share of industry in the total employment figure reduced from 33% in 1960 to 18% in 1994, while the share taken by the services sector (excluding transport and communication) rose from 40% to 64%.

There has been a shift in the occupational structure of the labour force in the Netherlands: the share of occupations in the traditional skilled trades, industrial and transport sectors shrank from 43% in 1960 to 23% in 1994, while the share of scientific and other specialist occupations and that of policy-making and senior management positions increased from 12% to 25% (SCP, 1996). Across the service sector, 5.3 per cent of vacancies are unfilled. That reflects rapid job creation in industries such as telecommunications where liberalisation in the past few years has more than doubled the number of people employed the sector. Since 1960, the jobs on offer in the Dutch labour market have consistently become more highly skilled. Over the past 25 years the average educational level of the Dutch labour force has also risen sharply. The number of people who have attended secondary and tertiary education increased from 32% in 1970 to 65% in 1995. This figure is forecast to exceed 70% in the years ahead.

Table 1: Level of Education of Labour Force between 1995-99

Education/Year	1995	1997	1998	1999
Senior vocational education	2,539	2,696	2,648	2,692
Vocational colleges	1,120	1,172	1,262	1,309
University education	513	582	625	652

Source: CBS 2000.

The increase in the number of university-educated persons in the labour force between 1995 and 1999 is remarkable. There has been a total increase of 139000 persons in a period of 4 years. The participation rate of these groups also went up by around 2%; in the case of university-educated persons, it went up from 78% to 90%. In a 1998 study analysing the future prospects of the Dutch Labour market, De Grip et al. (from ROA: Research Centre for Education and the Labour market) have expected future demand for university graduates to be higher than the demand for graduates of the HBO (Higher Vocational Education) system. A large part of that is due to the upgrading of skill levels (educational level) to meet demand by employers. This means that for various occupations employers will upgrade demands for education from lower to higher levels (De Grip et al., 1998). This is particularly true for educational levels in the technical, economics, management, and social studies fields. Table 2 below provides an insight into the employment situation of Dutch university graduates one and half year after graduation.

Table 2: Situation of Dutch university graduates one and half year after graduation by field of education (in %).

	Agri.	Techn	Econ.	Health	Social	Arts	Law	Sci.	Total
PhD	22	11	2	68	6	8	1	34	13
Job	59	82	93	21	76	66	87	52	74
Study	1	1	0	3	1	3	3	3	2
Unemployed	9	3	2	5	8	9	5	7	5
Other	8	2	3	4	9	14	4	4	6

Source: Berkhout &Webbink (1997).

Table 2 shows that a large majority of university graduates (87%) were in paid employment one and half years after graduation. A great majority of medical graduates go on to PhD based employment (scholarship), while 93% of economics graduates, 87% of law students, and 82% of technology students land in regular paid jobs within one and half years after graduation. The link between the field of study and area of employment is becoming less direct than often assumed. This is particularly true for graduates in humanities, social sciences, agricultural and environmental studies, law, and pharmacy. Indeed a survey in 1997 showed that 63% of all people employed in the ICT sector in the Netherlands did not have a formal education in IT (Intermediair, 1998).

This highlights the fact that competition for skills does not take place within sectors only, but also between them. Thus, what happens in one particular sector of the economy can have strong influence and spill over effect on the labour market of other sectors in the economy. Indeed, in a more recent survey of graduate employment in the Netherlands (see Allen et al., 2000) it was found that for the majority of university graduates the content of their field of knowledge is generally not a problem, but rather 'well developed personal characteristics and skills' seem to be the most critical for their employment. These are of various natures: oral and written communication, motivation and interpersonal aspects, the ability to work in teams (social skills), and being sensitive to commercial issues. Table 3 below provides an overview over the dispersion of graduates over broad occupational domains. 0 indicates no dispersion while 1 indicates high dispersion. In other words, 0 indicates that graduates work in the same fields they had graduated in, whereas 1 means that they work in different fields.

Table 3: Dispersion of fields of studies over occupations of graduates in the Netherlands 1985, 1990, 1993 (Gini-Hirschamn Index)

University Grads.	1985	1990	1993
Humanities	0.41	0.68	0.77
Sciences/Engineering	0.84	0.82	0.80
Medicine	0.36	0.38	0.48
Social Sciences	0.73	0.88	0.89

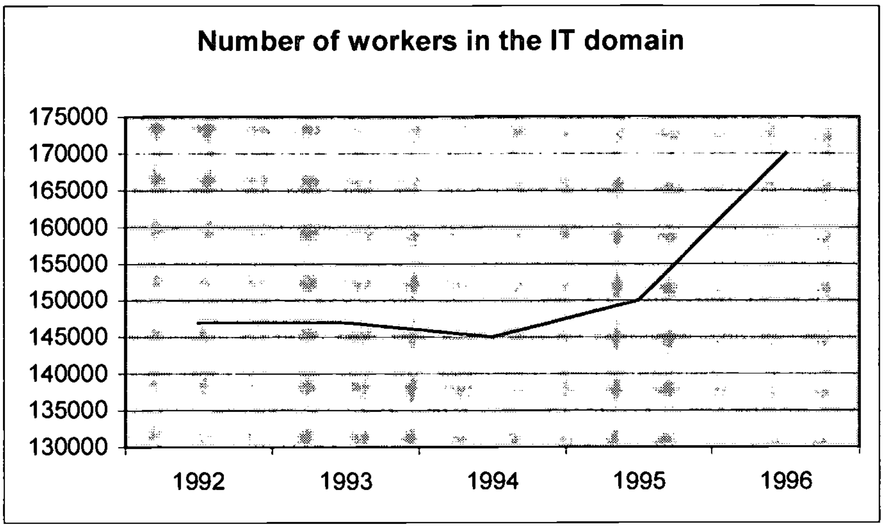
Source: Webbink & Paape (1997)

As we can see from table 3 graduates in the field of humanities have been increasingly employed in occupational sectors outside their traditional domains (outside socio-cultural sectors and arts). Medicine graduates however continue to be concentrated in the medical and health sector. Sciences & engineering maintain a quite high level of dispersion across occupational sectors and are not limited to traditional technical occupations.

In contrast, university graduates in medical sciences, veterinary, and dentistry work predominantly in the health sector (i.e. one specific occupational domain), hence their traditional occupational sector. This is perhaps expected due to the specificity of the medical profession, which restricts the possibility for substitution or replacement with other types of graduates or occupational sectors. In other words, you cannot work in the field of medicine health or veterinary science if you have graduated in social sciences. However, the authors of the survey found that a growing number of university graduates will find themselves employed in occupational domains (sectors) that are not specific to their educational background and which generally recruit from broad and diverse educational sources. The reason behind this trend according to the ROA's survey is the shortages of graduate supply in certain occupational domains, leading to recruitment from non-traditional educational backgrounds. In some occupational domains, such as Civil Engineering, there will be a shortage of demand for university graduates. Yet in order for those to adjust, some of them will seek employment in other professional fields than their own.

The increase in the demand for university graduates in the fields of electrical engineering and IT is expected to stem largely from occupational domains outside the IT sector itself (what the authors call 'alternative occupational domains'). This is perhaps a reflection of the continuing diffusion of Information Technology in greater segments of the economy and society in general. In other words, a greater number of IT & Electrical Engineering graduates will be employed in non-technical professions. Commercial and administrative types of occupations are the main competitors with technical occupations for this type of graduate. A majority of the graduates are coming from the HBO (polytechnics level) and MBO levels (two years post high school technical studies – See Smits et al, 1998).

Figure 1: Total number of IT workers in the Netherlands and the change of their numbers over time.



Smits et al, 1998.

Despite the sharp increase in the number of workers employed in the IT domain in the NL between 1995 and 1996, currently the Dutch labour market for IT graduates is characterised by tightness with an officially recorded vacancy rate of 8.7 per cent. Industry surveys carried out by industry consultants, such as Berenschot, put the IT vacancy rate in the year 2000 higher than official records, namely at 14.5 per cent. That is a 10 years record of vacancy rates in the sector. The greatest type of demand is for systems analysts and programmers. In particular junior programmers and Information Systems architects are the two positions most difficult to fill (Berenschot, 2000). Table 4 provides various estimates of the labour shortage in this hi-tech sector for the year 1997 in the Netherlands.

Table 4: Various estimates of the labour shortage in the ICT sector in the Netherlands in 1997

Survey	ICT shortages
ROA	10,000
FENIT	17800
PWC	21900

PWC: 1998

These numbers, however, do not take into consideration the substitute labour flows coming from other educational and occupational backgrounds. Since, as we have seen, around 63% of those employed in the ICT sector are 'converts' from other sectors or educational backgrounds.

Major existing national data Sets and surveys

The main existing data sets on the characteristics of the Dutch employees with regard to educational and occupational background can be found in the OSA labour supply panel. The OSA labour force survey, first fielded in 1985, is a face-to-face biannual panel survey among a representative sample of some 2,000 households. Its logical counterpart is the biannual OSA **labour demand panel** study, first conducted in 1989, among some 2,500 firms and institutions, which is fielded in rotation to the labour supply panel. The OSA conducts a survey every two years to collect data about the (potential) labour force in the Netherlands: the OSA Labour Supply Panel. The panel targets members of households between 16 and 65 years of age, who are not following daytime education. The survey is aimed at finding out about respondents' employment situation, and about their behaviour in the labour market. Also, information is collected about aspects that may be expected to influence their decision whether to participate in the labour market. The first wave of the **OSA Labour Supply Panel** was carried out in the spring of 1985. Subsequent surveys have taken place every two years, in the fall (from 1986 to 1998).

In addition there is the **Enquête Beroepsbevolking (EBB)**, which is a sample survey among almost all Dutch households. Only people living in institutions and establishments are excluded. Statistics Netherlands started the survey in 1987. Since then more than 100,000 persons have been interviewed every year. The results of the EBB should be considered as an estimate. However, this survey does not provide complete or wide ranging information on the previous occupational background which makes it less useful for the purpose of our study in trying to track the mobility rates between sectors. However, an extended version of the EBB, which is made available only to Eurostat, does provide to some knowledge of the retrospective employment status of persons in the technological sectors that are of interest to us. This database has been used in this study. The advantage of the Eurostat database is that it is the best available data on the Dutch labour force that is comparable to other EU and EEA countries.

List of references

Allen, J, Boezerooy, P., de Weert, E., & van der Velden, R., (2000), Higher Education & Graduate Employment in the Netherlands ROA paper # 157

Berenschot, 2000- www.berenschot.nl

Berkhout, P.H.G & H.D. Webbink (1997) Goede Studies, De Beste Banen. Stichting voor Economisch Onderzoek der Universiteit van Amsterdam.

Centraal Bureau voor Statistics : www.cbs.nl

Enquête Beroepsbevolking: www.cbs.nl

A. De Grip, Borghans, L., Smits W., 1998, Future Developments in the Job Level and Domain of Highly-skilled workers. ROA paper # 126.

Intermediair, 1998: http://www.intermediar.nl/

Organisatie voor Strategisch Arbeidsonderzoek : http://osa.kub.nl/

PriceWaterhouseCoopers 1998: An unpublished study for the Ministry of Economic Affairs.

ROA: Researchcentrum voor Onderwijs en Arbeidsmarkt (ROA)

Smits, W., Delmee, J.Grip, A.De. (1998) De arbeidsmarkt voor informatici. ROA-R-1998/2

SOC 1996: Social and Cultural Surveys 1996 [Sociale en culturele verkenningen 1996

Webbink , D., & Paape, A. (1997) De dynamisch relatie tussen hoger onderwijs en arbeidsmarkt (Den Haag, Ministry of Education, Science, & Culture).

Industrial classification

The study period is 1993 to 1999[1]. We use three broad classes of education; Low, Medium and High. The "High" group includes all education to University level, from short one- or two-year courses to a Ph.D. [2]

The high-tech industries are defined on a quite detailed level in the traditional industry classification[3]. However, as it is not possible to get data for employment and education on such a detailed level, we had to settle for data for a two-digit level. This means we are using slightly broader categories[4]. The industries studied in this paper are listed in Table 5.

Table 5: Industrial sectors, actual break down – general analysis

11	Extraction of crude petroleum and natural gas; related services, excluding surveying
24	Chemicals & pharmaceuticals
30	Manufacture of office machinery and computers
32	Manufacture of radio, television and communication equipment and apparatus
35	Aerospace & other transport
64	Telecom and post
72	Computers and related activities
73	Research and development

Using the 2-digit industry level is slightly problematic for our purpose, as we now cover broader areas than what are generally regarded as high-tech activities. For example, we wanted to study pharmaceuticals, but end up looking at both chemicals *and* pharmaceuticals. In the same way, Aerospace now includes Other transport, and Telecommunications includes Postal services. This compromises our study to some degree. Branches like manufacturing of chemicals, transport and postal services are generally known to have less highly educated staff and being less high-tech. However, only a detailed discussion building on information from other sources could really tell

1 Initially, we wanted to use the period 1992 – 1999, but in the Dutch case, the NACE standard was not implemented before 1993, and although there exists some rough methods for making the former ISIC classification comparable with NACE we felt that it was not appropriate to use them in this context. Consequently the time series had to start with 1993.
2 During this period, there has been a change in educational classification, the years 1993 – 1997 using the "old" international standard, the ISCED-76 and from 1998 onwards the "new" ISCED-97. Regrettably there is no mapping between the old and new standard that makes it possible to have a reasonably detailed breakdown of educational levels. This is a general problem and is not something specific to the Dutch data. In our opinion it would have been more fruitful to make a group of the university level qualifications that are more than three years, but that is not possible given the change in the educational classification – and as we will see below – there are major problems of sample size in the Labour Force Surveys. Problems that would only increase if one used a more detailed educational breakdown. See Appendix for details.
3 See Appendix, **Table**, for an overview of high-.tech industries and NACE codes
4 That may be due to the fact that the LFS data used here is the data from Eurostat. These data are aggregated and harmonised versions of the Dutch LFS. It is often the case that the data in the national LFS have more detailed breakdowns of many variables.

how much this would affect the results and consequently the conclusions. We do not have data to judge the effects at this point.

General trends in employment, 1993 – 1997

The Dutch business cycle has followed the general European trend in the post 1993 period, with growth in employment stagnating and later on a falling unemployment rate. The Dutch Economy has had a longer period of high unemployment than Norway. From a low level in the mid seventies it settled to a new level – between 6-11%. Only in the last two years did the unemployment rate go lower.

Table 6: Registered unemployment rate, Netherlands 1970-1999

	Males	Females	All	Males	Females	All
1970	36	8	44			
1971	51	11	62	1,4	0,9	1,3
1972	91	17	108	2,6	1,4	2,2
1973	88	21	110	2,5	1,7	2,3
1974	107	28	135	3,0	2,2	2,8
1975	153	42	195	4,3	3,2	4,0
1976	160	51	211	4,4	3,9	4,3
1977	145	58	204	4,0	4,4	4,1
1978	134	67	201	3,7	4,9	4,1
1979	123	71	194	3,4	5,1	3,9
1980	141	76	217	3,9	5,2	4,3
1981	217	100	317	6,0	6,5	6,1
1982	333	135	468	9,2	8,6	9,0
1983	446	166	612	12,3	10,3	11,7
1984	425	166	591	11,8	10,1	11,3
1985	358	153	511	9,9	9,2	9,7
1986	310	164	474	8,4	9,0	8,6
1987	278	178	456	7,4	9,0	7,9
1988	281	173	453	7,4	8,3	7,7
1989	244	163	407	6,4	7,8	6,9
1990	209	149	358	5,4	6,8	5,9
1991	190	145	334	4,9	6,3	5,4
1992	195	141	336	4,9	6,1	5,3
1993	240	175	415	6,0	7,3	6,5
1994	283	203	486	7,0	8,3	7,5
1995	260	204	464	6,4	8,1	7,0
1996	240	201	440	5,9	7,8	6,6
1997	199	176	375	4,8	6,5	5,5
1998	155	132	287	3,7	4,8	4,1
1999	115	106	221	2,7	3,7	3,1

Table 7 illustrates this by presenting the basic figures on active population, number of persons employed and the share of persons employed of the total active population. The table shows that the upturn started early in 1996 (the numbers are from the 2nd quarter). The share of persons employed passed 55 percent in 1996, and more than 7 million people now had a job.

Table 7: Total employment growth in absolute and relative numbers, 1993-1997

Year	Active population	Persons employed	Percentage
1993	12.173.713	6.631.101	54,5 %
1994	12.258.081	6.697.551	54,6 %
1995	12.328.280	6.772.188	54,9 %
1996	12.396.538	6.922.351	55,8 %
1997	12.469.121	7.175.401	57,5 %
1998	12.543.117	7.393.997	58,9 %
1999	12.622.098	7.597.371	60,2 %

At the same time, unemployment rates went down. In 1995, the unemployment rate was seven percent, four years later the share had more than halved to 3.2 percent (Table 7).

Against the background of increased employment in the Dutch economy, what were the trends in the high-tech sectors? Looking at all sectors (as defined in Table 6) we see in Table 8 that the high-tech sector actually shows a slight decline measured as a share of total employment. In 1993, the industries represented about 7,5 percent of total employment. In 1999, the share was reduced to 6,6 percent.

Table 8: Relative employment, three sectors, 1993 - 1999

	1993	1994	1995	1996	1997	1998	1999
Hi-Tech	7,50 %	7,20 %	6,20 %	6,00 %	6,50 %	6,50 %	6,60 %
Other Manufact.	14,40 %	14,00 %	14,30 %	14,10 %	14,00 %	13,80 %	13,50 %
Other Sectors	78,10 %	78,80 %	79,50 %	79,90 %	79,50 %	79,70 %	79,90 %

Looking more closely at the individual industries, we find that the largest reductions (measured as share of total employment) are found in telecommunications. Both manufacturing of radios/TVs/communication equipment (down 50 percent) and telecomm/post (down 15 percent) show marked reductions (Table 9). But also Aerospace/Other transport are reduced, as is chemicals and pharmaceuticals.

Growing high-tech industries are first and foremost computer activities. Office equipment grows from 0,1 percent to 0,2 percent, and Computer services show a doubling in employment, from 0,8 percent to 1,5 percent. However, we are still talking about relatively small numbers. The total high-tech employment in the Netherlands, even broadly defined as it here is, employs about 6,6 percent of the total employed workforce in 1999.

Table 9: Relative employment shares, nine sectors, 1993 - 1999

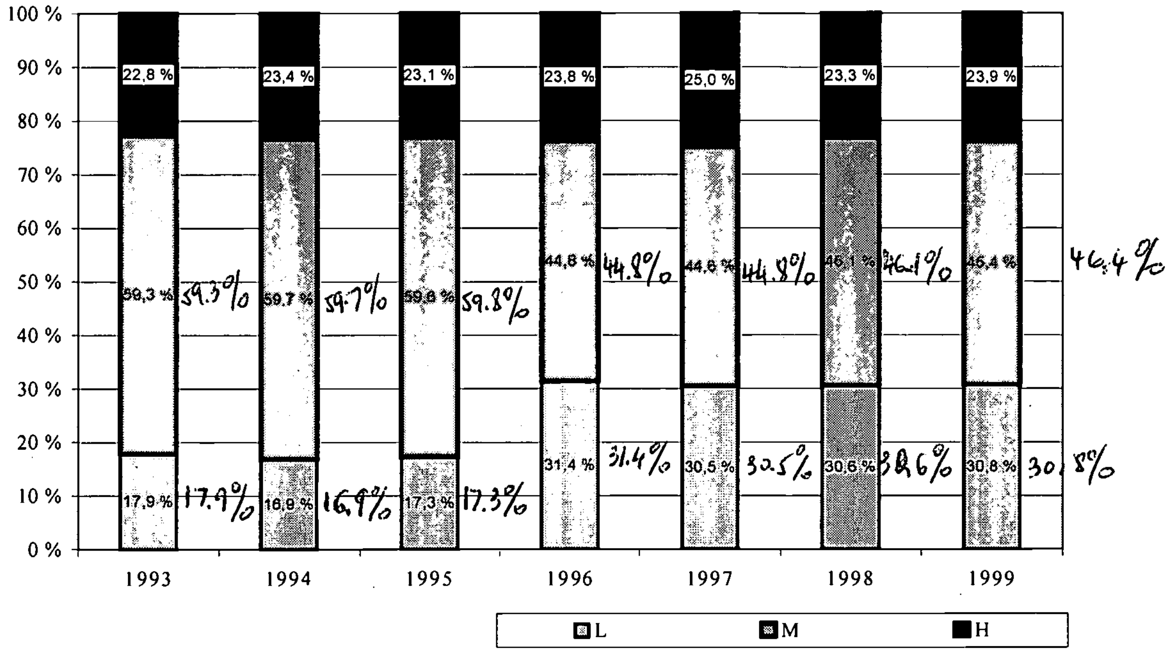
Sector	1993	1994	1995	1996	1997	1998	1999
Oil and Gas	0,2 %	0,2 %	0,2 %	0,1 %	0,2 %	0,2 %	0,2 %
Chemicals& Pharmaceuticals	1,6 %	1,6 %	1,5 %	1,5 %	1,6 %	1,4 %	1,4 %
Office/comp equipt.	0,1 %	0,1 %	0,1 %	0,1 %	0,1 %	0,2 %	0,2 %
Radio/tv/comm	1,6 %	1,6 %	0,8 %	0,9 %	0,9 %	0,8 %	0,8 %
Aerospace& Other Transport	0,6 %	0,5 %	0,5 %	0,4 %	0,5 %	0,4 %	0,4 %
Telecom and Post	1,9 %	1,7 %	1,8 %	1,6 %	1,6 %	1,6 %	1,6 %
Computer services	0,8 %	0,9 %	0,9 %	0,9 %	1,1 %	1,4 %	1,5 %
Research	0,5 %	0,6 %	0,4 %	0,3 %	0,5 %	0,5 %	0,6 %
Other Manufact.	14,4 %	14,0 %	14,3 %	14,1 %	14,0 %	13,8 %	13,5 %
Other sectors	78,1 %	78,8 %	79,5 %	79,9 %	79,5 %	79,7 %	79,9 %

The composition of the Dutch workforce has changed slightly during the 90s. Figure 2 provides an overview of how different educational categories are represented as the share of all employees in the economy in the period 1993 to 1999.

There are two trends. The first one is that share of higher educated persons is slightly increasing. In 1993 the share was 22,8 percent. In 1999 this share had increased to 23,9 percent. The second trend is stronger, and that is that the share of persons with low formal education has increased: from 17,9 percent in 1993 to 30,8 percent in 1999. This could mean that the boost in the Dutch economy in this period has to a large extent enabled people with low formal skills to enter the labour market.

Figure 2:

Educational groups, shares of alle employees, 1993-1997



The figure also shows that there is a break in the series between 1995 and 1996. This could be caused by moves in the border between Low and Medium education. As we can see, the shares of employees with respectively Low+Medium and High are fairly stable over time. One might have expected an increase in the High educational group, since the general level of education is rising. However, it seems to have been outweighed by previously unemployed people – with generally less education – getting a job again.

If we look at higher educated staff within the high-tech sector, other manufacturing sector and other industries sector, we find that on an aggregate level, the share is fairly stable. Table 11 provides an overview of how all persons with higher education are distributed within three sectors of the Dutch economy in the period 1993 to 1999. We see that there has been a slight increase in high-tech sectors, from 13,2 percent to 14,2 percent. At the same time, the other two sectors show marginal reductions.

Table 10: Relative employment shares, Highly educated, three - sectors, 1993-1999

Sector	1993	1994	1995	1996	1997	1998	1999
Hi-Tech	13,20 %	12,80 %	12,30 %	12,70 %	13,40 %	13,20 %	14,20 %
Other Manufact.	6,80 %	6,00 %	6,50 %	6,10 %	6,60 %	6,60 %	6,70 %
Other sectors	80,00 %	81,10 %	81,20 %	81,20 %	80,10 %	80,20 %	79,20 %

Table 10 shows the figures from the table above on a more detailed level. For most industries, the share is quite stable. The most marked changes are in Radio/TV/Communication, going down, and Computer services going up. These findings are compatible with the findings in Table 9.

Table 11: Relative employment shares, Highly educated, nine sectors, 1993 - 1999

Sector	1993	1994	1995	1996	1997	1998	1999
Oil and Gas	0,2 %	0,2 %	0,3 %	0,2 %	0,2 %	0,2 %	0,2 %
Chemicals& Pharmaceuticals	1,8 %	1,8 %	1,8 %	1,7 %	1,6 %	1,7 %	1,3 %
Office/comp equipt.	0,1 %	0,2 %	0,2 %	0,1 %	0,1 %	0,2 %	0,1 %
Radio/tv/comm	1,8 %	1,7 %	1,0 %	1,4 %	1,2 %	0,9 %	1,0 %
Aerospace& Other Transport	0,5 %	0,3 %	0,3 %	0,3 %	0,2 %	0,1 %	0,2 %
Telecom and Post	5,6 %	5,3 %	5,6 %	5,9 %	6,3 %	6,0 %	6,6 %
Computer services	1,9 %	1,9 %	2,1 %	2,2 %	2,6 %	2,9 %	3,5 %
Research	1,3 %	1,4 %	1,0 %	0,9 %	1,2 %	1,2 %	1,3 %
Other Manufact.	6,8 %	6,0 %	6,5 %	6,1 %	6,6 %	6,6 %	6,7 %
Other sectors	80,0 %	81,1 %	81,2 %	81,2 %	80,1 %	80,2 %	79,2 %

The question that now arises is how changes in highly educated staff vary or deviate from the general trend in employment in the different high-tech industries. Table 12 shows the share of higher educated staff in each high-tech industry in the period 1993 to 1999[5]. We find the highest shares in Research (62 percent) and Computer services (53 percent). The lowest shares are in Office equipment and Telecomm/Post.

The share of employees with higher education has decreased in most high-tech industries, like Chemicals & Pharmaceuticals, Computer services and Research. Telecomm/Post has increased its share of high-skilled staff in this period – the same as radio/TV/communication has done.

Table 12: Share of highly educated per sector, nine sectors, 1993 - 1999

Sector	1993	1994	1995	1996	1997	1998	1999
Oil and Gas	31,0 %	38,9 %	47,1 %	45,3 %	36,4 %	28,9 %	28,5 %
Chemicals& Pharmaceuticals	30,5 %	30,6 %	29,9 %	29,3 %	28,3 %	29,1 %	24,1 %
Office/comp equipt.	26,6 %	34,9 %	32,0 %	20,5 %	26,9 %	28,7 %	19,2 %
Radio/tv/comm	29,6 %	28,5 %	31,8 %	39,1 %	37,7 %	30,1 %	33,3 %
Aerospace&Other Transport	19,2 %	15,5 %	17,2 %	20,2 %	11,5 %	7,6 %	13,5 %
Telecom and Post	21,3 %	21,4 %	21,6 %	23,6 %	26,2 %	22,2 %	23,8 %
Computer services	56,5 %	56,8 %	56,6 %	57,9 %	56,4 %	47,6 %	52,9 %
Research	63,6 %	64,3 %	63,8 %	61,6 %	66,3 %	62,5 %	62,2 %
Other Manufact.	11,3 %	10,6 %	10,9 %	11,0 %	12,7 %	11,8 %	12,7 %
Other sectors	24,3 %	25,1 %	24,8 %	25,9 %	26,7 %	25,0 %	25,3 %
All employees	22,9 %	23,5 %	23,2 %	24,3 %	25,4 %	23,6 %	24,2 %

Set against the background that fewer persons are working in these two telecomm-industries *but* at the same time the share of persons with higher education is increasing, we seem to have found an important change in the composition of the Dutch telecommunication industry: Put bluntly, during

5 The shaded sectors are those where numbers get too small and unreliable, due to a wide and stochastic variation.

the 90s, low-educated persons has been shed while the high-skilled staff have been kept. This points towards a more skill-intensive and science-based orientation in Dutch telecomm-manufacturing. To the extent that higher skilled employees indicate more advanced innovation processes, the trend we have discovered points toward a more science-based innovation process in this industry.

Training provided during the last four weeks

The so-called knowledge economy is based on the increased role of knowledge as an input in the production process. Although empirical studies vary in how they judge the role of knowledge compared to, for example, investments in physical equipment, knowledge is nevertheless to some degree an important input to innovation and economic change. Innovation is about doing something new, and doing new things involves learning. One might therefore claim that knowledge is inseparable from innovation and economic development.

We have hitherto looked at the role of employees with high levels of formal skills in the Dutch economy. Another important approach to knowledge use and development is the role of upskilling employees. Given the often emphasised rapid change in technology, together with reduced product life cycles and increased R&D efforts, a need for upskilling should be more necessary now than before.

Looking at trends in the general provision for training, we find that such activities are surprisingly stable. Table 13 provides an overview of the share of persons with either no training or training between 1993 and 1999. The share of persons with some training has actually decreased from 77,7 percent to 77,0 percent. Given the change in the business cycle (Table 7 and Table 6) one might have expected greater variation in the provision of training as a consequence of the change in labour market conditions over the period.[6]

Table 13: Provision of training, all employees

Training	1993	1994	1995	1996	1997	1998	1999
No training	77,0 %	78,1 %	79,2 %	79,6 %	79,0 %	78,5 %	77,7 %
Some training	23,0 %	21,9 %	20,8 %	20,4 %	21,0 %	21,5 %	22,3 %

What happens when we break down these figures by educational level (High, Medium, Low)? Do the persons with high formal skills get training more often than those with low formal skills (a specialisation pattern)? Or will we find that those with the lowest formal skills more often participate in training (an equalisation pattern)?

Table 14 provides an overview of how provision of training is distributed by educational groups. The table shows two interesting things. Firstly, that highly educated staff are more rarely than other people provided with training. The share for highly educated people is 19,3 percent in 1999. For medium and low educated persons, the share is approximately 23 percent for both groups. Secondly, we see that the share of people provided with training has increased for the medium educated group, while for the two other the share has decreased. The decrease has been about three percent points for both groups.

6 No answer has been coded as no training

Table 14: Provision of training, all employees by educational groups

	1993	1994	1995	1996	1997	1998	1999
High	22,0 %	20,4 %	22,4 %	20,8 %	20,5 %	16,9 %	19,3 %
Medium	22,4 %	21,4 %	18,6 %	20,0 %	20,5 %	23,3 %	23,5 %
Low	26,1 %	26,0 %	26,6 %	20,9 %	22,3 %	22,5 %	23,0 %

The highly educated seem to have experienced a decline from 1996 onwards. That might reflect the fact that there is less time for training when the business cycle is getting better.

We have also checked whether the occupational classification showed different trends in provision of training (Table 15). Apart from large variations, predominantly between different occupations and to some degree from year to year within the same occupations, there are no dominant trends to be drawn from the material.

Table 15: Provision of training, all employees, four occupational groups

	Armed Forces	Managers	Professionals	Technicians
1993	22,3 %	14,3 %	23,4 %	28,7 %
1994	29,8 %	13,0 %	21,9 %	27,9 %
1995	25,2 %	12,0 %	22,5 %	23,0 %
1996	25,6 %	11,8 %	19,5 %	21,4 %
1997	27,7 %	12,8 %	18,7 %	21,6 %
1998	28,0 %	13,9 %	20,0 %	21,5 %
1999	33,5 %	15,8 %	22,5 %	23,2 %

Looking at the occupational main categories[7] one can see that there are certainly differences in level. Managers clearly get less training than the three other groups. There is a possible rising frequency of training in the Armed Forces. On the other hand, we see that technicians seem to get less training as the business cycle improves. This might relate to the fact that if mobility increases, there are fewer incentives for firms to train their staff, as the risk of losing skilled people is getting higher.

Table 6 shows the provision of training by main occupational groups (1993-1999 average). The two bottom groups are Managers and Plant and Machine operators in contrast to the top groups: Service workers, Elementary occupations and Armed Forces.

7 1 digit level

Table 16: Provision of training, main occupational groups, average 1993-1999

Occupational group	Some training
Armed Forces	27,61 %
Managers	13,40 %
Professionals	21,15 %
Technicians	23,85 %
Clerks	22,47 %
Service workers	28,45 %
Skilled agricultural and fishery workers	19,75 %
Craft and related trades workers	16,04 %
Plant and machine operators and assemblers	12,80 %
Elementary occupations	25,87 %

There are also some varieties in different industries with respect to average provision of training (27). Again we divide the economy in three broad sectors (high tech, other manuf. and other industries), and divide the high-tech sector into the separate industries. There are no clear overall sectoral trends, but we can see marked differences in levels. It comes as no surprise that Telecommunications and Post and Computer services are the top sectors in regard to provision of training.

Table 17: Provision of training by industry, average 1993-1999

Sector	Some training
Oil and Gas	20 %
Chemicals&Pharmaceuticals	19 %
Office/comp equipt	15 %
Radio/tv/comms	17 %
Aerospace&Other Transport	12 %
Telecom and Post	27 %
Computer services	27 %
Research	17 %
Other Manufact.	17 %
Other sectors	21 %

It is possible to break down the results from table 17 by education level. We recall from what has been said above that people with higher formal education had a lower propensity to get training. How does provision of training vary by educational level if we categorise by industry? The general picture is presented in Table 18.

Table 18: Training, sectoral average, 1993 – 1999 (shaded = uncertain figures)

Sector	High	Medium	Low
Oil and Gas	18 %	22 %	18 %
Chemicals&Pharmaceuticals	18 %	22 %	14 %
Office/comp equipt	16 %	18 %	9 %
Radio/tv/comms	16 %	19 %	14 %
Aerospace&Other Transport	14 %	13 %	9 %
Telecom and Post	31 %	28 %	17 %
Computer services	25 %	28 %	31 %
Research	14 %	25 %	12 %
Other Manufact.	17 %	17 %	17 %
Other sectors	20 %	21 %	23 %

In most high-tech industries, staff with medium formal skills are trained more often than people with high or low formal skills. The highest propensity to receive training among medium-skilled persons is found in Telecommunications and Post, Computer services and Research, with respectively 28, 28 and 25 percent of the staff getting trained.

There are two industries where training is more frequent for high-skilled than medium-skilled, and that is in Telecomm and Post, and Aerospace and Other Transport. However, in Computer services, we see that the group with the highest propensity to receive training is the low-skilled, with as much as 31 percent. This is also the single largest share for any group of persons, only equaled by high-skilled Telecomm-workers.

Tentative conclusions with respect to training

- stable differences in levels between groups
- no strong tendencies – but the period is short – we ought to look at more years, if the treatment of training is similar, from early eighties would be better
- Again hitting cell size problems – shows the severe limitations of the LFS for analytical purposes of this nature.

Mobility

From earlier studies we know it is a general result that when unemployment is reduced there is increased mobility. Normally, the cause is a micro chain reaction: New jobs are created – either by established or new firms – and filled both by unemployed and employed people. One also often finds increased mobility due to accumulated need for change. Both firms and persons become less risk-averse as the economic prospects are getting brighter.

Labour mobility is one of the major adaptation mechanisms in a modern market economy. People are moving between occupations inside the same corporation, crossing state borders, people get new jobs in the same enterprise, but in different establishments (workplace). Finally people move in the job hierarchy of the same workplace. From a skill and competence perspective all these processes are important, but when focusing on the demand for skill needed in a certain group of industrial branches the change of workplace is of primary interest. There are many different, but relatively independent and relatively interconnected processes that lead people to change workplace.

Table 19: Mobility in the Dutch economy (shaded = uncertain figures)

Status in year T Status in T-1	Self-employed w/empl.	Self employed	Employee	Family worker	Not employed	Total (start)
Self-employed w/empl.	289 106	700	2 359		6 332	298 497
Self-employed	297	434 406	11 279		89 692	535 674
Employee	2 271	20 825	6 158 572	1 877	311 774	6 495 319
Family worker	371		295	56 334	1 961	58 961
Not employed	5 237	58 348	551 875	3 219	4 614 017	5 232 696
Total (destination)	297 282	514 279	6 724 380	61 430	5 023 776	12 621 147

The easiest way to read such tables is to start with a category, look at Total (start) and show how these people move to various destinations[8]. For example, of the 58.000 family workers, 56.000 were still family workers the year after. The rest of the group became either self-employed, employees or not employed[9].

What actually dominates the picture is the great stability. If you were an employee one year, chances are high you will be so next year too. However, under the surface, there is large movement. For example, of the more than five million "not employed" in year T, 550.000 became employed the next year. But since 311.000 of the employees in T became "not employed" in T+1, there was a net gain of 200.000 employees.

In the labour mobility literature two categories of mobility have emerged: "wide mobility" and "narrow mobility". Wide mobility includes both those coming in from the category "not employed", i.e. recruitment; and those leaving employment (retirement etc). Narrow mobility is the mobility of those who were working last year and are still working this year. This is typical for the highly educated, very competent worker. They are not on the margins of the labour market. They are not greatly affected by short or long spells of unemployment. That is why most of the tables in the following part will discuss the "narrow" mobility rate for the chosen sectors and educational and occupational groups. Narrow mobility is basically the change of work place of the 6,1 million persons that were employees both years. There are also nearly 300.000 self-employed with employees, and 430.000 self-employed, but these two groups stick to their one (wo)man firm in the overwhelming majority of cases.

8 The grey shades indicate that the number is unreliable. Dark grey means totally unreliable, light grey means that in a long time series – or together with other reliable information, it might give some indication of what is happening.

9 Not employed here is *not* to be confused with unemployed. Here it means all kind of destinies, besides being employed (illness, disability, military service, studies, unemployment, retirement , child birth etc.)

Table 20: Broad mobility, inflow,[10] by educational groups, 1993 - 1999

	All	High	Medium	Low
1993	17,7 %	15,5 %	17,1 %	22,5 %
1994	16,4 %	15,3 %	15,8 %	20,0 %
1995	17,2 %	16,3 %	15,9 %	22,9 %
1996	14,3 %	14,3 %	13,2 %	15,9 %
1997	10,8 %	12,7 %	10,3 %	9,9 %
1998	19,5 %	18,8 %	17,7 %	22,9 %
1999	20,3 %	18,7 %	18,7 %	23,8 %

There is a sharp decline in the rate between 1997 and 1998 that is hard to explain by labour market and/or business cycle factors, and it is probably to a large extent due to a change in data collection and/or statistical methods used. A clear indication of this is that the number of non-responses is much greater in 1995 and 1996 increasing almost ten times to 1997[11] (Table 21).

Table 21: Missing observations by year, 1993-1999

Year	Missing observations
1993	1 146
1994	1 424
1995	25 201
1996	89 304
1997	791 376
1998	6 002
1999	9 161

If we look at the missing observations for the three educational groups, the pattern is generally stable, i.e. the share of missing observations of the groups total observations are about the same for all groups each year[12.]

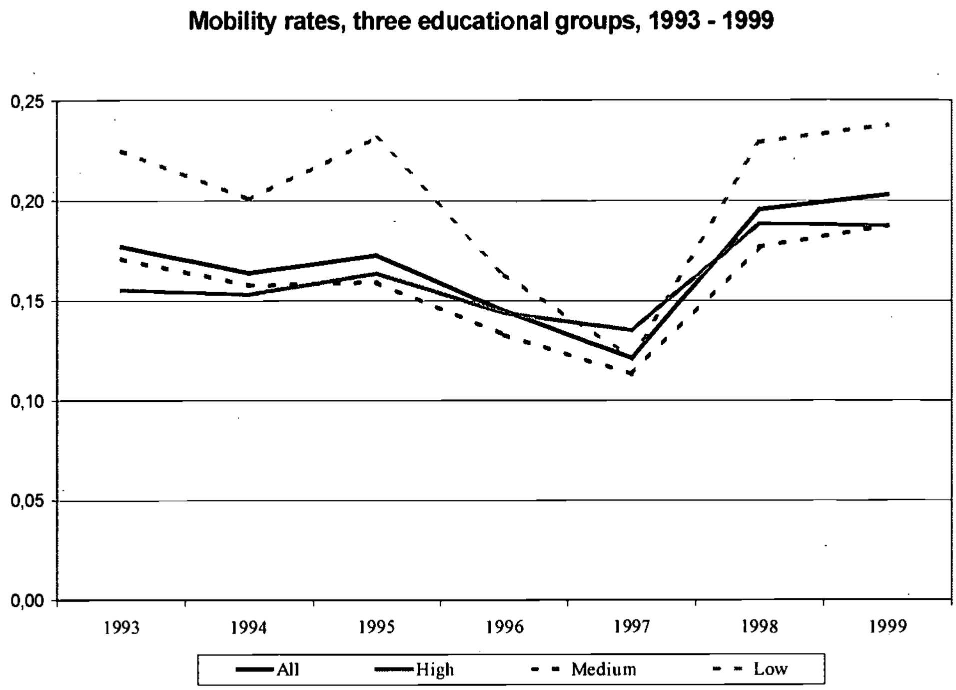
Table 22: Missing observations by educational group, 1993-1999

	High	Medium	Low
1993	0,10	0,15	0,35
1994	0,17	0,12	0,59
1995	0,77	2,97	10,52
1996	7,40	8,50	23,89
1997	63,76	100,56	218,18
1998	0,86	0,57	1,15
1999	1,62	1,35	0,70

10 The inflow rate is the number of people who changed job (workplace) from t-1, to t, divided by the number employed in t.
11 We have asked the Dutch CBS for a possible explanation for this, but have not received any answer at the time of writing.
12 The indicator is just (missing/total)*1000

The table shows that very roughly the share of missing in High and Medium is about the same, High being lower in most years. The share of missing for "Low" is at least twice as high as for the Medium group. But the striking fact is the enormous increase in missing values in 1997.

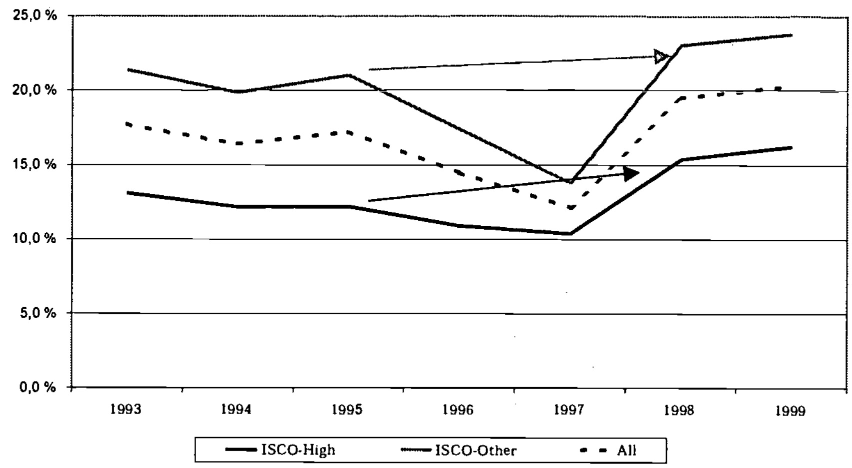
Figure 3: Mobility rates, three educational groups, 1993-1999



The Medium group is the largest and dominant one, being almost as big as the other two groups together. Since the High and Medium group has nearly the same level of mobility they dominate the overall rate. The low rate is significantly higher. This is explained to a large extent by the fact that it is the youth that is less educated, and they are very mobile. Regrettably, the dataset we have for this particular project does not have an age variable, so we cannot isolate the effect of age.

As mentioned above the trends in the mobility rates are hard to interpret due to the enormous increase in missing values in 1996 and especially 1997. The arrow indicates a slight upward trend in mobility. Since mobility in most countries is increasing, we think that this is the most probable development of the mobility rates from 1995 to 1998.

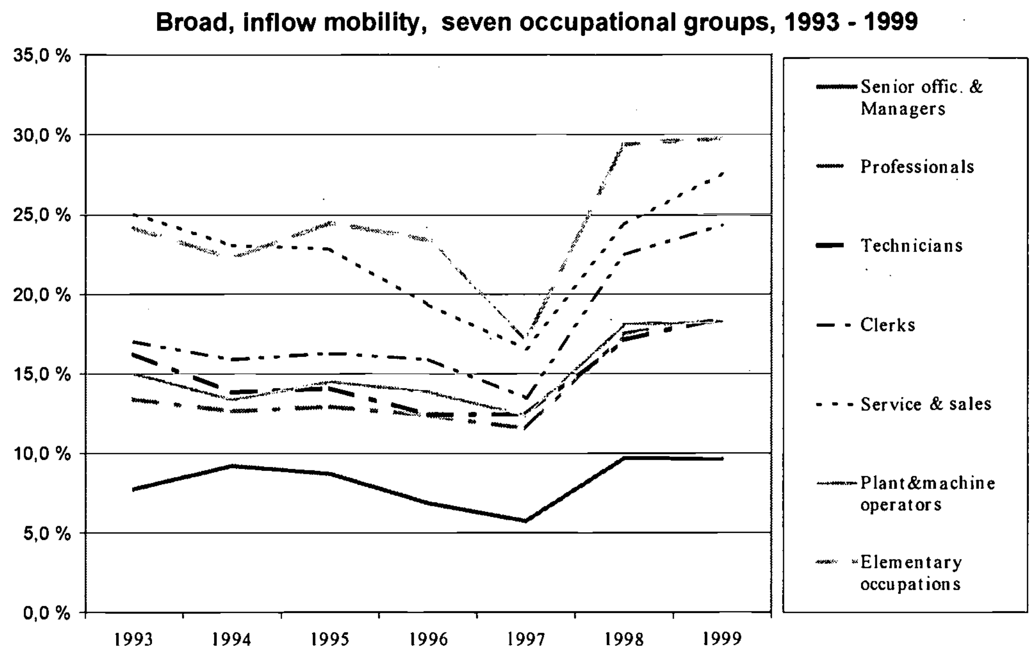
Figure 4: Mobility rates, two occupational groups, 1993-1999



In this graph we have the same "youth" phenomenon, i.e. that people with "high" occupations are older and change job less frequently in relation to those who are younger, and in the other ISCO classes. The mobility rates are not very different from the ones we get using an educational breakdown. That is not surprising since the "high" ISCO classes are to a large extent defined by the educational level. Generally the ISCO classification is a problematic one since it does not classify people according to homogenous dimensions. So even though the "High-ISCO" includes most top leaders, it does not include army generals, because the 1-digit ISCO is partly your position in the power hierarchy, partly your education (implicitly supposing that education gives power) and partly the sector of society you work in, so the Armed forces – generals and privates alike are in ISCO 9 on the one digit level we are working with[13].

13 In addition the pure problems of classification of occupation is qualitatively more difficult than classification of education, which of course is by no means straightforward.

Figure 5:



If we look at a more detailed breakdown of occupational groups, we see that the patterns are more or less similar, but that there are marked differences in levels.

The "Legislators, senior officials and managers" group has significantly lower mobility than, for example "Professionals", "Clerks" or "Technicians". The highest mobility is found in "Elementary occupations", second comes "Service workers and shop and market sales workers". But here we probably have the "youth" effect. But the "youth" effect can probably not explain all the difference between the mobility of top managers and other highly skilled groups. Part of the difference is probably due to the fact that top managers, both in public institutions and private firms have reached their career destination, while a larger share of the other groups are using mobility to increase wages, get more challenging jobs, are more hit by down-sizing etc.

Individual mobility – the problems with sectoral breakdown

When it comes to mobility in/out of economic sectors, we directly stumble into the problem of sample size. If we want to perform a breakdown in the chosen economic sectors and educational levels at the same time, we do not have enough observations to get robust results14. The number of observations in each category is too small. Only in about one third of the categories do we have enough numbers to gives us reliable results.

One good example is the research sector. As we can see from the table below, only in a few years is the number or mobile persons above the *minimum* 4500 limit set by Eurostat, i.e. in 1995, 1996 and 1999. In all the years the number of mobile persons is far from the limit of 10.000 persons for results to be published without warning.

14 More about this in the Appendix

Table 23: The research sector – the problem of sample size

Year	Stable	Mobile	Rate
1993	26315	3591	12,0 %
1994	29309	4328	12,9 %
1995	18758	4876	20,6 %
1996	18521	4719	20,3 %
1997	26574	3500	11,6 %
1998	29686	2444	7,6 %
1999	32257	4612	12,5 %

The table shows a "dip" in the number of employees in 1995 and 1996 that is not straightforward to explain. The mobility rate varies considerably, but in such a small sector (only 30.000 employees) there will be considerable variation, even if we could follow every single employee – as can also be seen from the Norwegian case.

Since the number of mobile persons is not that far from the Eurostat minimum, one might with great caution try to interpret the numbers using other sources of supplementary information. The real problem is that the focus of this study is skills, as measured by educational and occupational codes. But breaking these numbers further down will of course only make things worse.

Table 24: The research sector – by educational groups - the problem of sample size

	Data	High	Medium	Low	All
1993	Same job	16430	8346	1539	26315
	Mobile	2597	994	0	3591
	Rate	13,6 %	10,6 %	0,0 %	12,0 %
1994	Same job	19349	7881	2079	29309
	Mobile	2280	2048	0	4328
	Rate	10,5 %	20,6 %	0,0 %	12,9 %
1995	Same job	11612	6522	624	18758
	Mobile	3466	1148	262	4876
	Rate	23,0 %	15,0 %	29,6 %	20,6 %
1996	Same job	11714	4748	2059	18521
	Mobile	2595	1067	1057	4719
	Rate	18,1 %	18,3 %	33,9 %	20,3 %
1997	Same job	17339	5555	3680	26574
	Mobile	2887	547	66	3500
	Rate	14,3 %	9,0 %	1,8 %	11,6 %
1998	Same job	18914	9502	1270	29686
	Mobile	1158	539	747	2444
	Rate	5,8 %	5,4 %	37,0 %	7,6 %
1999	Same job	19634	11295	1328	32257
	Mobile	3177	1163	272	4612
	Rate	13,9 %	9,3 %	17,0 %	12,5 %

As expected the mobility rate is even more erratic, but we also see numbers that clearly are unrealistic, because there is always mobility from a firm even if it has only 15 employees. The table above shows categories that are supposed to have several thousand employees, and no, or totally marginal mobility (for example the "Low" educated). We know that this is not the case. There is never any mobility when you have one thousand employees. To make things even worse, the rate makes jumps from 0 to 37% in some cases.

Table 25: Overview of the "cell size " problem by sector

	ISCED -high	ISCED - low	ISCO-low	ISCO-high
Sector	Waming	No waming	Warning	No waming
Oil and Gas	Not at all	Not at all	Some	Not at all
Chemicals& Pharmaceuticals	A few	Not at all	Some	Not at all
Office/comp equipt	Not at all	Not at all	Not at all	Not at all
Radio/tv/comms	Not at all	Not at all	Not at all	Not at all
Aerospace&Other Transport	Not at all	Not at all	Not at all	Not at all
Telecom and Post	Yes	Some	Yes	Yes
Computer services	Some	A few	Most	Some
Research	Not at all	Not at all	Not at all	Not at all
Other Manufact.	Yes	Yes	Yes	Yes
Other sectors	Yes	Yes	Yes	Yes

The table shows the sectors, and the possibility to publish results from these sectors by education and occupation. The conclusion is clear, only one of the high-tech industries "Telecom and Post" can be studied in any detail due to the cell size problem. But that does not help very much since we initially wanted to study only the "Telecom" part of this big sector. As pointed out several times already, the LFS was not made for detailed studies like this. Not only was the LFS made at a time when computers where much less powerful that today, but the costs of surveying a large enough sample of the population makes it improbable that we in the foreseeable future will be able to get around this "cell size" problem.

Summary

The Dutch literary review reports on a sharp increase in the demand for jobs from 1995 and onwards. The number of vacancies in the private sector almost tripled from 1995 to 1999, corresponding to a reduction of the unemployment rate from 7% in 1995 to 3,2% four years later. In the public sector the greatest proportion of vacancies was found in the education sector and in local government.

A prospective analysis of the Dutch labour market foresees the demand for university graduates to be higher than for graduates from the system of higher vocational education. The reason is that employers seem to be on a track of upgrading the skill level for their employees, especially in the service sectors.

The tight labour market puts special constraints on recruitment to the soaring ICT sector that recruits candidates with a panoply of skill profiles. Hence, the fact that in 1997 63% of all Dutch ICT employees did not have formal ICT education reflects the strength of the skill substitution effect. In addition, this figure might indicate new recruitment patterns in the ICT sector, now reflecting the need for a broader range of skills. Moreover, statistics on the dispersion of fields of studies over occupations reveal that graduates in humanities are increasingly employed in occupational sectors outside their traditional labour markets (i.e. public administration, education, socio-cultural sectors and arts). These statistics underscore the point about broader recruitment patterns in the ICT sector and perhaps in other labour market segments.

By contrast, graduates in medicine, veterinary science and dentistry predominantly get jobs in their traditional occupational sector, which is the health sector. This phenomenon can partly be explained by the specificity of these professions. They require very specialised skills, to the extent that the substitution effects in this labour market segment are of little importance. Important here is also the question of certificates for professions. The fact that you for example are not allowed to practise as a medical doctor without a licence is a key regulatory factor in the labour market for health care.

Moving on to the analysis of data from the Dutch Labour Force Survey it appears that the increased employment from the mid-90s have not been translated into a growth in the seven high tech sectors defined for this study. To the contrary, the relative high tech employment fell from 7,5% in 1993 to 6,6% in 1999. The only exception is computer services and office and computer equipment. We should bear in mind that similar statistics from Norway and UK confirm the role of high tech sectors as modest contributors to national employment.

It is interesting to notice that the share of low educated employees rose from 17,9% in 1993 to 30,8% in 1999. For the most part this is probably due to the change in the educational code from "old ISCED-76, to "new" ISCED-97, but this also confirms the well-known fact that an economic boom enhances the employment chances for the lower educated, without necessarily making them more employable in a longer time perspective. In the high tech sectors the share of high educated was fairly stable, oscillating between 12,7% and 14,2% over the same period. The telecommunication sector shows one interesting deviation from this rule. Here, it appears that low skill employees have lost their jobs while the higher educated telecom staff remains on the payroll.

The statistics on training provided during the last four weeks show a quite equal distribution among the three categories high, medium and low education level. The only significant change applies for highly educated persons, for whom the provision of training seems to decline when the business cycle improves from 1995 and onwards.

When the same statistics are split down on occupational groups it looks like technicians receive less training. But given the fact that the training for professionals remains quite stable, there is little room for drawing any clear conclusion about decreasing training for high skill groups when the economy is booming.

When splitting training down on sectors it turns out that the medium skilled echelons receive most training, apart from those in telecom&post and aerospace&other transport. Among the seven high tech sectors chemicals&pharmaceuticals is less training intensive than telecom&post and computer services.

Finally, no general conclusion emerges from the Dutch statistics on mobility due to unreliable data.

References

Ekeland, A. (1998) 'Indicators for human resources and mobility', IDEA Paper No.9, STEP Group, Oslo.

OECD (1995) *Canberra Manual*, Paris: OECD.

Nås, Svein Olav, Ander Ekeland, Eric J. Iversen, Mikael Åkerblom, Markku Virtaharju, Christian Svanfeldt, Johnny Ullström, 1998, *Formal competencies in the innovation systems of the Nordic countries: An analysis based on register data*, STEP report 6-98.

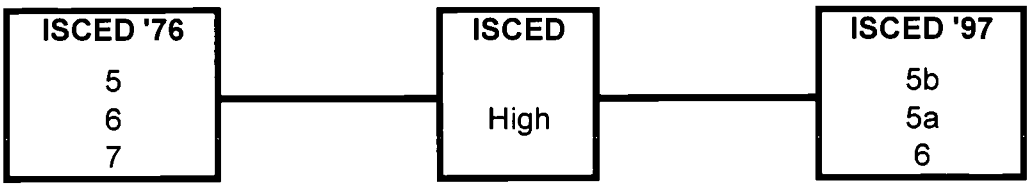
Rosenberg, Mikael, 1998, "An Inventory of National Priorities and availability of data in OECD Countries to Quantify Science and Technology Personnel Mobility Patterns", Room Document No.2, joint NESTI/TIP/GSS workshop, 17. June 1998, OECD.

Stimpson, Alex. (2001) (forthcoming) Preliminary Results from the HRST Mobility analysis, Procedings from OECDs Focus Group on Human Mobility, Camire Luxemburg.

Åkerblom, M. (1999) Mobility of highly qualified manpower, a feasibility study on the possibilities to construct internationally comparable indicators. Report for Camire (Eurostat) and OECD. Statistics Finland, 14th December.

Appendix

Figure i: The relation between ISCED-76 and ISCED-97



Employment and industry

In principle everybody classified as working should have a NACE code, but in reality this is not so easy. A significant share of those being either

1 Self-employed with employees

2 Self-employed without employees

3 Employee

4 Family worker

did not have a NACE code as can be seen from the following table:

Table i: Percentage of missing industrial classification (NACE)

Year	No NACE in 1000	All employees in 1000	Percentage of all empl.	Percentage of Highly educ.
1993	152	6631	2,3 %	1,8 %
1994	143	6698	2,1 %	1,6 %
1995	206	6772	3,0 %	2,0 %
1996	398	6922	5,7 %	3,5 %
1997	420	7175	5,8 %	3,9 %
1998	349	7394	4,7 %	3,0 %
1999	394	7597	5,2 %	3,6 %

As expected there are less highly educated persons without industrial classification, but still 3,6% is too high a share[15]. We get very similar results if we look at the occupational groups. The "Manager, Professional, Technician" = ISCO groups 1, 2 and 3 have the same level of persons without an industrial classification.

The high-tech sector: Initial industries for the study

15 In comparison with the Norwegian register data, of all the persons classified as working less than 0,003% did not have an industrial code.

In this study we wanted to focus the following sectors:

Table ii: Industrial sectors - preferred break down

NACE	3-digit	Title
110		extraction of crude petroleum and natural gas; related services, excluding surveying
244	x	manufacture of pharmaceuticals, medicinal chemicals and botanical products
300		manufacture of office machinery and computers
320		manufacture of radio, television and communication equipment and apparatus
353	x	manufacture of aircraft and spacecraft
642	x	Telecommunications
720		computers and related activities
730		research and development

Problems with few observations – "cell size" problems

The Community Labour Force Survey, like all surveys, is based upon a sample from 0,5% - 1,5% of the population. It goes without saying that the number of observations of a special combination of characteristics like "male, researcher, Ph.D." will be represented with very few observations in the sample. That means that even though the sample is a randomly drawn representative sample there will be very few persons in a particular group and you do not get very accurate estimates of the total number. This is often referred to as the "cell size" problem.

Based upon the sample size and design in the various Member States, Eurostat implements basic guidelines intended to avoid publication of figures, which are statistically unreliable. These guidelines consists of two limits, A and B for publishing numbers regarding subgroups. For example the number of highly educated persons in "Oil and Gas" must be greater than A to be published at all, and published only with a warning if greater than A, but less than B. In the case of the Netherlands the limits are A = 4.500, and B = 10.000.

In the Dutch data, there are three sectors that are in the "danger zone" of having numbers in danger of being to small. That is "Oil and Gas", and "Office machinery and computers" and "Aerospace and other transport". The first two are just around 10.000 before dividing into subgroups. "Aer&Transp" have three times that, but have very few highly educated, so looking at this subgroup of the employees in this group is not possible, due to too few observations.

There are several possible solutions to this problem; the most obvious would be to combine sectors with few observations with another sector. One possibility would be to combine "Manufacture of office machinery" with "Computer Services", arguing that the difference between them is not that important for our purposes. One argument might be that office machinery has changed from being a machine into being a dedicated computer like for example a desktop calculator. For a study of skill and skill mismatches, the important question is whether the two sectors overlap each other to a reasonable degree when it comes to skills. One indicator would be the share of highly educated, and that number is clearly different.

There is no obvious way this sector cannot be combined with one of the other high-tech sectors focused in this analysis so the only solution would be to put it into "Other manufacturing". That is a pity, because we then lose the possibility to have a comparison with Norway – where the oil sector is very "engineer intensive", more so than many of the other high-tech sectors. From the meagre information we have it emerges that this sector seems to be a fairly stable one in the Netherlands, both in size and educational and occupational composition.

This merging of sectors is not a very attractive solution. One would get reliable estimates, but of something other than we wanted to study. In the case of the 3-digit sectors we had no choice, but in this case we have chosen to keep the problematic sectors – and shading the numbers to indicate that these numbers are not estimates, but have a more illustrative character, and that no policy conclusions whatsoever should be based upon them.

NOTICE

Reproduction Basis