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INDICATORS FOR HUMAN RESOURCES AND MOBILITY

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ABSTRACT

The paper is a discussion of present and future indicator possibilities with respect to the analysis of human resources and mobility. It takes as its starting point the OECD "Manual on Measurement of Human Resources Devoted to Science and Technology" – the so-called *Canberra Manual* (CM). It discusses the international classifications used in the CM to define human resources in science and technology (HRST), the educational standard, ISCED, and the occupational standard, ISCO. There is room for improvement in both standards to cope with recent developments. The educational standard ought to be more fine-grained at the top levels as the general level of education rises, and as more and more policy questions relate to the very highly educated part of the workforce. The occupational standard is seen as more problematic, mixing various competence dimensions at the same digit level leading to lower reliability of occupational data. The paper goes into some important problems regarding buisiness demography in relation to studies of flows of HRST. It argues that the stability of the workforce is an useful indicator of the identity of the firm.

Throughout the paper it is argued that the future of studies of HRST lies in the use of register data. A few countries in OECD have such data as a part of their statistical system, and in many countries registers exist, or will be constructed, that contain enough information to establish register data useful for statistical and analytical purposes.

To illustrate the use of register data some results from a comparative project involving the Nordic countries are presented. The general finding in this data is that there is 20% gross turnover in the labour force, somewhat lower in Norway than in Finland and Sweden, probably due to lower unemployment in Norway in 1995-96. Generally this means that the labour markets are rather more flexible in the Nordic countries than might be expected, and that mobility is high. If these results are generalisable to Europe – which is surely a reasonable assumption – then the whole idea of 'Eurosclerosis' can be discarded. This is therefore an important area of future indicator development.

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INTRODUCTION

There is on the one hand a general agreement that human resources in various ways are important for science, technology and innovation policies. On the other hand, there are still very few generally acknowledged indicators. This is a consequence of the scarcity of statistical work done in this area. There are several reasons for this lack of statistical work, but the main reason was - and still is - the lack of adequate data. The rapid spread of digital information technology will change this situation in the coming years. The development of large public registers in some countries has made it economically and practically feasible to study human resources in society in radically new ways.

In the late eighties and the nineties the need for some measurement of HRST has been stressed in a number of important documents[1]. Programmes like "Human capital and mobility" organised by the European commission in 1992, is a clear indication of increased attention on human resource issues. As a consequence of this need for a measurement of HRST, the OECD Secretariat together with the European Commission and the Group of National Experts on S&T indicators, initiated work on a statistical framework that resulted in the so-called Canberra Manual. It was published by the OECD in 1995. The full title is "Manual on the Measurement of Human Resources Devoted to Science and Technology". The Canberra manual states in the introduction:

> "Highly skilled human resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being. While the number and distribution of scientists and engineers were recognised as important indicators of a nation's S&T effort when the first S&T indicators were being designed in the early 1960s, countries and international organisations usually saw a need for internationally comparable data on human resources only in the context of

short-term policy issues, for example, the "brain drain" debate and the "ageing" of the S&T workforce.

In consequence, very few countries established and systematically maintained coherent systems for the monitoring of stocks and flows of scientific, technical and engineering personnel deemed necessary for longer-term analysis or the examination of a wider range of issues. Hence, despite intermittent efforts in the 1980s, the methodology, collection and analysis of quantitative information on human resources devoted to S&T (HRST) at the OECD was confirmed to personnel engaged in R&D only."

The key to measuring HRST – and other kinds of human resources - is the connection between the employee and the workplace/employer. There is a surprisingly wide range of questions resulting from this connection, relating to:

- the stocks and flows of human resources between firms, sectors, regions
- establishment of new firms, spin-offs
- after high-tech bankruptcies – what happens to the core personnel?
- the use of education
- returns to education
- traditional labour market issues.

In addition we get a "dual" approach to these issues. We can characterise the individuals by the firms they work in and the firms by the characteristics of the workers. The basic reason why the number of possible questions to be studied is so large is of course that work is a central feature of our lives and a very important sphere – in many respects *the* central sphere - of society. This also means that the data collection cost can be justified in terms of its possible uses for administrative and scientific studies – not only for HRST studies.

[1] See among others: "Background report concluding the Technology/Economy Programme (TEP)", especially chapter 6 "The Supply of Scientist and Engineers: Current Trends and Concerns" and chapter 7 "Human Resources in the Production System and New Technologies".

In this paper we are going to focus on questions related to human resources from an innovation perspective. We will also occasionally point towards other connected research topics that can be studied with the same kind of data. The structure of the paper is as follows:

1. A short overview of data sources.

2. The standards and methods used to measure human resources in the Canberra Manual.

3. Business demography.

4. Possible indicators discussed in the light of experiences from recent research projects.

5. Recommendations for further work on human resource indicators.

Data sources are a central concern of this paper. Data is of vital importance for HRST to be measured with the level of quality required for policy development. In particular, we will discuss the use of public registers: these are a relatively new data source with an undeveloped potential.

THE EXISTING DATA SOURCES

In 1993 OECD and Eurostat made a joint inventory on international and national sources of information that are relevant for the HRST. This report, with the long title, “Availability of Methodology and Data on Human Resources in Science and Technology in the OCED and the EU Member States” is summarised in the Canberra Manual (CM), chapter 7. A data source is considered “international” if it contains comparable numbers for a group of states - and as the CM dryly comments - “Very few data sets are in fact collected at the international level”. Recently OECD initated a inventory that updates the 1993 survey,

adding a preliminary list of special studies[2]. The has been no radicalchange in the availability of data in this period. The types of data sources listed are:

- quarterly and annual labour force statistics
- industrial structure statistics; employment, wages, hours of work
- population statistics: education and occupation
- R&D statistics: personnel by sectors

The data collection methods vary, but postal questionnaires are the main method.

LABOUR FORCE SURVEY

The most important source is the labour force data, even in the Nordic countries where public register data is available. In most countries the labour force data is based on a large sample[3] which is interviewed in a systematic and professional way over a three-year period. Since 1992 - and even more so since 1996 – there has been an agreed terminology and methodology for labour force surveys. The samples were enlarged, educational variables introduced and made comparable. This opens up for combinations of cross-sectional and longitudinal studies to a certain extent, but this possibility has not been used as far as we know. Only stock data has been generated.

REGULAR SURVEYS

Other data are based on surveys with coverage and cycles varying from full censuses, like the decadic population census, 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 - leaving out very small firms (with less than five employees) altogether.

[2] Mikale Rosengren, Statistics Sweden: ”An Inventory of National Priorities and Availability of Data in OECD Countriesl to Quantify Science and Technology Personell Mobility Patterns”, paper presented at the joint NESTI/TIP/GSS workshop 17th June 1998, Room document No 2.

[3] The Norwegian sample is 23000 of about 3.2 million persons between 16 – 70 years.

REGISTER DATA

The last source is register data, mainly found in the Nordic countries. The CM writes that these countries "have a tradition of centrally co-ordinated registration of characteristics of individuals". But this is not quite 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.

Across the Nordic countries, the various administrative systems in quite different parts of public administration have made use of this unique identification number. The characteristics selected for the register, 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 a lot of contradictory information in the various systems. Persons are registered as employed and seeking employment at the same time, they have two full jobs at the same time etc. 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. That is of course a necessary task if one is going to reap all the potential benefits of the unique person identification number.

Although there is no centrally co-ordinated registration, the unique person number makes the use of all register data possible. The dataset used for research purposes is actually a merging[4] 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.

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

What is lacking is the general understanding of the potential benefits of a database - and the corresponding political, legal and administrative framework.[5] There are of course also many private institutions like banks and insurance companies that have large databases and make use of the unique official identification number. This means that the borders of the virtual distributed database are not restricted to public registers alone. Already - at least in Norway - the authorities are to a large extent dependent on the databases of banks and financial institutions for tax purposes. In addition, there are registers that have enough information (date of birth, name, address, workplace, car registration number etc.) to make the merging with other data quite feasible for statistical purposes. Such a linking/merging exercise is actually the first step towards using existing public and private registers to build up an official person identification system.

BUILDING UP THE AGGREGATED STATISTICS FROM MICRO DATA

It is in principle no problem to build up consistently almost all labour force statistics, industrial statistics and national accounts data by using register data. This is done by using all available register data on persons, all available register data on firms – and then using the connection between individuals and workplaces. There is work going on in the statistical agencies to harmonise the numbers emerging from the registers with the other statistical sources. This is an important method for reciprocal validation of the data collected by different methods.

As digital information systems are both broadening and deepening their coverage of social and economic events, register data will replace the traditional survey as a means of collecting sales, number of employees etc. The purpose of the traditional survey will be the collection of data about the motivations underlying observed behaviour. That the administrative registers will never tell us.

[5] This means that the line between use and misuse is not clearly drawn, which in its turn leads to a situation where private - locally unique identification codes pops. One example being the plethora of various cards where the main benefit for the card issuer is the information gathered about consumption patterns related to personal characteristics.

PAST AND PRESENT MOBILITY PROGRAMMES

The hypothesis that one has to go to new locations and get first hand knowledge is of course an old one. For centuries craftsmen, artists and academics of all sorts have visited other places and milieus to study and learn. Then as now the mobile person got new knowledge, both formal and tacit. Mobility was and still is of vital importance for the building of networks. In academia substantial resources are allocated to sabbaticals, inviting guest researchers and lecturers etc. Generally speaking, this tradition does not include research and development institutions outside of academia, either the research institutes or the research labs.

What is new – or at least given more emphasis - in research policy formulation in the last twenty or thirty years is the need to encourage interaction between the universities, the applied research institutes and firms. To achieve this one has create institutions like science/research parks, establish adjunct posts at universities, and develop different kinds of personnel mobility schemes. These mobility schemes offer incentives for academics and researchers to work in other institutions and firms - for a shorter or longer period – not excluding the possibility of a job shift. Besides the national programmes, there are international programmes like the ”Training and mobility of researchers” which was part of the Fourth Framework programme of the European Commission, and which will be strengthened in the coming Fifth Framework program.

THE CANBERRA MANUAL

The starting point for discussing the mobility of researchers is of course the Canberra Manual, which - published in 1995 - is the newest of the “Frascati” family of innovation related manuals. The manual itself is an indicator of the growing importance of HRST in policy formulation. While it outlines in brief the various policy areas where HRST is important, the main purpose of the manual is to discuss the definition of HRST and the classifications and standards to be used to make the definitions operational. There is also a short overview of existing databases: however, the manual does not explicitly discuss data

collecting-, reliability and validation issues. But as we shall see the classifications and standards used reflect the data available.

THE POLICY ISSUES

The policy issues are of course the motivation for the definition of concepts and the information collected. The Canberra Manual formulates its own purpose in this way:

> "The combination of science and technology (S&T) and human resources (H&R) is seen as a key ingredient of competitiveness and economic development and also as a means of safeguarding and enhancing our environment over the coming decades. New technologies are being developed and applied, very quickly in many cases. An increasingly skilled and effective workforce will be required if countries are to negotiate the rapid change and new challenges that are emerging in S&T."

The policy issues fall into various categories:

- General demographic issues - ageing, demographic downturn
- Structural changes and their repercussion on the labour market - e.g., decline of defence industries may lead to a surplus of specialists with what were once scarce S&T skills
- The internationalisation of the labour marked for HRST.
- Brain drain, brain gain in different contexts, international, regional, sectoral.
- Issues relating to education and training, like planning supply, the actual use of acquired education and training.

There are many other possible research areas not mentioned directly in the CM. Here are some examples:

- The interaction between industry and the public research system
- Interfirm flows of highly skilled human ressources
- The contribution fof the national educational system to industry
- Gender related mobility
- Job creation and destruction in a macro economic employment perspective
- Job creation as entrepreneurship, like spin-offs from firms and academic institutions

- What happens to HSRT when hi-tech, high-risk firms are closed down or taken over?
- The HRST-flows between public sector and private sector, between growing and declining sectors
- Studying the mobility patterns of f.i. IT-specialists, and other narrowly defined educational/occupational groups.

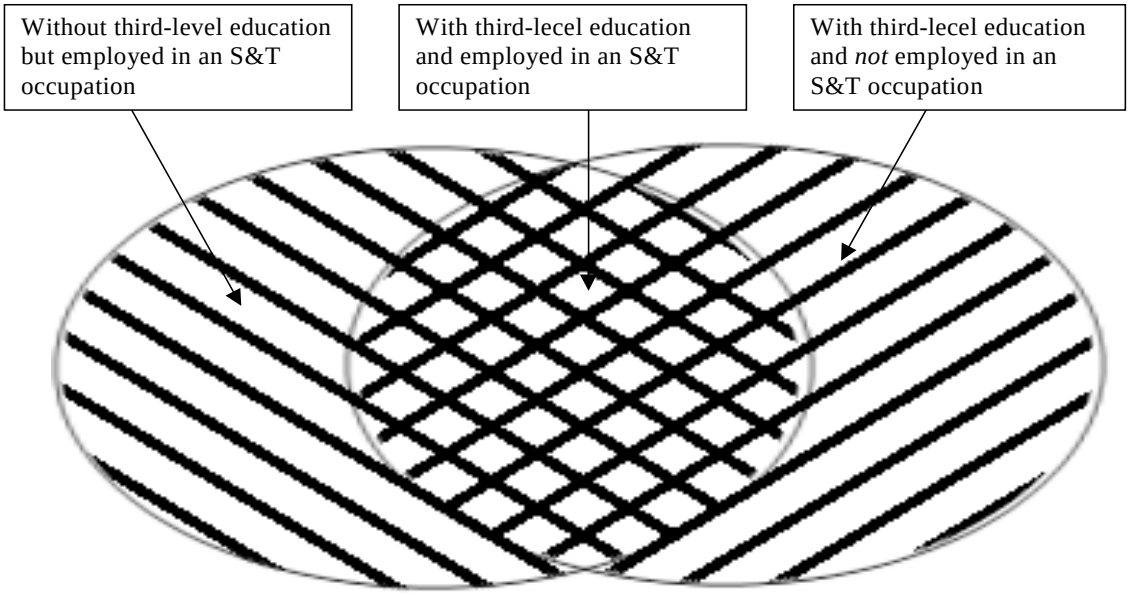
Although many of the items listed above are long-standing policy concerns[6], the limited data has made it difficult to really answer these questions.

THE POPULATION

The population of HRST is defined using two established classifications: the International Standard Classification of Education /ISCED/ and the International Standard Classification of Occupations /ISCO/. The HRST encompasses those who either have a formal education in the field of HRST or have a job where such an education is normally needed. The defined territory is meant to delimit the group of persons that are central for the development and diffusion of technology in a NIS-perspective. The manual wants to show both the potential resources - being qualified but not working, or working in occupations where their education is not relevant - and the actual resources, i.e. those working and using their education and experience.

Figure 1 The definition of HRST by means of occupation and education

[6] Rosengren 1998, asked national experts on S&T indicators to prioritize a limited set of research topics, but like Rosengren we think one should be very aware of a ranking based on the opinion of such experts – mostly one from each country.



There are of course a lot of the HRST persons who are doing more routine work and others more directly involved in innovation and diffusion. As we shall see later on in the discussion of the Nordic Comparative Project[7], new questions are raised when the concepts of the Canberra Manual are brought into action. This comes as no surprise. The manual explicitly says that the definitions worked out so far need to be tested by being utilised in various research and policy contexts.

ISCED AND THE NATIONAL EDUCATIONAL STANDARDS

The standard has two components which indicate both the level of education attained and the field of study. The problems arise when the level indicator applies not just to the actual years of study, but the level reached. This is problematic because the degrees granted in various countries do not directly correspond to the ISCED levels. There are two major problems for HRST policies. The definition of level 5, education based on 12 years of previous education without attaining a university degree, is a very heterogeneous group and difficult to classify. It includes practical, vocational training with very little theoretical content and the first two years at university. Two years that might bring the student quite a bit into advanced mathematics or computer science. At the top end of the scale, the ISCED level 7 includes those with a higher university degree but does not distinguish between those with a specialised research education, e.g. PhDs., which are very often of special

[7] This project was a part of the OECD "National Innovation System" program.

interest, both from a stock or flow perspective. Again we have the problem of a group being too heterogeneous to be of much analytical value.

These differences makes comparative analyses difficult even in Nordic countries. The Finnish and Swedish degree structure is more like the Master-PhD system. Denmark, and especially Norway, have less PhDs, but on the other hand, they have a greater number of persons with research experience as a part of their highest university degree. For many purposes the current ISCED levels are not fine-tuned enough and national standards will be used in an ad hoc manner. The growing importance of formalised research education outside academia points in the direction of a more differentiated scale for education at the highest levels. Basically, it is possible today to record the full time equivalents spent on education in various fields for each person in a much more precise manner than the current ISCED standard allows. The pragmatic solution to this problem with ISCED level is often to read level 6 – three or more years of university level education - as the definition of "highly educated".

The "problem" of mixed courses like humanities and computing is increasing, but again this problem would be of considerably less importance if one used a more detailed, cumulative method when measuring education. This is clearly true because in many instances it is possible to give a rough estimate of the amount of time spent respectively on the various components – linguistics and computing for example.

Although it could certainly be improved, by being more detailed, the ISCED classification, built on formal and in most cases national standards is a rather reliable indicator of educational level and field of study.

The problem with only using formal education as an indicator is, of course, first of all that it does not tell us directly what people do when they work: we know that a number of people do not have occupations directly related to their education. Secondly - there are a lot of people who have acquired their skills by working. To delimit that group the Canberra Manual uses occupation statistics.

THE PROBLEMS OF OCCUPATION STATISTICS

The classification of occupations is much more difficult than educational classification due to the greater dimensionality of occupation, and the varying prestige attached to different occupations in different cultures. The dimensions of “occupation” are, at the very least:

- the structure of decision power in the workplace
- the type of work, routinized, creative
- the field of work can be classified according to materials used, techniques, markets served, education/certification required
- institutional setting: public, private etc
- social status of the occupation

The best way to describe such a multi-dimensional area is to have a combined index with one ore more numbers expressing the ordinal scale in each dimension. The ISCED typically has a first digit for level and a second digit for field of study. For historical reasons the ISCO standard has not been so organised. That leads to a situation where different dimensions are mixed on the same digit level. Our impression is that one major source of the problems with the ISCO classification is this mixing of dimensions. The first digit groups are defined both in terms of the hierarchy in the workplace (Mangers versus subordinates), ISCED level codes (higly educated, skilled and unskilled) and the institutional context - the armed forces being a one-digit group.

But even if the ISCO had been organised as a series of numbers in rather homogenous dimensions, there are still fundamental problems in the way data is collected since very often the type of occupation is self-declared. This will then require a further judgement by those responsible for transforming the information to the ISCO-codes. Experience shows that there is no consensus for interpreting this kind information. Various recoding exercises, i.e letting two different groups transform the same set of job descriptions have been carried out to check both individual coders and different types of coding. These exercises have shown that there are differences between persons with identical training as well as between trained coders and "experts". There is an 80-90 percent agreement at the

first digit level, going down to 70-85 on the second digit level[8]. There is no a priori reason to believe that the "experts" coding is more consistent than other groups of coders. Some even claim that there is more disagreement about coding among "experts" than trained coders. How much such problems would be corrected by having homogenous dimensions on the various digit levels is hard to tell, but it would at least have made the classification easier to use.

The earlier versions of ISCO from 1953 and 1968 were not used by many countries, but the latest standard ISCO-88 seems to be more widely employed. Many countries use their own principles for a national standard which they then transform into an ISCO-88 code when needed for international comparisons. This transformation can often only be done on a rather aggregated, i.e. 2-digit level.

ELECTRONIC CURRICULUM VITAE AND OTHER SOURCES OF INFORMATION

The use of CVs might be considered another potential source of information about what people do at work because they contain more detailed information on the exact content of a person's work such as scientific field, concrete projects worked on, type of experience acquired etc. They might be especially useful in the study of small groups, for example sresearchers in research institutes. There already exist firms that via the Internet collect CV information and offer them to other firms looking for people with certain combinations of education and experience. It is not unlikely that CV-like information will be a natural part of everyone's homepage in the future. To tap the potential of such sources of information - standardisation is essential. Only standardisation allows automated collection and treatment that makes collection of such information economically feasible. Such a standard could be very helpfull in making the labour markeds by invcreasing the amount of easily obtainable information about job-seekers.

[8] See Peter Elias, "Occupational classification (ISCO-88): Concepts, method, reliability, validity and cross-national comparability", Labour marked and social policy – Occasional papers No 20, OECD, avialable on OLIS

Another source of information that might be useful when studying those HRST - and other highly educated persons - is to use a bibliometric approach. More and more reports, documents, working papers etc. are found on the homepages of firms and other institutions with the authors name(s) which. Like the CV, such information might be a valuable supplement to the ISCO code, even be a way of validating the ISCO code.

STOCKS AND FLOWS

The stocks of HRST are an indicator to be used in many analytical contexts. One example is that in many growth models use - as an indicator the educational level - the proportion of the workforce with education on ISCED level 6. Often the degree of aggregation is too high because the shares for engineers and natural scientists might be significantly different in Asian Tiger countries and Latin-American countries even if the share of ISCED level 6 persons is roughly the same.

The development of databases with accurate dates for job shifts also raises the question of how the traditional stock data is compiled, how representative a snapshot of the workforce can really be when the labour market is constantly changing. One example of this is the problems of harmonising the labour force surveys with register data. There are several problems. One of the is the very broad definition of being employed that the labour force survey[9] uses makes it difficult to harmonise labour force surveys with the register data due to the fact that register managers do not like a very frequent changes. That increases the costs maintaning the register, both physically and not at least the quality of the register drastically. That is why the registers (tax, social security etc.) generally ignore very short, temporary jobs of a couple of hours or days and in practice use a definition closer to the everyday meaning of "having a job". The Norwegian registers "underestimate" the number of persons working by 10% compared to the labour force survey. Or the labour force survey “overestimate” the number of people working. But this only reflects the fact that the registers have been made to administer people in stable full time occupations, while the labour force survey has been directed towards studying the movements in and out of the workforce, in and out of employment.

[9] The labour force surveys mostly define being employed as having worked at least one hour of paid labour in the previous week

The major challenge in interpreting stock data - apart from the ISCED and ISCO classification problems - stems from the different sectoral structures in different countries. One classic example is that Norway is under the average level of R&D due to the fact that the most important sectors in employment terms are not R&D intensive. In R&D intensive sectors Norway is above the average level. In the same manner the size of the various sectors in a given economy will influence the aggregate numbers of HRST. A large public sector means usually a great number of highly educated people. But the size of sub-sectors of the public sector might be very different as for example if we compare the armed forces to the health system. The same goes for industrial sectors, most of them have about 5% share of engineers, but oilextraction has more than 20%.

FLOWS

The main measure of flows is of course mobility rates. Such rates can be defined in many ways, depending on:

- the population – static or dynamic
- the time scale used
- the basic units used

MODELS WITH RECRUITMENT

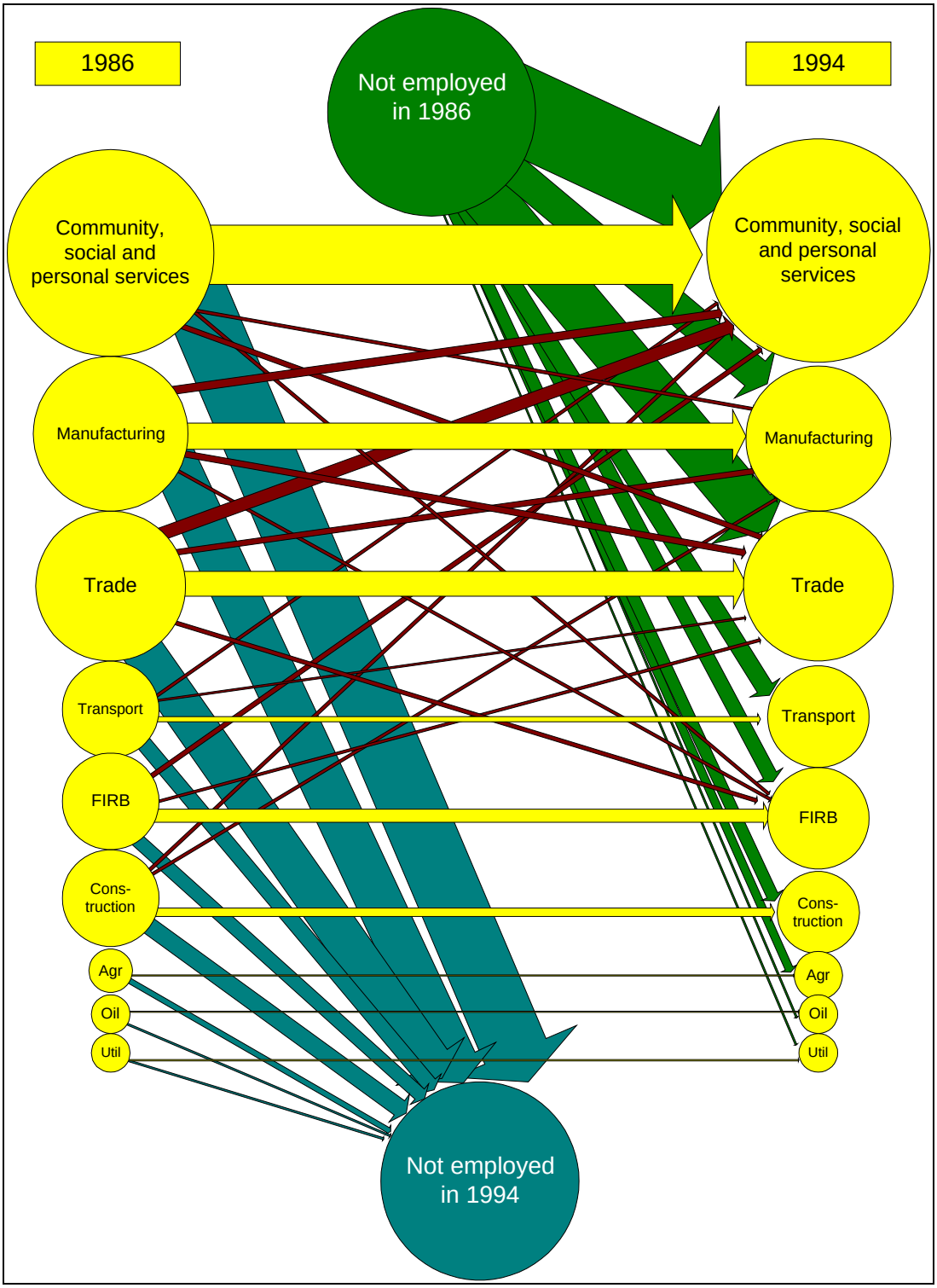
With regard to population, a basic choice must be made about whether the model has a given population or if there are new individuals entering the population during the time period studied. A given population is easier to study because whatever the actual distribution of the population at time T over the different states[10], the percentages of the population in the different states have a straightforward interpretation. But when recruitment is introduced the denominator changes between the time intervals, so the resulting distribution is the combined result of the movements of the 'original' population and of the persons recruited. If the time scale is just a few years then the problem is often solved by actually studying two models with a given population, the original and the

[10] With states we mean being employed, unemployed, employed in sector X, dead, inactive. What is considered to be a state is of course dependent on the problem being studied

"recruits" (another given population) and then analysing the resulting distribution. But if the time scale is as much as a decade this becomes inconvenient and one has to use other techniques for analysis and presentation of results. Here we shall not go into the details of the "changing population problem" and the interpretative and statistical properties of the various techniques. One example of such problems is: should the various rates be measured against the number of employees in year T or T+1, or the average between them? There has been an extensive discussion about this “trivial” problem in the "job creation, job destruction" literature[11].

[11] See f.ex Kjell G. Salvanes, ”Employment policies at the plant level: Job and worker flows for heterogenous labour in Norway”, paper presented at the 20th conference for economic researchers, for references and an example use of register data for purposes not related to HRST.

Figure 2 Gross mobility in Norway 1986 – 1994. One digit ISIC sectors



The size of the circles and arrows indicates the size of respectivly the sector in the economy and the size of the mobility. The horisontal arrows are people changing employer but staying in the same sector, the other arrows are flows to other sectors and in and out of the workforce. Dividing the economy into more sectors, looking at a sequence of years gives at even more complicated picture. A major analytical challenge is to develop ways to summarise these complicated patterns.

TIME SCALE - ANNUAL DATA OR EVENT HISTORY ?

Very often there is no choice – if we have only the annual data - although the events to be studied happen at discrete moments and are actually recorded with high precision, i.e. in days, weeks or months. The annual data then might become an obstacle to studying the causal connections between events. We often cannot tell from the data if there was a spell of unemployment between jobs, because we just can only ascertain occupational status at a certain moment. We cannot tell if a person got that job because he passed that exam, or if he took the exam as part of the training in the new job. Did he get a new job and then move, or did he move and then get a new job?. The last example also highlights the problem when "cause" and "effect" are dependent on each other. The person might both want a new job and a new place to live and there is no cause and effect relationship between moving and getting a new job.

But apart from such simultaneous cases, having the real dates of events would enable us to study the causal relationships in many cases. Again we should note that the use of register data and large databases open up new possibilities because very often the dates of job shifts, exams etc. are recorded with sufficient precision. The researcher often gets/asks for aggregated annual data. It will take some time before the new possibilities of storing and processing data will change this. In the meantime, EHD (Event History Data) becomes the rule. Event history data means that one can construct a continuos history of a person in all the dimensions we want to study - working life, civil status, criminal record, health etc. Given a detailed recording of various events, the researcher can construct models with more or less complex state-spaces by defining states as combinations of the atomic events recorded in the registers.

BASIC UNITS - BUSINESS DEMOGRAPHY

The problems of defining the basic units when doing business surveys are greater then most economists believe. In the statistical agencies around the workd increased efforts are made to solve these problems both on a conceptual and on an operational level, including the problems of data collection. On the conceptual level there is no clear answer in many cases to the question: Is this the same firm X or should it be considered as a new firm Y? This is because there is no single characteristic that is generally accepted as the essence of the firm – and firms change theire characteristics all the time. The firm is might be described by several characteristics:

- geographical location
- ownership - both legal aspect and actual control
- employees
- internal structure (single/multi product firm, holding company etc.)
- what it produces and how (industrial classification)

We shall not go into how the firm is treated in various schools of economic thought[12], but look at the problem from a more operational point of view, i.e. the actual practice of national statistical agencies. The main conclusion is that there is no agreed or commonly used set of rules for defining the birth and death of a firm. That is. the rules for issuing new identification numbers and deleting old ones. In most countries there is no central, public register of business units.[13] In the following we shall limit the discussion to the Nordic countries having such registers, taking most concrete examples from the Norwegian experience with which we are most familiar.

[12] The fact is that most schools of economic thought generally takes the firm as a given, unproblematic entity.

[13] A good overview is given in Brenda G. Cox et al, (eds), Business Survey Methods, Wily Series in probability and mathematical statistics, 1995

In 1995 Norway got a new common business register used by all public authorities, "Enhetsregisteret", the register of legal entities. The Norwegian register is a recent construction dating from the early nineties. The antecedents were various public registers, the most important being the business register of Statistics Norway, social security and the tax registers. These different registers had different practices when it came to issuing, deleting or changing an identification number. There was done a large non-trivial job merging these registers. Since there is now one common register, "The Unit Register," it as become more imperative to agree on a set of rules for maintaining the register. This entails a more conscious attitude towards the problems of business demography. The organisation of the first "Round table on Business Surveys" in 1986 is a clear indication of the growing awareness of the importance of high quality business registers for economic statistics. It also reflects the new possibilities offered by information technology.[14]

BIRTH AND DEATH OF THE FIRM

In many cases the birth of a firm is straightforward. It is a so-called "greenfield birth": A person not previously owning a firm sets up one in a specific location and hires people to work there producing a rather easily classified product. Some deaths are also easy to identify. The production stops, the workers are laid off, and the capital equipment is scrapped. But the exceptions to this rule are far too numerous and interesting to be ignored. There are spin-offs, mergers, take-overs, break-ups, changes in activity (radically new products, going from own production to sales), changes in ownership, change in geographical location. In other words, one can have changes in all dimensions over time, and of course simultaneous changes in two or more dimensions. The number of different combinations of events can get very high. In addition, a lot of the changes are not discrete events, but rather of a more continuos type (changes in ownership in a shareholding company, minor changes in geographical location, change in product mix). This poses the

[14] At that time one was generally very optimistic regarding data collection from EDI, Electronic Data Interchange, but that process has been much slower than expected. In the meantime the Internet has appeared as the medium for electronic commerce and consequently for data collection. While both EDI and the Internet have great potential and are more or less suited for business and/or data collection, one should realise that there are many obstacles to be overcome before such technologies takes off, even if it isn't clear already that they will be dominant in the (near) future.

question of what characteristic, or combination of characteristics constitute the essence of the firm. To take one extreme example: An entrepreneur trying to establish firms in different locations to do different things before finally succeeding. Is this then just one firm (the founding firm) changing location, and nature of activity and employees, or is this a row of births/deaths?

It is interesting to note that “common sense” does not seem to have any such problems with defining a firm. One will hear people say things like:

- “They have changed owners but it is basically the same firm”
- “They have changed owners and moved, but is the same firm”.
- “They have previously produced X, but quit doing that, moved to Y and now only produces Z”

We know from the biographies of individual firms that there has been changes in very many dimensions ownership, location, product, employees – so many changes that given the current practices of statistical agencies would have issued and deleted many identification numbers. But the economic historian still consideres it to be the same firm.

Actually most registers defines a "kind of activity unit" as the basic unit. This is defined as a "certain type of activity performed at a geographical location". The intuition is that a firm is a some persons organised produce a more or less homogenous product, having a "headquarter" that can be geographically located. This is a producing institution, independent of who owns it, and - in some cases - the actual persons who are working there. The basic homogenous dimensions in which most statistical agencies record changes are:

- change in ownership (both who owns and the type of ownership)
- change in geographical location
- change in kind of activity

The rule of thumb in Norway has been that if two there are simultanous changes in two dimensions then one firm is dying and a new one is born. For most analytical purposes this is quite reasonable, but there are regrettably a number of problematic cases. Take the example of a local grocery store that changes owner and all of its employees. Since it is located in the same place, and since the nature of its activity is the same, it would in

Norway not be given a new identification number. It would not be considered a birth. There is actually two numbers characterising the firm in Norway. One number – the establishment number - is used to identy the geographically localised production unit, and another – the enterprise number - to identify the owner of this local production unit. In the case of the local grocery store only the enterprise identification number would change. If the new owner was not one of the great chains, but a classical gründer one might want to treat this a birth. That could easily be done by using the change in ownership and employees as the decisive criterium. Another classic problem example is the small expanding firm, being bought up by a big firm and moving to new (the big firms) premises at the same time. According to the Norwegian rules one should have changed both the establishment and the enterprise number. But the actual practice has been more nuanced. If the change in geographical location was only local - defined as staying in the same municipality - only the enterprise number was changed. In some cases this is of course arbitrary the borders of the municipalities cutting through industrial centers. This example illustrates the general problem of distinguishing between take-overs and mergers, and the different types of take-overs and mergers. Is a firm extinguished in the take-over process? Is it just becoming a sub-unit? Is this a real merger, i.e. the death of two firms and the birth of a new one or is it the bith of a new corporation with two sub-units?

BUSINESS DEMOGRAPHY AND HRST

From a human resource point of view changes in ownership and location is generally of less importance. The focus is on persons working to together, constuting a goods and/or service producing organism, each person contributing with their differnet competences, with the producing organism being more than the sum of its ataomistic elements. When persons move they take with them these competences, experiences and networks from one frim to another. Consequently the stablility of the workforce should be a important criterion of the births and deaths of firms. This criterion has been used in the Nordic countries, but mostly to validate and correct “incorrect” changes in identification numbers. The main problem is that the statistical agencies and other public authorities has been using ownership changes as a decisive criterion for changing identification numbers. This will then give an upward bias to the mobility rates. This has led to exercises where one uses the employees to identify the firm. Procedures have been developed in Denmark, Sweden and Finland to verify and correct the change of identification number of firms by using the actual persons employed as an indicator. If a large proportion of firms with

identification number X is found by firm Y, then it is considered to be the same firm And, consequently, that Y should not have been given a new identification number. In Denmark a 30% limit was used, in Sweden and Finland a 50% limit. There are arguments for both. A 30% limit means that if a core group of employees are stable, then it is considered to be the same firm. But the situation might arise where one finds 30% of the "former" employees of firm X in firm Y and 30% in firm Z – how shall that be handled? Using 50% avoids that problem, but might – given the substantial "natural" mobility of about 20-30 % - be too restrictive[15]. Such exercises will lower mobility rates by about 2 – 3 % depending on the registration practice, the business cycle etc. Keeping track of the employees is the essence of studying the importance of out-sourcing in the economy, in the growth of the service sector etc.

THE STRUCTURE OF ENTITIES

Small firms are generally located in one place and carry on activities which are easily classified. The problem with small firms is their short life expectancy. Larger firms are much more stable in terms of life and death, but they are much more dynamic in terms of structure, How they organise themselves into departments, branches, regional offices can change considerably even if we for the moment disregard take-overs, outsourcing, splits and mergers. There is also a marked difference between their legal structure and their "production" structure. This creates problems when issuing identification numbers: should legal considerations be fundamental or should a production-oriented point of view guide how many entities a complex, large firm is subdivided into. The national statistical agencies devote substantial resources to so-called "profiling", that is, case studies of large firms to classify their internal structure. The choices made here will influence the mobility rates, especially when it comes to international comparisons. And of course not only the mobility rates: this problem will have an influence on industrial statistics for the issues here are by no means limited to the large private corporations. The public sector is often a hierarchical structure with many levels, but registration practice (at least in Norway) has been very inconsistent and accidental. Since public authorities are such an important

[15] One should also keep in mind that both the 30% and 50% limit should be seen as a rough guiding line. The both leads to complex algorithms when implemented due to the fact that the number of employees is an integer. This is especially important when we are talking about small firms - and there are always a lot of small firms.

employer this means that a lot of important information on mobility has been lost. This situation has led to the construction of an entirely new - and more detailed - classification system of the public sector. The new system has a four-level hierarchy of organisations, "owning" various types of sub-units. In contrast, the Norwegian system for classification of enterprises and establishments has only a two level structure, as in many other countries. A two level structure is not enough to reflect the often complex structures of modern corporations. It is not only a question of identification numbers, but also of industrial classification. Industrial classifications do not have concepts like "headquarter"or "central administration and staff" resulting in that the administration of large multi-product firms were often given an industrial code even when they where geographically very far from their produciton units. The classic example in Norway being the administration of Norsk Hydro, located in the center of Oslo, classified as producing chemical fertilizers, but with most of the employees having quite other competences than chemical production. The actual production facilities are located 150 kilometers from the administration of Norsk Hydro.

OTHER PROBLEMS

The divergence of the reporting unit on financial indicators from the actually production facilities is of course also a major problem in business demography. One has often got the production and employment figures from local production facilities (establishments), and accounting data from the enterprise unit (central administration). This has of course made impossible or made very complicated all kind of analysis between inputs (R&D, human resources) and financial indicators like sales, revenues etc. But again the situation is changing due to spread of information technology and the general tendency to regard sub-units as "profit-centers". This makes it possible and feasible to collect much more information on the establishment level using tapping directly from the internal accounting systems.

BUSINESS DEMOGRAPHY – CONCLUDING REMARKS

Business demography is of vital importance for the systematic study of HRST flows, but it is at the same time a complex matter both when it comes to concepts and to actual data collection. It is not the aim of this paper to systematically discuss these problems, just to

point to some of the more important problems. Generally we feel that the solution is to define a concept like “producing organism” where the employees, the subjective feeling of being part of an organisation producing certain things is fundamental. Much more fundamental that changes in ownership, specific products or processes. How this is operationalised in the routines of the statistical agencies is a difficult matter. There are certainly many trade-offs to be made between different legitimate administrative and analytical purposes. It is probably more important that the definitions and registration criteria used are the same, than that they are “correct” from any particular point of view.

Finally the advent of new information and communication technologies may make it even more difficult to define a firm, but we will not complicate matters further[16]. Experience has shown that such changes (“the paper-free office”, “virtual firms” etc.) eare much slower to materialise – if at all – than some people tend to belive.

[16] See Jacob Ryten, ”Business Surveys in Ten Years’ Time” in Brenda Cox et al. 1995

THE MOBILITY OF RESEARCHERS

PREVIOUS RESEARCH

In this paper we have concentrated on results based on register data. We turn now to mobility, especially of reserchers, and survey techniques. The background for this is work by the author together with collegues in the STEP group in the early nineties on survey-based studies of researcher mobility. In Norway the contract research sector is relatively large and has many small institutes. Most of them has less than 100 researchers. These institutes were more or less public institutions until the mid-eighties when there was a general deregulation of the sector. The institutes were used to reporting bi-annually the changes in their research personnel. Regrettably in these reports the only destinations specified were other academic institutions, anywhere else being simply a residual category. The STEP survey was a similar but more detailed on the destinations. The main finding was that the overall mobility was 6 - 8 percent. This is significantly lower than the rates discovered by using the registers. There might be various reasons for this discrepancy, such as the institute administration failing to remember all who have been formally employed, or people who just came and went, part-time workers etc. But the registers might also "overestimate", in the sense that they might treat a sabbatical as a jobshift.

From an implementation point of view, the survey was very time-consuming, sending out constant reminders about questionnaires for example. The private sector was divided into "industry" and "services". The personal characteristics were mostly in rough categories (age, education, how long they had worked etc.) No career analysis was possible. To get such data would have put too great a burden on the administration departments of these institutes. Compare this with the register data, where the sectoral division can be in five digits – and one can look for individual firms as well. For example, when choosing candidates for case studies, the personal characteristics in the registers are very detailed, one knows every higher level exam passed, income every year, from each particular job is known etc. The registers are time series getting longer and longer for each passing year as part of the administrative routines. Having access to the most detailed data, the researcher

could change categories for different analytical and presentational purposes. In short - the registers give much more information with radically less costs required for data collection, and no extra burden for the respondents since data is collected as a part of the financial reporting of the institutes. In many cases – if not most by now - a rather automated exercise using the institutes' own databases instead of filling out questionnaires by hand.

EXPERIENCES FROM THE NORDIC NIS INDICATOR PROJECT

To further illustrate some of the more general and abstract points made in this paper, we will turn our attention to results obtained in recent work based on data from public register in some of the Nordic countries, Sweden, Norway and Finland.[17] The project was a part of the OECD's NIS program, more specifically the result of the focus group on human resources. Denmark participated in the discussions, but did not deliver data due to financial constraints. That was regrettable since there has been some very interesting work done in Denmark with this kind of data as part of research on job creation and destruction[18].

The aim of this project was to carry out a comparative study of mobility rates focusing on HRST and the Higher Education Institutions and Research and Development institutes. Even this three-country project shows that doing a comparative HRST study is not a straightforward matter, for despite the fact that the educational systems have many common features, there are structural differences which make some comparisons difficult. Take for example the question of education on the highest levels, of Ph.D.s and licentiates. None of the countries has a clear cut Master - Ph.D. structure. In Norway, to become a doctor requires first 5-6 years of university studies and then 4-5-6 years of doctoral studies in the humanities and social sciences. Medicine and the natural sciences have other traditions. That meant that there was few doctors appearing. Over the last fifteen years there has been a planned and gradual shift to shorter and more organised doctoral studies and the number of doctors has increased rapidly. In Sweden and Finland, shorter basic university courses have been implemented and more people are becoming doctors. Finland

[17] STEP participation in this project was part of its activity with respect to IDEA.

[18] As far as we know, the results of this work has not been published in English. For a short summary of results in danish: Per Vejrup Hansen: "Virksomhedsdemografi: Overlevelse og vækst i nye virksomheder", Samfundsøkonomen nr. 2, 1993

and Sweden also have used - to complicate matters even more - the degree “licenciates” partly being equivalent to Ph.D, partly being clearly inferior to a real doctoral degree.

Another kind of problem is the different structures of the national research system. Sweden has a small institute sector – a lot of applied research is located in the university system. Norway has a larger and and more fragmentet contract research sector with one large Finland has one great research center, VTO. The structure of higher education instutuions also differ. How important – even how real – these differences are, is difficult to say. There are so far few stylized facts about the national innovation systems, few points of reference. As a consequence the study was mainly an explorative one.

The main result of the studies were tables with stock data and flows/mobility rates.
Stock of employees by level of formal education and country. Absolute numbers. 1995.

The figure shows the relative size of the three countries by the number of employees. Sweden being roughly twice the size of Norway and Finland. But the stock data was actually background information to contribute to the interpretation of the mobility rates. A typical table of mobility rates would look like this:

Table 1 Mobility rates 1995-96.Employees with higher education broken down by sector. Sweden, Norway, Finland. Percent of total employment, 1995. Wide type of mobility: Including persons leaving active work force. Narrow type of mobility: Excluding persons leaving active work force.

Sector	Sweden		Norway		Finland	
Type of mobility rate:	**Wide**	**Narrow**	**Wide**	**Narrow**	**Wide**	**Narrow**
Agriculture, hunting and related service activities	23.0	16.5	31.8	21.6	11.8	4.0
Forestry, logging and related service activities	41.4	30.8	29.5	22.0	15.5	9.0
Fishing, oper. of fishing hatcheries and fish farms	46.3	34.1	19.9	14.6	16.7	12.5
Mining and quarrying	17.8	13.2	18.3	12.8	15.0	8.3
Food products, beverages and tobacco	24.9	19.5	25.9	19.0	31.8	24.4
Textiles and textile products	35.1	30.2	26.5	16.4	17.6	11.2
Wood and products of wood	24.7	19.0	20.9	15.8	21.8	14.3
Pulp, paper, paper products	16.8	13.5	12.9	6.8	22.2	17.7
Publishing, printing, repr. of recorded media	27.3	20.1	19.0	12.2	21.7	16.2
Coke, ref. petr. products, nuclear fuel [1]	41.5	36.4	18.4	9.2	14.1	11.7
Chemicals and chemical products [1]	..	..	9.6	5.3	19.6	15.7
Basic chemicals	22.2	18.8	14.4	8.2	16.0	10.3
Pharmaceutical preparations	7.6	5.5	15.5	10.7	25.2	21.0
Rubber and plastic products	29.8	24.8	19.8	15.1	14.8	11.4
Non-metallic mineral products	19.9	12.7	19.4	13.4	21.0	13.4
Basic metals	16.5	13.7	17.7	11.3	14.7	10.7
Fabricated metal products	22.2	17.0	23.1	17.3	20.1	14.3
Machinery and equipment n.e.c.	18.2	14.7	21.0	15.8	18.5	14.2
Office machinery and computers	39.2	36.7	71.4	64.3	25.4	21.8
Electrical machinery and apparatus n.e.c.	22.4	20.1	18.6	14.2	20.2	16.3
Radio, tv and communication equipment	14.7	9.7	12.4	8.2	36.3	32.6
Medical, precision and optical instruments	16.0	14.0	20.2	15.8	17.2	13.4
Transport equipment	11.8	8.5	31.1	25.8	26.4	21.3
Manufacturing n.e.c.	29.2	21.6	17.7	13.6	21.1	14.9
Electricity, gas, water supply	12.3	9.4	15.4	9.9	14.5	11.2
Construction	22.3	17.3	20.4	15.3	26.2	16.3
Wholesale and retail trade	28.3	20.7	26.3	21.1	21.4	14.9
Wholesale of machinery and equipment	25.1	19.9	26.5	19.4	18.7	12.9
Transport and storage	20.5	13.9	23.9	16.7	18.7	12.2
Post and telecommunications	15.8	11.7	20.8	15.5	17.9	13.5
Financial intermediation	17.6	14.0	16.0	10.5	31.3	25.3
Other, mainly private services	32.3	23.8	19.2	14.4	29.4	21.6
Computer and related services	19.5	16.5	20.3	16.1	20.7	17.2
Research institutes, technology	33.8	30.3	18.2	13.5	19.9	15.2
Research institutes, social sciences	25.0	21.2	21.0	14.5	22.0	13.1
Other business activities	21.6	16.3	33.4	23.7	17.5	12.0
Architectural and engineering activities	16.9	11.9	20.3	13.8	18.7	10.9
Technical testing and analysis	16.4	13.0	41.3	35.6	15.0	10.3
Public administration	13.4	9.3	16.7	11.3	24.1	19.1
Higher education	22.1	17.5	18.5	11.4	32.5	22.5
Other non-public services	20.4	14.0	20.1	13.0	17.8	11.1
Total	**17.1**	**12.5**	**18.5**	**12.7**	**23.9**	**17.9**

[1] For Sweden chemicals and chemical products are grouped with coke, ref. petr. products, nuclear fuel.

We shall not go into a detailed analysis of these numbers here. They are meant just as an illustration. There is a lot of still unexplained variation – between sectors nationally and when compared between countries. There are also a great deal of variation from year to year. But these longitudinal variations could not be studied comparatively due to the change in industrial classifiacation from ISIC to NACE. The industrial classification is comparable for all three countries only between 1995 and 1996. A another and more aggregate view of these mobility is looking at the rates for persons with education three broad categories

Table 2 Mobility rates 1995-96. Total employment and employees with higher education, broken down by technical, medical and social sciences and other. Sweden, Norway, Finland. Percent of total employment 1995. Wide type of mobility: including persons leaving active work force. Narrow type of mobility: excluding those leaving active work force.

Type of employees	mobility rate	Sweden[1]	Norway	Finland
All employees	Wide	24,0	20,1	23,3
All employees	Narrow	16,2	12,4	11,5
All higher educated employees	Wide	23,4	18,6	23,9
All higher educated employees	Narrow	19,5	12,8	17,9
Natural sciences and engineering	Wide	22,4	19,9	23,3
Natural sciences and engineering	Narrow	19,0	14,6	17,8
Medical fields of science	Wide	25,1	21,4	26,7
Medical fields of science	Narrow	21,9	14,7	21,2
Social sciences, humanities etc.	Wide	23,3	17,4	23,6
Social sciences, humanities etc.	Narrow	19,2	11,7	17,4

At this stage it is would be premature to draw firm conclusions from such tables, but the level of mobility is rather high, both the narrow and the wide rate. The Nordic countries have a more egalitarian wage structure than many other countries and one might expect low mobility rates. It would be very interesting to se comparable mobility rates from countries with greater wage differentials. A priori one could on the one hand argue that small differential relative to the transaction costs of a job shift should imply low rates, but on the other hand since the wage is not so important people might search more to get a more interesting job resulting in high mobility rates.

THE INTERACTIONS BETWEEN THE RESEARCH SYSTEM AND THE ECONOMY

The focus of the project was the flow of highly educated persons from the R&D institutes (R&D) and the higher education instutions (HEI). Below is reproduced to comparable graphs for Norway and Finland. The focus is on flows from the HEI and the R&D institutes, so the rest of the economy is reduced to three broad categories. There is a lot to be said about the construction of the three categories, the relative sizes of them in Norway and Finland, given that the countries are of roughly the same size. But that is beyond the scope of this paper. One significant feature is that the flow of persons from R&D to the three categories – each having hundreds of thousands of employees - are of the same order of magnitude as the flow between R&D and HEI. Does this indicate that there is too little mobility in these broad categories? What kind of persons are moving from private services to HEI? These are interesting questions for further research.

Figure 3 Norway 1995-96, Mobility of employees with higher education by delivering and receiving sectors. Absolute numbers.

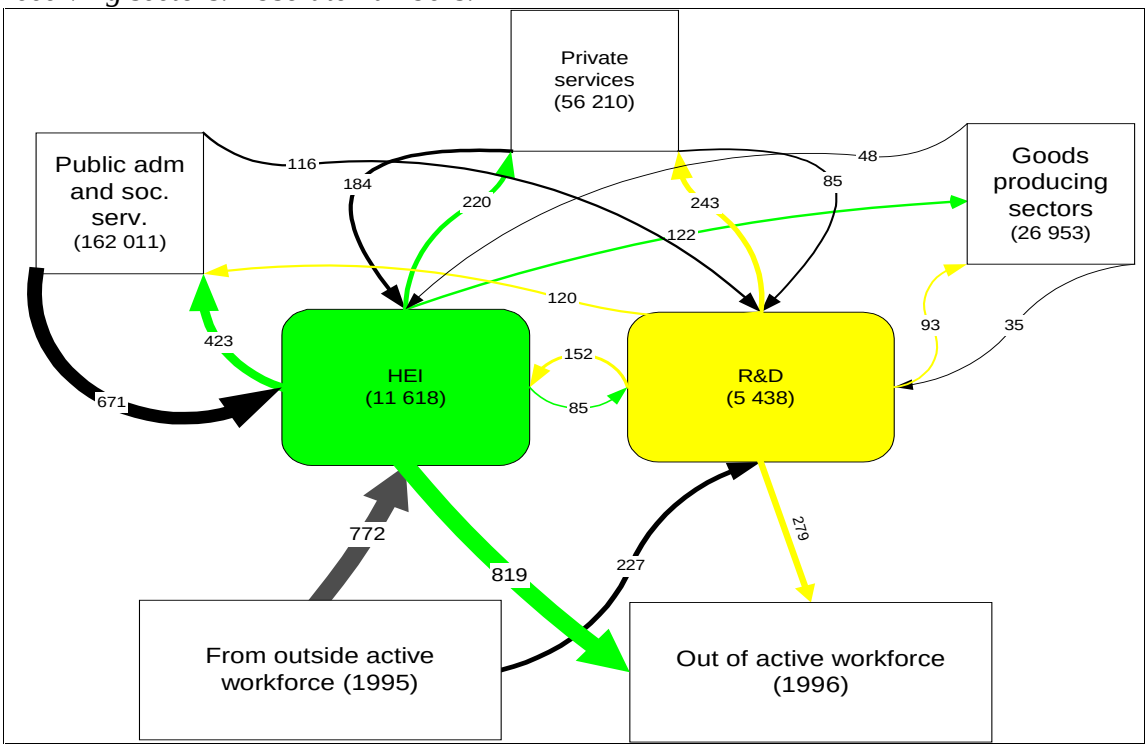
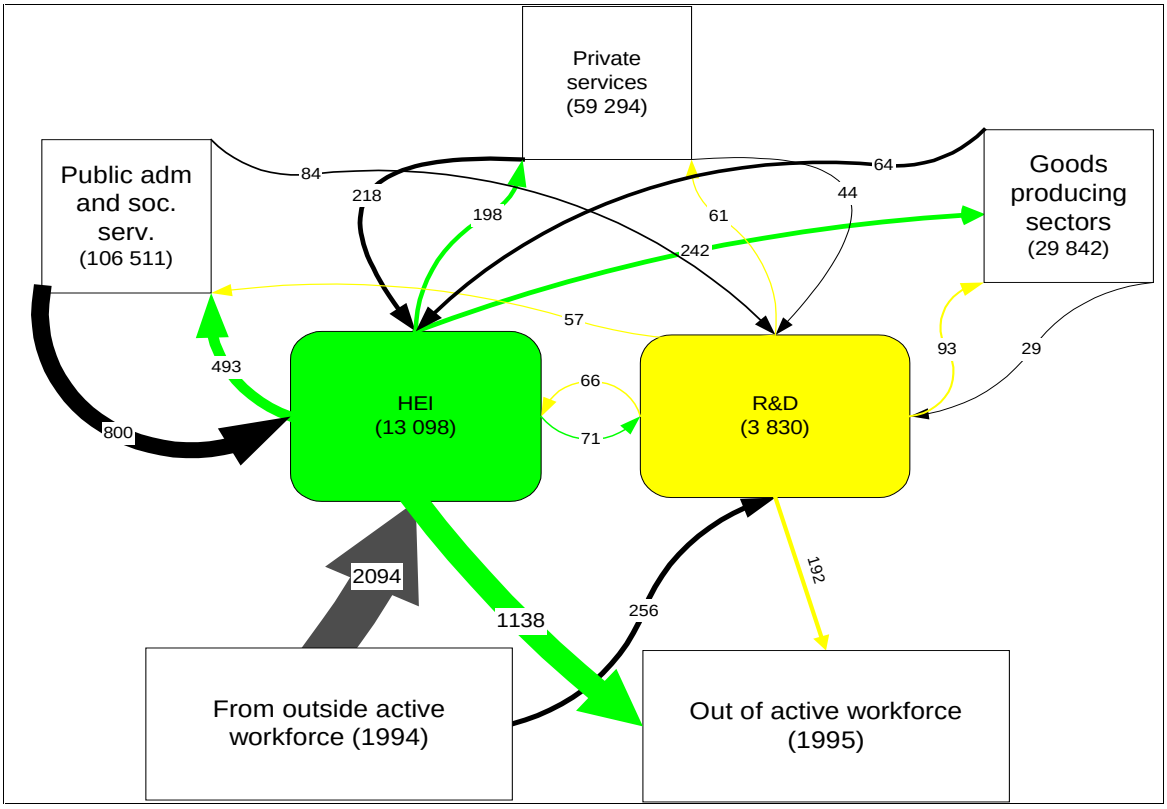


Figure 4 Mobility of employees with higher education by delivering and receiving sectors. Finland 1994-95.



COMPLEX CAREER PATTERNS – EVENT HISTORY ANALYSIS

Due to the lack of comparable time-series this project concentrated on changes from year to year. But many of the interesting questions concerning HRST is best studied in a career perspective. The classic question being of course what happens to a cohort of engineering graduates as the years pass by. But as the graph below shows – looking only at three consecutive years - very quickly gives rise to complex patterns, because the possible combinations of different states "explode". This calls for more advanced analytical techniques. One such technique is Even History Analysis[19] which is capable of handling complex state-spaces, calculating transition rates from one state to another. The

[19] For an elementary introduction see: Paul D. Allison, "Event History Analysis", Sage Series – Quantitative Applications in the Social Sciences, 1984

proportional influence of various background variables can easily be expressed using so-called proportional hazard models.

Figure 5 Overview over a path-dependent state space. Combinations of recruitment, unemployment and job shift.

LOOKING FOR OTHER INDICATORS – THE INVERTED HERFINDAL-INDEX

Mobility tables very rapidly get big and complex. Using 40 sectors in an input-output table – which is not a very detailed study of various sectors – the I/O tables become increasingly difficult to analyse. There is a need for summarising indicators. One indicator of this type was tried out in this project. The indicator tries to capture the differences with regard to the degree to which persons with different scientific backgrounds are evenly distributed between the potential user sectors. To investigate what this distribution looks like, we have utilised a measure known as the "Herfindahl index" – simply a measure of variance.[20] The

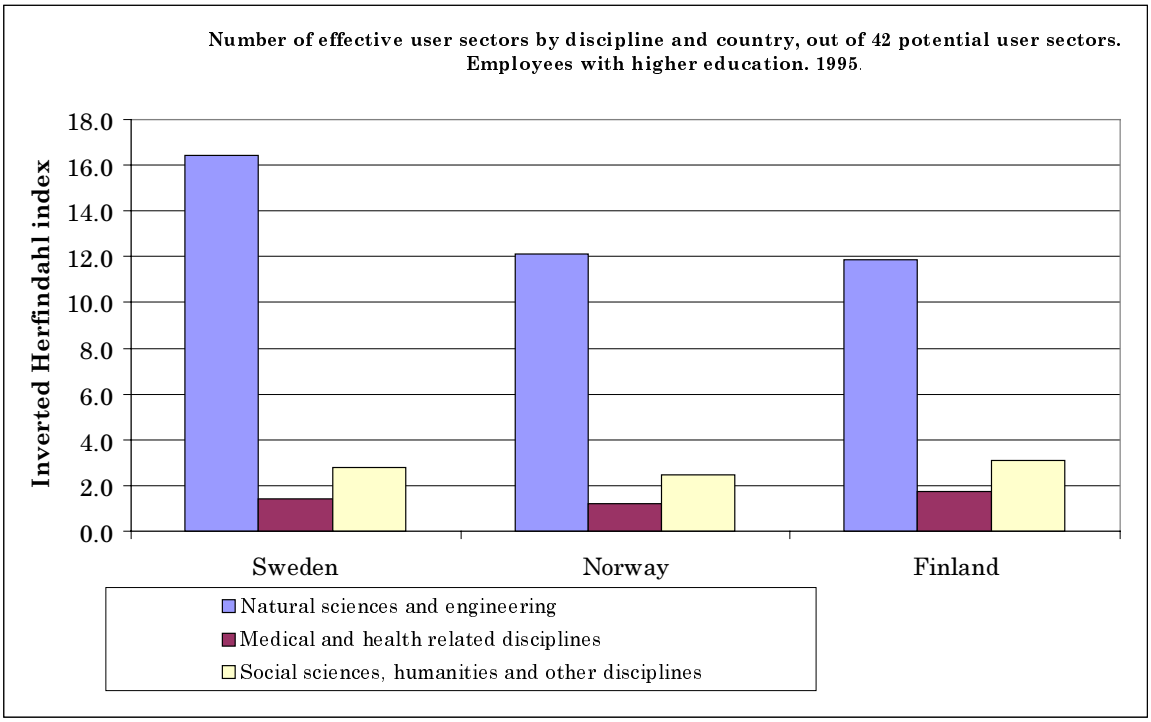
[20] The Herfindahl index is calculated as follows: $H_j = \sum_i s_{ji}^2$ where s_{ji} = share of total in sector i for educational category j. In this case, i=1-42, whereas j represents three different education types. In this case, the minimum possible value for the inverse of Hj (presented in figure 3.18) is 1, the maximum is 42.

index varies between 1 and the inverse of the number of categories used. If the distribution on the categories is even, the number becomes small and close to the inverse of the number of categories. If the distribution is concentrated to one or a few categories, the Herfindahl index increases towards its maximum, 1. Taking the inverse of the Herfindahl index we get an indicator for the number of "effective user sectors". It can be viewed as an indicator of the number of categories, or sectors in our case, which dominate the distribution. The number of categories, and the distribution on the categories of total number of employees, affects the indicator.

Results are presented in the figure below. As can be seen, the results are clear cut and the same for all countries: natural sciences and engineering are used widely in the sectors specified, with a number of effective user sectors in the order of 12-16. Medical and health related disciplines have a far more focused user group: between 1 and 2 effective user sectors. Even social sciences, humanities and other disciplines are strongly focused, with 2-3 sectors out of the 42 dominating as users.

One should be aware, however, that the classification used is biased towards the manufacturing sectors. Around half the categories belong to manufacturing, a much higher share than their actual share of employment justifies. The public sector and private services are split into broader categories than manufacturing. As a result, there are a higher number of sectors where those looking for work in manufacturing can go. It is more relevant for the natural scientists and engineers, and explains part of, but not all of, the higher number of user sectors for this educational group.

Figure 6 *Inverted Herfindahl indexes for the number of effective user sectors (broken down by 42 sectors), by scientific field. .*



RECOMMENDATIONS

The question of studying human resources, stocks but especially the flows in the economy is critically dependent on data. We therefore recommend that:

The development of HRST indicators should be based on register data

To be economically feasible the development of indicators must be done on the basis of registerdata. For the time being only a few OECD countries (the Nordic area, France, and Israel) have register data for persons and firms as a part of their statistical systems. But in many countries there are various registers, containing sufficent information so that registerdata could be constructed for statistical purposes. We should put great effort into overcoming scepticism concerning the construction of such datasets. There are of course non-trivial problems of linking the various datasets, but these are of a statistical nature. Traditional surveys should be used to get information on motivations and other subjective factors.

We need joint efforts to get establish register data

In itself the study of HRST would not justify the efforts required to construct register data in countries where they do not exist. It is of vital importance to point out the very broad range of topics that can be studied once the employee-employer nexus is established. This is a vital link for all kind of economic statistics and prognosis purposes.

Business demography – there is a need for common definitions

We recommend approaching problems of business demography by using the “producing organism” as a basic concept. This means using the stability of the employees as an important if not the decisive criterion for births and deaths of firms. In addition one needs to have an develop adequate statistical categoires to capture the structure of the large firms and cooperations and the new developments due to the new information and

communication technology. In general there is a strong need for international coodination with respect to definitional issues. We see an important role for the European Commission here.

The occupational classification should be further developed

We should consider further development of ISCO in a situation where many countries still have not – or only partially – implemented the classification. The present classification should be made more homogenous on the various digit levels. We should investigate the possiblities of making the occupational categories part of the nomenclature used by public authorities when collecting information from the public, such as tax-forms etc.

Develop educational classifications further

We should consider a more fine grained scale in ISCED on the top levels. As the general level of education has been raising rapidly since the sixties a more fine-grained scale is needed after the 10-12 first years of schooling. Weshould explore the possibility of using the full time equivalents of education for each individual in various fields of study as an alternative to a classification of levels.

We should encourage defacto standards for private and business home pages

We should encourage standardisation of the information persons and firms have on their home pages so that it might become an alternative source of information about individuals and establishments, suplementing and validating register data and surveys. Presumably the information on the Internett will be more up to date.

We should emphasize the need for longitudinal data

The change from ISIC rev. 2 to NACE (or ISIC rev. 3) has in many countries broken the time series in most economic statistics. One should initiate common projects to transform historical files (ISIC rev. 2) to NACE – using the same rules as far as possible. If this is not done, one will have to wait many years befor sufficently long times series for most

analytical purposes have been established. That is irrational given the limited costs of transforming the old ISIC data.