Proceedings of the third CEIES seminar

Statistics on Research and Development

Aarhus, Denmark, 3rd - 4th December 1997

CONTENTS

PREFACE WITH CONCLUDING REMARKS

The European Advisory Committee on Statistical Information in the Economic and Social Sphere (CEIES) organises seminars to establish a better contact between users, dataproviders and producers of European statistics. The third seminar organised by CEIES was held at the University of Aarhus, Denmark 3rd-4th December 1997. The topic of the seminar was Statistiscs on Research and Development.

Papers presented at the seminar covered a broad range of issues raised by the measurement of R&D, from both producer and user perspectives. The seminar must be judged a real success given the quality of the papers and the liveliness of the discussions they generated. A particularly valuable feature was the interaction of the producers and users of R&D statistics. At times in the discussions, the contrast in the attitudes of producers and users to the data was marked. In the many areas of research in which the producers and users of data are not the same people, communication between them is vital.

Data which are published and not subsequently analysed are like research papers which are written and not subsequently published. They constitute avoidable waste. Producers of R&D data can only benefit by greater exposure to the uses to which their data are put. Equally, users can only benefit from a much more intimate knowledge of exactly how published R&D data are collected and of the difficulties faced by data producers. Such sentiments, of course, are commonplace, but the seminar revealed that they have continued relevance in this field.

The seminar was organised jointly by CEIES and the Danish Institute for Studies in Research and Research Policy. Most of the work of the organisation was undertaken by Karen Siune and the staff of the Institute. I'm sure that all the participants will wish to be associated with an expression of thanks to them for providing such a friendly and hospitable environment and a well run, stimulating seminar.

Patrick Geary
Professor
Chairman of the subcommittee on R&D statistics

Opening session

What is it all about?

OPENING: WHAT IS IT ALL ABOUT?

Karen Siune
Vice-president of CEIES
The Danish Institute for Studies in Research and Research Policy

Welcome to CEIES seminar on Statistics on Research and Development and to the University of Aarhus.
This seminar is no. 3 in a series of seminars organised by CEIES.

CEIES stands for:
"The European Advisory Committee on Statistical Information in the Economic and Social Spheres".
"CEIES shall assist the EU Council and the Commission in the coordination of the objectives of the Community's statistical information policy, taking into account user requirements and the costs borne by the information producers".

CEIES functions via a plenary meeting once a year for all members of the committee. Each country is represented by three persons; the director general of the national statistical institute and representatives from users and dataproviders. CEIES has organised its work based on subcommittees. At the moment CEIES has subcommittees as follows:

- Subcommittee on Social Statistics
- Subcommittee on Economic and Monetary Statistics
- Subcommittee on Innovation in provision, production and dissemination of statistics
- Subcommittee on Research and Development.

The subcommittees prepares presentations for the assembly and prepares seminars to establish exchange of viewpoints regarding the diverse topics. Each seminar is organised in cooperation with a national institution.

This 3rd seminar is organised by The Danish Institute for Studies in Research and Research Policy in cooperation with the subcommittee on Research and Development.

The Danish Institute for Studies in Research and Research Policy has other responsibilities than R&D statistics.

Presently we are working on:

- Nationwide surveys related to R&D
- Content analysis of mass media's coverage of R&D
- Economic implications of investments on R&D for small and medium sized companies
- Social implications of change in financing R&D.

Today we focus on **R&D**.

WHAT DO WE WANT R&D STATISTICS FOR?

Ove Poulsen
Ministry of Research and Information Technology

Policy making is a complex process. It is formulated on the basis of the past and with a desire to define scenarios for future development. In this respect it is equivalent to the prediction of earthquakes. With sophisticated scientific equipment important parameters characterising earthquakes can be measured, except for one parameter, the onset of a quake. Thus we exclusively deal with the past without predictive power. This is contrasted by the development of the natural sciences which are able to device machines based on laws also valid at future times.

R&D statistics is like a quake. All you want to know about the past is available, but the future is outside reach. This pessimistic view calls for abandoning such statistical exercises and just base policy making on human thoughts and intuition like science itself, being driven by strong individuals, interacting in a complex and non linear space. Is it, at all, possible to define cuts in a R&D multiparameter space, that can isolate useful information to improve policy making?

Yes, R&D statistics can describe and analyse past performance and thus, at least, tell us what not to do. The interaction space not being known, this does not implies, that we learn what to do. But strong poles can be avoided. And knowledge about past performance at least also isolates performers from non performers. Based on past performance, the future performers are more easily isolated. We thus need R&D statistics because it separates the good from the bad. Other arguments also supports professional R&D statistics. Science, and its expressions in research and development, has developed itself into a powerful driver for societal changes beyond that of merely training students. Science policy today rivals other policy areas like social, educational, labour market, environmental and industrial policies. Therefore R&D statistics must be able to argue for the impact of these different policy areas on basic societal parameters as growth and job creation, productivity and derived effect on wellfare.

Thus R&D statistics shall access the value of science investments to society and give guidelines in defining future scenarios. The real agenda are regions competing on control parameters like wealth and productivity, job creation and wellfare. The winners are those regions who are differentially more adaptable than other regions in creating added-value as result of its policies. The process is complicated by the long time constants, often underestimated by policy makers and politicians. This is an important complication, because the impact of R&D on society can not rapidly be assessed, as no feed back loops can be defined and stabilized. The only feed back loop is the one defined by politics.

A final reflection on R&D statistics concerns the very nature of the whole enterprise. R&D statistics are not of any interest in its own rights, but only gains importance if such data are combined with intuition and political nose as to define new cuts in the statistical multi-parameter space. Only in this case will dead numbers give life to an exciting interplay between politicians, policy makers and R&D statisticians.

CAN R&D STATISTICS MEASURE THE ROLE OF R&D IN A GIVEN SOCIETY?

Patrick T. Geary[1]
National University of Ireland, Maynooth

"We should not be cursing the darkness, but rather, we should keep on lighting candles"[2]

"Discoveries differ from other inputs in the sense that many people can use them at the same time. In the language of public finance,…information is non-rival"[3]

1. Introduction

"Research and Development" is a term which encompasses a wide variety of activities, ranging from capital-intensive scientific experimentation to sitting and thinking. Distinctions are drawn between basic research, applied research, maintenance research, development and extension. The very diversity of the activities subsumed under the title of R&D poses difficulties for the collection of information about it. In general terms R&D is usually thought of as adding to a society's or the world's "stock of knowledge". Research is an activity that involves the investment of scarce resources in the production of knowledge. Its object is to increase future productivity, broadly defined. Scarcity of resources implies that not all research problems can be addressed simultaneously (or ever); thus choices must be made about the total resources to be devoted to research and to their allocation. Essential to this process is information both on the costs of research inputs and on the likely benefits in terms of output.

Of course, knowledge in itself is of limited value; benefits depend largely on **whether and when the knowledge is used**. The extent to which it is used depends on its applicability as determined by the expected benefits of using it and the user costs of acquiring the information.

Crucial are the ability of users to perceive potential benefits and their ability to buy off or otherwise persuade opponents of its use. In some cases, lags between research and profitable application can better be measured in decades rather than in months or years. In contrast, maintenance research, designed to compensate for obsolescence, may involve much shorter lags. Recent estimates suggest that up to 33% of research in US agriculture is maintenance research[4].

The **private** benefits of R&D also depend on the ability of researchers and innovators to appropriate the results of their efforts. A major issue in R&D is the extent of "spillovers" and their nature; i.e. whether they are intra-industry, inter-industry or international. The perspective of R&D policy-makers in small countries may differ from that in large countries because of spillovers; more generally the case for public support for R&D is affected by spillovers, which reflect higher **social** benefits.

2. R&D statistics

What are R&D data for? A brief answer is (a) to document an important input of the production process; (b) to enable us to increase our understanding of the sources of productivity growth. To the extent that they do this, they can contribute to the framing of appropriate public and private policy responses to questions of the amount and nature of resources that should be allocated to the activity. A corollary is that however presented, R&D statistics should illuminate the **output of the activity** as well

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[1] I acknowledge the comments and suggestions of my colleague, G.E. Boyle.
[2] Griliches (1990), p1703.
[3] Romer (1994), p12.
[4] See Alston et al (1995), p32.

as the activity itself. Input-based measures are of limited value unless there is a stable, identifiable relationship between R&D input and output. This is an unlikely prospect: as noted, the relationship between research activity and usable technological changes is subject to long and variable lags and inherent uncertainty[5].

The notion of **R&D statistics,** which this seminar will discuss in the next two days, involves particular conceptualisations of what is involved in Research and Development. **Measurability of concept and accessibility of quantitative information** become decisive criteria when the objective is the production of statistics. The attempt to quantify imposes a stringent discipline, that of unambiguous definition. Not everything yields to this discipline; in imposing the strait-jacket the concept may be obscured. Naturally, the easier measurement problems are likely to be solved first and their solution will influence what becomes published as R&D data. Once published, R&D data may become synonymous with the underlying concept which is much less precise. As will be observed below, the most we can expect to achieve is precise measurement of something which falls short of our objective. What this suggests is that we require **a portfolio of R&D related statistics** which, as far as possible, span the concept.

2.1. R&D expenditures

The most widely published indicator of R&D is **expenditure on R&D.** Measuring expenditure on R&D fits naturally into the tradition of national accounts data. Once published, R&D expenditures can be (and are) used to compute a "stock of knowledge", in exact parallel with the computation of stocks of physical capital. Current R&D expenditure is "investment"; knowledge is assumed to become obsolete at a constant rate (depreciation); when a benchmark assumption is added, a series representing the stock of knowledge can be computed. Crucial to this method is the assumption that knowledge grows in continuous small increments, not in large, infrequent shifts. At a high enough level of aggregation, this is a tolerable assumption; stocks of knowledge have been calculated at industry and economy level. A number of studies have used R&D expenditure in this way; recent examples include a paper on international R&D spillovers by Nadiri and Kim (1996) and references cited there[6].

The information content of the data on R&D expenditure can be jeopardised in various circumstances. A particularly serious issue is raised by the level of aggregation of the published data. Aggregate (economy-wide) data on R&D expenditure suppress information on **the industry composition of R&D, the mix of basic, applied and other research** and **the mix of publicly funded and privately funded research,** and so on. Since returns to R&D expenditure under these headings are almost certain to differ, the resulting aggregation biases render international comparisons of questionable value. It is arguable that for the purpose of international comparison some disaggregation is essential; for the purpose of analysing the relationship between R&D and productivity growth, the more disaggregated the data, the better.

Another potential problem is that as R&D increasingly becomes the subject of public policy and performance indicators are used to rank countries or industries, reclassification of expenditures will bias the information content of the data. In the longer term, with an unchanged policy regime, changes in expenditure levels may prove to be reasonable indicators of changes in R&D effort.

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[5] Lags are influenced not only by the specific research problems being investigated, but also by the calibre and experience of the researchers, the facilities they have at their disposal, the quality of the administration and how funds are allocated.

[6] Among the issues addressed by Nadiri and Kim is the effect of international R&D spillovers on total factor productivity growth in the G-7 countries. They find significant differences across countries. The relative importance of **own** R&D effort relative to **foreign** spillovers is about 6:1 for the U.S. For Germany, Japan, France and the U.K. it ranges from 1.6:1 - 1.2:1 while for Italy and Canada it is only 0.3:1. But see the following discussion.

Calculating "real" R&D expenditure, in principle, presents no new problems. In practice, however, problems can arise. A particularly difficult issue is posed by the effect of R&D on product **quality**; as Griliches (1994) remarked, "quality change is the bane of price and output measurement". He cites the dramatic example of computer prices in the US national accounts. Until 1986 they were assumed to be constant; when a major revision was made, based on the notion of quality adjusted (hedonic) prices, it was found that they had been falling at an annual rate of more than 15% at least since 1972! The effect of using the constant price was seriously to underestimate the effect of R&D in the computer industry by understating output growth, and thus its returns. It also involved underestimating real investment and thus **overestimating** productivity growth in all sectors to the extent that computers were an input. Of course, other high-tech sectors are due comparable consideration - Griliches mentions semiconductors and electronic components in general - which in the US they didn't get (or hadn't by 1994). How other countries address the quality problem may be subject to the same comment.

2.2. Other measures of R&D

Can **output based measures of R&D activity** be found which supplement R&D expenditure?

The outputs of R& D are notoriously hard to anticipate. Consider the following questions[7]:

(a) What is probability that research will be successful (what is success?)? (b) If successful, how soon will results be available for adoption? (c) Once adopted, how much will results of research contribute to changes in productivity and output and for how long? It is obvious that uncertainty lies at the heart of much R&D endeavour.

However, there are output-based sources of R&D data. One which has received and continues to receive a lot of attention is **patent data**. Another is **publication and citation of scientific articles**. Patents may seem like an obvious measure of R&D activity[8]. However, they must be treated carefully, as the title of a recently published NBER Working Paper by Kortum and Lerner (1997) makes clear: "Stronger Protection or Technological Revolution: What is Behind the Recent Surge in Patenting?". The title shows that there may be other explanations for changes in the level of patenting; they may be legal, administrative, or due to the availability of other ways of appropriating the profits of innovation, as well as to changes in the amount of marketable innovation itself. However, existing patent data have potential; the survey by Griliches (1990) of the advantages and drawbacks of patent data emphasises this. So does the paper by Kortum and Lerner: this provides extremely useful information on patenting in US, Japan and Europe, as well as providing economic rationale for a relationship between research productivity and patenting activity. One of the advantages of patent data is that they are published at a highly disaggregated level, creating the possibility of investigating R&D at the level of the individual firm Adams (1990) uses **published scientific papers** as a basis for computing a stock of "fundamental" knowledge; he compares this to patents and copyrights as a measure of "applied" innovation. In computing the stock, he also uses an **input-based** measure, data on **the number of scientists employed across industries**, which, he argues, "identifies the mapping of sciences to industries. Knowledge divides along the lines of academic science, and scientific employment links specialities to industries of use" [p676]. He argues that "data on world-wide scientific papers are superior to R&D expenditures in some ways, apart from their focus on basic research. They are largely independent of particular industries, which contribute little to the thrust of world-wide science. Also the article count

[7] See Alston et al.,(1995), p22.

[8] The relationship between R&D expenditure and patents has long been investigated. Across firms and industries there is a strong positive relationship; over time within firms it is weaker. In the time-series context, it has proved difficult to establish a relationship between patents and lagged R&D expenditure in U.S. data, suggesting the relationship between R&D expenditure and patenting is almost contemporaneous. This accords with the observation that patents tend to be taken out early in the life of a research project. For a detailed review and references, see Griliches (1990).

data [which in some cases date back to the 1870's] cover a longer period, inviting flexibility in tests of lags in effect" [p689]. A feature of Adams' findings is the very long lags he identifies between basic research output and its effect on productivity at the industry level. Academic technology and academic science exhibit lags of about 10 and 30 years, respectively. An implication is that rises in real interest rates would lead to a shift from "basic" research to more applied or "development" research. Correspondingly, a redirection of tax incentives or direct public funding would have the same effect. Adams' work serves to heighten awareness of the difficulties of isolating the consequences of R&D.

3. Can R&D statistics measure the role of R&D?

Adams concludes his paper with a list of unanswered, pertinent questions. Among them are the following:

> "Are observed shifts in demand toward higher-quality factors the result of the growth in knowledge? Can the influence of knowledge first be traced to its effects on R&D and from there to products and processes? How large is the role played by the international diffusion of basic science in the recent surge of trade and the twisting of the US wage structure in favour of the highly educated?" (p700)

From a broader perspective, Griliches (1994) concludes as follows:

> "..both the rate and direction of inventive activity are subject to economic influences and analysis. So also is the diffusion of innovations. But the outcome of inventive activity is not really predictable. True 'innovation' is an innovation. If it were knowable in advance it would not be one and the innovators would not be able to collect any rents. In that sense it is futile to expect that we could control it or predict it well. Given the fundamental uncertainties entailed in the creative act, in invention, and in innovation, there is no reason to expect the fit of our models to be high or for the true residual to disappear. We should, however, be able to 'explain' it better *ex post* even if we cannot predict it." (p18)

At the heart of the question posed in the title of this paper is R&D evaluation. Can R&D statistics enable us to evaluate the effects of R&D? The answer is **"partially"**. The R&D statistics which can be collected are a necessary condition for evaluation; but they will never be sufficient.

The amount of resources devoted to R&D and the importance of understanding more about the relationship between research, knowledge and growth lend further strong support to the case for reassessing both the level and the existing allocation of the resources of statistics gathering agencies. This seminar addresses major questions; we are all indebted to Professor Siune and her Institute for organising it.

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First session

Producers presentation

R&D STATISTICS IN THE EUROPEAN UNION

Daniel Defays
Eurostat

Introduction

The Commission has been involved in Research and Development statistics for a long time but has only become deeply involved in the 1990-s. In the following presentation I will show you the width of the data we have and the impact on providers and users.

Following demands from various policy making bodies in the Commission, Eurostat increased its coverage of Research & Development statistics substantially in the 1990-s. Through the 1980-s it covered no more than Government appropriations. Nowadays Eurostat has far more data on Research & Development: it has data on performance of R&D, broken down by sector, by region and reported both in terms of expenditures on R&D and personnel devoted to R&D.

The scope of data also widened in several directions: we have data on patents, innovation, trade in high technology goods ... and a number of other Science and Technology indicators.

Historical view

How did this all come about? The increased efforts of Eurostat have both a legal and a user needs background which, of course, are linked.

The Treaty on European Union states that the Community shall have the objective of strengthening the competitiveness of its industry and encouraging research and technological development. In order to design, implement, monitor and evaluate policies in this field, the European Union must have statistical information at its disposal. The 4th framework programme of Community activities in the field of research and technological development (1994-98), the management of the structural funds, the promotion of technological innovation and the co-ordination of national R&D policies are examples of programmes which require statistical information providing a sound basis for comparison between Member States, their regions and between the European Union and its trading partners.

On 22 July 1993, the Council adopted Decision 93/464/EEC on the framework programme for priority actions in the field of statistical information 1993 to 1997, which it intended as a response to the demand for statistical information in general. Decision 94/78/EC, Euratom focuses more particularly on statistics relating to research, development and innovation, and is part of the overall framework defined in Decision 93/464. In the framework programme for 1998-2002 (not yet adopted) the need for statistics of R&D, technological innovation and science and technology in general is repeated.

The Council Decision specified among others that user needs need to be examined. For this purpose the European Parliament, the Commission services, several international organisations and the Member States have been surveyed in this respect and the outcomes of this survey have been the Leitmotiv of the Eurostat efforts.

DG XII of the Commission - Research and Development - has always been interested in statistics in its field of interest. When it decided to produce a report on Science and Technology Indicators it boosted Eurostat's efforts enormously. In the 1990-s DG XVI - regional policy making - required for its management of regional policy more information on regional technological development. At the same time, DG XIII - dealing among others with innovation - needed a substantial database to found its long term policy making upon. Furthermore, the Member States needed more and better harmonised data on Science and Technology to improve their own policies.

Perhaps the renewed interest also found a cause in the understanding - known since the 1950-s, but drawn again into the centre of economic analysis from the mid 1980-s onwards - that economic growth cannot be based on capital accumulation alone, but consists in its equilibrium of technological development.

Eurostat built its statistical system on an existing frame: the OECD FRASCATI family of manuals. This means that in the data collection there is no break with the past. This also means that in addition to existing data collection for the OECD limited additional burden was put upon the respondents. This only took place when regionalisation of the figures demanded greater samples and when the data collection was totally new as in the case of innovation.

The reliance on an existing framework of Science and Technology statistics embedded Eurostat in an environment of fruitful co-operation with a large number of partners.

I will now turn to different area's of S&T statistics one by one and discuss them separately. I shall address the issue of the burden to businesses repeatedly as this is of considerable interest to the CEIES. In its report of September 1995 it pointed out that statistics account for about 5% of the gross administrative burden - or load - to businesses. It will be clear from the discussion below that Science and Technology statistics added little to that.

Innovation

Before the 1993 Community Innovation Survey there had been no internationally comparable innovation surveys. Yet there existed a common methodology and there existed a widely felt need for comparable innovation statistics in the Member States and in the Commission. The OECD produced a methodology to measure innovation, called the Oslo Manual. In 1993 Eurostat and DG XIII of the Commission launched their innovation survey on the Oslo Manual concepts. In all the then 12 Member States plus Norway a survey was sent out. Eventually 40.000 enterprises replied.

Eurostat assembled the data and made them available for researchers. At first the data were only available to those that DG XIII commissioned to a study, but later to any researcher that promised to make use of the semi confidential data in a responsible manner. In practice researchers of universities, of ministries and of the OECD secretariat have used the data to increase their understanding of the innovation process. Eurostat itself produced a CD-ROM with about 7.000 tables drawn from the database.

The Innovation Survey has been costly in terms of response burden to enterprises but met policy and research needs at many levels. Data have been provided to universities, to ministries and to the OECD secretariat. The DG XIII studies have had a major impact on the Commission's Green Paper on Innovation of 1995 and its Action Plan for Innovation in Europe of 1996. These studies helped to identify which public actions promote innovation.

The intensive use of the innovation data and an in depth evaluation of the first CIS by independent researchers have created a favourable atmosphere for innovation surveys. Therefore DG XIII, the Member States and Eurostat decided upon a second innovation survey that is taking place right now. It has been designed to overcome most of its shortcomings of the first survey and to produce results in a much shorter time span. In recent time the interest for innovation of DG III - Industry - and XXIII - small and medium sized enterprises - has increased clearly.

For short, innovation surveys are a promising area for users of data but relatively expensive in terms of costs to data providing enterprises.

R&D

Now I shall turn to Research and Development data.

Government appropriations - budget figures - were for years the only R&D data that Eurostat provided. In the course of time its breakdown into chapters and subchapters has improved, and methodological issues have been solved but little has changed over the past 10 years. Note that these figures cause no response burden other than that of a budget analyst.

R&D performance data - data on the actual execution of R&D - have been collected in the Member States and for the OECD much longer than for Eurostat. Eurostat has, however, from the moment it started to collected data, focused on its regional dimension. For the purpose of regional policy making it was deemed necessary to trace in what respect regions fall short of what one would expect for a rapidly developing area. Also the cohesion and structural funds nowadays spend a considerable fraction of their budgets into R&D type activities.

The performance data typically deal with R&D in the Business Enterprise Sector, the Higher Education Sector and the Government Sector. With respect to the former, Business Sector, the regionalisation has increased the burden for enterprises to the extend that regionalised data demand larger samples.

The methodology of R&D statistics has been developed in the 1960-s under the auspices of the OECD secretariat and has become known as the FRASCATI Manual. It has been regularly updated since that time in collaboration with the OECD Member Countries and with Eurostat and DG XII of the Commission.

The R&D data are published annually in our book on R&D statistics. This regular availability is of course good for the users, but deprives us of the personal contact with clients such as we have in the area of innovation. Book sales figures and an occasional specific data request do give us some idea of what the users want to see in this area. Inside the European Commission the R&D data are frequently used.

The Commission needs the information on R&D for its own Research policy making. Both DG XII, Research and Development, and DG XVI, regional policy, need this information to properly execute their tasks.

In recent years the DG XII European Report on Science and Technology Indicators brought substantial additional information to our users. This report provides R&D statistics, many other Science and Technology data and an analysis of these. The database upon which the report and its statistical annex is a Eurostat product.

Summarising, the European R&D data are obtained at little extra costs, but used relatively widely.

For some years Eurostat has published data on patents. The source of our statistics on patents is the European Patent Office which provides us with records on patents applied. Data are broken down by international patent classification and spatially: through a link between the postal codes of the inventor and regions this is possible.

Patent data are useful for policy making in various ways. The acquisition of intellectual property is an important indicator of innovative activities. Also patents are a way of measuring whether public support for research has led to inventions.

Clearly these statistics are cheap for enterprises. No administrative burden is caused apart from the one that is necessary to apply for the patent. Users are hard to analyse since they will mostly obtain our data through our paper publication but we do receive data requests that prove that the data are of interest to policy makers and to the scientific community.

Patent statistics are therefore free in terms of burden and relatively well used.

Human Resources in Science and Technology

Eurostat has collected and published data on stocks of Human Resources in Science and Technology. This means the total number of people in a society with third level education or working in an occupation that normally requires such an education. These stocks give another, wider, idea of the number of people involved in potentially innovative activities.

Both under the fourth and the fifth Framework Programme, the Commission has a human capital policy. In order to promote human capital, policymakers must know about the present state and its shortcomings. This exercise attempts to fill the gap in our knowledge.

Eurostat and the OECD secretariat collected these data for the first time in 1996, following a first joint methodological handbook in the Science and Technology field: the Canberra Manual. It published its findings and analysed the problems in data collections. Now, Eurostat aims to implement a second stock collection exercise in 1998.

Again these statistics are cheap in terms of burden for enterprises or households: the data are taken from census data or other population registers or Labour Force Surveys.

The data seem to be well used as both from Commission services and from the national statistical institutes we received data request.

Other administrative data

DG XII’s European Reports on Science and Technology Indicators of 1994 and 1998 need data far beyond the ones mentioned above. They are, however, all data that are collected for other purposes and copied straight into our database or reworked before being copied.

University graduation data are an example of the first type of ready data.

Trade in high technology products is an example of the second type of data. Information on trade by type of product is available. By defining a subset of products as high technology, one can find out what countries export and import and how much high-tech products.

Confidentiality

Innovation data are at enterprise level. The presence of such data is both an opportunity and a threat: an opportunity because they allow for much more detailed analysis than aggregates and a threat because of the confidentiality issues involved.

Eurostat has found a good solution to exploit the opportunities without giving up the confidential nature of the data. The micro data are only used in house in a separate office which guarantees that no outsider can take away the data.

For analysts from universities, ministries ..., we modify the data by micro-aggregation. These are changed in such manner that no enterprise can be meaningfully recognised, yet that any aggregation or analysis of the data results in more or less the same outcome as with the original, confidential data.

Diffusion

These statistics are available in various ways. There is the "R&D annual statistics" that covers Research and Development and patents: it appears every year. There is the recent CD-ROM on innovation and there are various ad-hoc publications in the Statistics-in-focus series. The widest source of information is the European Report on Science and Technology Indicators. The second edition of this report is about to appear and will contain the full width of S&T data.

Future

The mission of Eurostat is to provide the European Union with a high-quality statistical information system. In order to better attain that goal, the future of the Science and Technology statistics will mainly consist of improving the accuracy, timeliness and regionalisation of the data. It is likely that innovation, surveyed at the European level in 1993 and 1997, will be surveyed more regularly in the future.

A main area of new statistics will be the development of statistics on R&D implemented on behalf of the European Union. Its decentralised organisation made it hard to analyse in the past. Nowadays, the need for information on the whole of the EU research efforts led to a renewed and apparently successful attempt to gather comparable data.

Other new statistics will be on the impact and output of R&D. Of course, shifts in user needs will adapt our workplan into providing new indicators according to these.

Summary

Summarising, I would like to stress that Eurostat Science and Technology statistics has been extremely friendly in terms of not being a burden on enterprises. The Innovation surveys have had an impact but otherwise the European statistical system has been neutral - for most variables - (or slightly negative - for the regionalisation of business R&D surveys).

At these limited costs, Eurostat provides its users in the Member States and in the Commission a wide range of statistics on Science and Technology.

The emergence of the so-called knowledge economy is creating new measurement problems that official statistics will have to face. Globalisation is calling for a more international approach. Eurostat and its partners are in the centre of these new challenges and prepared to meet them.

OECD WORK ON R&D STATISTICS: FROM STATISTICS TO INDICATORS

Alison Young
OECD

Introduction

OECD work on R&D statistics is part of its wider programme on science and technology statistics. It covers the design, collection and diffusion of R&D statistics and indicators, the development and subsequent improvement of the underlying methodology (the Frascati manual) and the use of R&D statistics to monitor changes in the level and structure of national S&T efforts and also in more specialised studies to test hypotheses about National Innovation Systems and their links to employment and to economic and social progress.

This work is undertaken by the staff of the Economic Analysis and Statistics Division (EASD) of the Directorate for Science, Technology and Industry (DSTI) under the aegis of the Group of National Experts on Science and Technology Indicators (NESTI). The Group represents both the producers of the data collected by EASD and the users of the resulting international statistics and indicators in Member countries. (Box 1 shows the full range of actors involved.)

OECD international S&T statistics and indicators are used both in individual countries and at OECD and other international agencies for policy studies and for economic analysis and are also made available to the general public via paper and electronic media.

Box 1. S&T indicator activities : The OECD context

a) The OECD Secretariat

The OECD Secretariat is organised in directorates of which one is the Directorate for Science, Technology and Industry. It is composed of five divisions: Information, Computer and Communications Policy Division, Science and Technology Policy Division, Economic Analysis and Statistics Division, Industry Division, Sectoral Issues Division plus the Programme of co-operation in the field of Road Transport Research. The Economic Analysis and Statistics Division is responsible for the directorates quantitative work on science, technology and industry but not for information and communications indicators which are being developed by the division concerned.

There is also a Statistics Directorate which has a general co-ordinating role (see B below) and which deals with National Accounts and with Main Economic Indicators in OECD Member countries and in countries in transition. In the past statistics and indicators were developed and collected in the directorates to whose programmes they contribute (science and technology, industry, education employment labour and social affairs, agriculture, development aid etc.). The Organisation is currently considering the possibility of grouping some basic data collection in the Statistics Directorate in order to maintain performance at reduced costs.

b) The Committees and Working Parties

Countries are represented at OECD by a network of committees of which the OECD Council is the highest instance. The Directorate for Science Technology and Industry works with three main committees, the Industry Committee, the Committee for Scientific and Technological Policy (CSTP) and the Committee for Information, Computer and Communications Policy (ICCP). The CSTP has five working parties, the Group of National Experts on Science and Technology Indicators (NESTI), the Working Group on Innovation and Technology Policy (TIP), the Group on the Science System (GSS), the Working Party on Biotechnology and the Megascience Forum. There are two formal statistical working parties, NESTI for the CSTP and the Statistical Working Party of the Industry Committee. There is an ad hoc group on to develop indicators for the Information Economy for the ICCP. The Working Party on Public Support to Industry (Industry Committee) manages a data-base which contains some S&T statistics.

The NESTI Group represents both users and producers of S&T indicators with two-thirds of its principal delegates coming from ministries of science and technology or associated bodies, such as research councils, and one-third from central statistical offices or similar producer agencies. Its annual meetings attract about seventy experts. All OECD countries are usually represented . Observers attend from Israel, Russia, the Slovak Republic and also from UNESCO.

Users and producers from the European Commission are members of NESTI and there is growing co-operation between the organisations both on substance and organisation. Meetings are scheduled so that there are two rounds of discussion each year, one at OECD and the other at Eurostat (with non-Member states able to attend as observers where appropriate.) Further co-operation with UNESCO is also planned.

2. Designing new or improved methodology

Internationally comparable data must be based on common standards. OECD is the lead international organisation for international S&T statistical standards, i.e. the "Frascati family" of Manuals on the measurement of scientific and technological activities as shown in Box 2. he Frascati Manual itself, first published in 1963 and now in its fifth edition, deals with R&D. Manuals have also been issued on the technology balance of payments, on the measurement of industrial innovation (Oslo Manual) on the use of patents as S&T indicators, and on human resources for science and technology - HRST - (Canberra Manual). Over the years methodological work has also been undertaken on the identification of high-tech industries and products, on the measurement of intangible investment and on bibliometrics.

Box 2. OECD Manuals on the Measurement of Scientific and Technological Activities

Type of data	Title
R&D	Proposed Standard Practice for Surveys of Research and Experimental Development ("Frascati Manual" 1993)
R&D	Main Definitions and Conventions for the Measurement of Research and Experimental Development (R&D) (A Summary of the Frascati Manual 1993)
Technology Balance of Payments	Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments Data (1) (TBP Manual)
Innovation	OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data (Oslo Manual 1997) (with EC/Eurostat)
Patents	Using Patent Data as Science and Technology Indicators (1) (Patent Manual 1994)
Human Resources	The Measurement of Human Resources Devoted to S&T (1) (Canberra Manual 1995) (with EC/Eurostat)

(1) Dealing mainly with the problems of classifying and interpreting existing information

Whilst these manuals are essentially designed for use in OECD Member countries, they are being increasingly adopted elsewhere notably countries with observer status in NESTI. Interest has also been expressed and in the rapidly growing Asian economies and in Latin America. For example a request for permission to translate the latest edition of the Oslo manual into Chinese has recently been granted

3. OECD R&D data-collection, data bases and products

The data on which S&T indicators are based are either derived from purpose-built surveys (R&D, innovation) or are assembled from sources originally set up for administrative purposes (patents, technology balance of payments, foreign trade) or for other reasons (bibliometrics). The OECD is a second degree compiler of statistics and indicators, generally depending on the agencies who collect the basic data in Member countries to supply them arranged to meet international standards. However, some OECD S&T indicators, notably patents, are compiled directly from international or special sources by consultants or by the Secretariat.

Box 3. Agencies reporting R&D data to OECD

National Statistical Offices	S&T ministries and agencies
Australia	Belgium
Austria (3)	Denmark
Canada	France
Czech Republic	Germany (1) (2) (3)
Finland	Greece
Hungary	Iceland
Italy	Ireland
Japan	Korea
Netherlands	Mexico (2)
Poland	New Zealand (2)
Spain	Norway (1) (2)
Sweden	Portugal
Switzerland	United States
Turkey	
United Kingdom	

(1) The NSO is represented at NESTI
(2) The NSO or equivalent is responsible for collecting some of the data concerned.
(3) The industrial R&D survey is undertaken by another body (change to NSO in Austria).

The EASD divides its databases into two categories, first level bases of statistics and second level: bases of indicators, which are complete and coherent sets of data ready for use.

a) Collecting and processing the "first level "R&D data

The OECD R&D survey is based on a questionnaire which is itself based on the Frascati manual. It covers both the results of retrospective surveys of R&D performed in the different sectors of the economy and funder reported data on government budget appropriations or outlays for R&D (GBAORD). The core questionnaire comprises five main tables needed to calculate the key indicators,[1] more detailed tables on R&D expenditure and personnel at national level and in the business enterprise and higher education sectors. The questionnaire also includes additional tables which are mainly used for checking international comparability of data, (for example treatment of different types of institutes) or which are confidential (e.g. defence R&D) or which are frankly experimental (e.g. data on R&D foreign owned enterprises).

The survey itself takes the form of rolling exchange of a modular set of tables containing the data for the country concerned between the reporting agency (see box 3) and the Secretariat. The tables are exchanged on diskette or by E-mail. Countries can send in updates as data become available from the national survey either in blocks by sector or for all the tables together. They are invited to return the Main tables for two dates in the year for MSTI (see below) and to supply a full set at least once every two years.

Box 4. **OECD S&T Statistics**

[1] Plus a summary table on the Technology Balance of Payments.

(First level data bases)

I. The main data-bases

1. Research and Experimental Development

Coverage: This base covers the resources (expenditure and personnel) devoted to R&D in different countries, sectors, industries and fields of science and also according to other criteria including source of funds, type of costs, type of R&D activity and socio-economic objectives. The main set of data, compiled on the basis of retrospective surveys of the performers of the R&D, build up into national totals, notably "Gross Domestic Expenditure on R&D or GERD. A second set of data "Government Budget Appropriation or Outlays for R&D", GBAORD, cover government funding of R&D as reported by the funder broken down by socio-economic objective. R&D data are stocked for all OECD countries except Luxembourg and are reasonably reliable and comparable as from the 1970s.

Sources: The data are derived from national R&D surveys and budgets and are supplied via the rolling, diskette-based, "International Survey of Resources Devoted to R&D by OECD Member countries", which comprises the long questionnaire returned at least once every two years plus the summary tables returned twice yearly for MSTI (see Box 5). Some data on Government Budget Appropriations or Outlays for R&D are provided by the Statistical Office of the European Community (Eurostat).

2. The Technology Balance of Payments

Coverage: The TBP registers the commercial transactions related to international technology transfers. It consists of money paid or received for the use of patents, licences, trademarks, designs, know-how and closely related technical services (including technical assistance) and for industrial R&D carried out abroad, etc. Simple TBP data are available for the majority of OECD countries. More detailed data, broken down by industry and/or country of transaction are available for selected countries.

Source: The data are compiled in OECD countries from the most appropriate national source (Central Banks, special surveys etc.) OECD collects the main TBP aggregates via the summary tables of the "International Survey of Resources Devoted to R&D by OECD Member countries." A special questionnaire is used to collect data with detailed TBP data.

3. Patents

Coverage: The global data concern the number of patents applied for (as opposed to the number finally granted) via national, European and other international procedures broken down by country of application and country of residence of the applicant.

Sources: Basic data come from the WIPO (World Intellectual Property Organisation, Geneva) which publishes since 1985 patents data covering all application routes (national patent offices, Patent Co-operation Treaty Administration and European Patent Office). The resident patent applications via European procedure are adjusted to avoid double counting.

II. The main product: Basic Science and Technology Statistics -- BSTS --

Presents detailed country-by-country annual historical series on the resources devoted to R&D (expenditure and personnel) patents and technology balance of payments together with short methodological notes.

It is published every two years on paper (data for the last eight years) and annually on diskette (back to 1981). It is also included on "The OECD Statistical Compendium" CD-ROM issued jointly by OECD and DSI Data Services and Information (Germany).

The first task at EASD is to undertake number of simple checks on the standard data[i], essentially to confirm the coherence between the data in different rows, columns and tables and to read any accompanying material from the country to identify any changes in the characteristics of the R&D series which need to be signalled to users in the form of notes attached to data points and in sources and methods files. Even where explanations have not been supplied with the response the Secretariat may notice major changes or potential anomalies and contact the national agency with queries. Sorting out the matter may involve several exchanges of E-mail, particularly where there have been staff changes in the country concerned and the new person is not familiar with the adjustments to national R&D needed when reporting to OECD. Once this period of quality control is finished the data are entered in the various segments of the data base which are open to DSTI staff for consultation and once a year are published in “Basic Science and Technology Statistics”. The final set of tables with agreed corrections and annotations are returned to the national agency to await the next update.

b) From R&D statistics to R&D indicator

Indicators are statistics arranged so as to answer questions. Potential users of R&D data ask different questions and differ as to how far they want pre-calculated indicators or prefer to design and calculate them themselves.

The first and most immediate use of R&D data is to permit governments to monitor their own science and technology activities compared with those of other countries with which they have affinities of size, structure or language and history (see table 1) or which they regard as targets (notably the United States and Japan) (table 2). In some cases, international comparisons of evolving structures of funding and performance of R&D may contribute to the establishment of priorities and targets for government R&D funding.

The Main Science and Technology Indicators (MSTI) data base was set up to meet this need. Seventy of the 89 indicators involve R&D expenditure or personnel data compared either with national totals (percentage of GERD financed by government or percentage of researchers employed in the Business Enterprise sector.) over time (percentage growth since preceding year), or with total national resources (e.g. GERD as % of GDP or R&D personnel per thousand labour force). These indicators are calculated country by country as first level responses are received and checked. They often reveal potential problems with the underlying data which are not immediately obvious from a simple examination of the national currency data at current prices and which may require further contacts with the country concerned.

The contents of the MSTI base are used in a variety of ways in Member countries. A standard sub-set may be published regularly in a national S&T statement or S&T indicator report. For example EASD supplied special extracts from MSTI for "Bundesbericht Forschung" in Germany for the “Forward Look” in the United Kingdom and for the forthcoming issue of the National Science Board “Science and Engineering Indicators” report in the United States. Policy staff may consult the paper publication for ad hoc use (ministerial speeches, answers to parliamentary questions etc.). In some countries such as the United Kingdom, some or all the diskette is downloaded onto the intranet of the S&T policy agency to facilitate such ad hoc use.

Box 5. OECD S&T Indicators (Second-level data-bases)

1. Main Science and Technology Indicators (MSTI)
Aim: To provide a timely selection of the most frequently used yearly indicators on the scientific and technological performance of the OECD Member countries.

Coverage: The base includes 89 series (ratios, percentage shares, growth rates etc.) of which seventy concern R&D expenditure and personnel involved. The last 19 series deal with patent applications, technology balance of payments (TBP) and trade in selected industries. All OECD countries are generally included and zone totals are calculated. Science and technology indicators include final and provisional results and forecasts by governments as well as methodological notes. The contents of the base is generally quoted as from 1981. The series for 1971-80 may also be released in future.

Source: The R&D, TBP and patent indicators are calculated using the data from the first level data bases. The Export/Import ratios are based on data from the OECD trade data base.

Diffusion: The data set is issued twice yearly on paper (for the latest years) in "Main Science and Technology Indicators" and on diskette (from 1981). The latter's contents is available on the OECD on-line system (OLIS) and via the OECD web site (Internet).

2. ANTECH
Aim: To develop a set of technology indicators designed to be used in an integrated fashion with : Bilateral Trade, Industrial (STAN), and input-output data. Of the three planned components of ANTECH, ANBERD, ANRSE and ANPAT, only the first is fully operational. Its specific aim is to have a consistent data set, that overcomes the problems of international comparability and time discontinuity in the official BERD data provided to the OECD by the Member countries.

Coverage: The ANBERD base covers the period 1973 to 1995 and 27 industries for 15 countries: Australia, Canada, Denmark, Finland, France, Federal Republic of Germany before unification as well as Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States.

New: In 1996, the Secretariat extended the coverage of the ANBERD in order to incorporate the Revision 3 industry listing for the services' sectors, thereby creating a hybrid between ISIC Revision 2 (for manufacturing) and Revision 3 for services from 1987 onwards. These data are only available in the paper edition.

Source: The ANBERD data set for each country is constructed by the Secretariat in close collaboration with national statistical authorities. Statistical estimation techniques are used to fill in missing values or to adjust the Member countries' official submissions of business enterprise R&D data in order to obtain improved and more extensive time series.

Diffusion: As it is based on estimates, the ANBERD database is published under the responsibility of the Secretary General of the OECD. It is issued annually on paper in "Research and Development Expenditure in Industry" which also includes the official data on business enterprise R&D expenditures submitted to the OECD by 27 of its Member countries together with the sources and methods used for compiling and reporting this data. The data is also available in electronic format and via the OECD web site (Internet).

When making international comparisons of technology efforts, governments need to be able to review them in light of national industrial structures. For this purpose, EASD set up the STAN database which combines industrial, input-output, trade and S&T indicators using a common industrial classification. The S&T part, called ANTECH has three components ANBERD (see box 5), ANRSE and ANPAT. Although the data are finally published on the responsability of the OECD ANBERD and ANRSE are prepared in close co-operation with the national reporting agencies and these discussions may reveal problems whose solution also affects the official data in BSTS notably concerning industrial classificiations.

National government agencies, such as Japan's Ministry of International Trade and Industry, Australia's Department of Industry, Science and Tourism, Industry Canada, the French INSEE and the US National Science Foundation, have drawn on the ANBERD/STAN database as have private research organisations, such as the Sanwa Research Institute (Japan), McKinsey and Co. and MERIT (the Netherlands). They have also been extensively used in the European Science and Technology Indicator reports.

Quantitative international comparisons are also sought for individual areas of S&T either by government agencies or by specialists from the areas concerned (including those who wish to prove that it is underfunded in their particular country). Typical areas are environmental R&D, biotechnology or academic science in general. Sometimes ways of calculating indicators from OECD sources can be suggested. The paper and diskette versions of Basic S&T Statistics (BSTS) are provided for this purpose (see box 4).

Internationally comparable data are also required by analysts, often academics, in Member countries to develop their models of S&T and the economy. For this socio-economic research they usually prefer to work from the detailed data to construct their own indicators. Until recently OECD published a tape with all its S&T data, sold on a *caveat emptor* base. Where the data they need to test their new hypotheses are not available they may undertake *ad hoc* pilot surveys which, if successful, are subsequently adapted and adopted by statistical services.

c) OECD studies

OECD also prepares its own international comparisons designed to assist member governments, with varying degrees of “value added” in the form of analysis of quantitative data by the Secretariat. EASD publishes a biennial *Science, Technology and Industry Scoreboard of Indicators*. EASD R&D indicators are also used in a wide range of other OECD reports notably the *Science, Technology and Industry Outlook* (alternate years to the scoreboard), reviews of national S&T policy in individual countries and special studies such as *Technology, Productivity and job Creation: Towards Best Policy Practice.* The Annex shows an extract from the latest STI scoreboard showing how ANBERD data can be used to analyse business sector R&D intensity. R&D data are also provided to users in other parts of the OECD, for example the Energy Agency and the Environment Directorate.

Using ANBERD and input-output data, the staff of the EASD also have made socio-economic studies of the flow of technology between industrial sectors and countries incorporated in intermediate and capital goods, which, in turn has lead to a re-evaluation of the OECD standard list of industries classified according to level of technology.

4. Next steps

It is forty years since the European Productivity Agency, the forunner of the OECD DSTI, first took an interest in R&D statistics and thirty five years since the fledgling Committee for Scientific Policy ordered the first edition of the Frascati manual. We now have time series back to the early 1970's for many countries and even earlier for the pioneers. The Frascati Manual is in its fifth edition. However nether the S&T system for our understanding of it stand still and further improvements are needed if R&D data are to continue to answer policy relevant questions.

a) Developments in the economics of technology

In recent years both the conceptual framework for the analysis of science and technology and the structures of national economies and S&T institutions have changed in ways which have important consequences for the collection and use of R&D statistics. A key change is the recognition that simple indicators taken in isolation can be misleading and that sensible analysis of S&T requires a variety of indicators, ideally tied together by a conceptual framework. These frameworks are emerging from theoretical and empirical work focusing on the central role of knowledge accumulation and diffusion in the process of innovation and economic growth.

The analysis of S&T systems is also changing from one which dealt mainly with the resources and spending patterns of the public and private organisations involved to one which treats them as a network and concentrates on describing those interactions which are essential for the creation and diffusion of technological knowledge. This model known as the "national innovation system" will have significant influence for the development of R&D indicators both for industry and for the public sector.

The information needed to describe these relations cannot easily be expressed in simple quantitative terms. The surveys designed to acquire this information sometimes ask "how much?" or "how many?" but more often "how influential?" or "how detrimental?". It is not easy to design questionnaires about the strategies of the firm as regards, for example, intellectual property or sources of knowledge whose results can be satisfactorily compiled and compared, particularly at international level.

b) Intangible investment and changes in the treatment of R&D in the SNA

While S&T specialists were rethinking their framework mainstream economists, dissatisfied with the failure of traditional analysis in terms of factors of production to explain economic performance, also turned their attention to technology and more particularly R&D, in the framework of "intangible investment".[ii]

Intangible investment was discussed at length during the revision of the System of National Accounts. The outcome was that, although a category for produced intangible assets was established, it does not cover R&D. Some steps have been taken to identify R&D activities/units and the preparation of satellite accounts is recommended. This has two consequences for S&T statistics. The first is that the instructions for identifying industrial R&D activities/units in the SNA, taken together with the instructions for their classification in ISIC Rev 3. are not compatible with those for their treatment in R&D surveys undertaken according to the Frascati Manual. This matter came to light at a NESTI meeting and is being followed up by the Group. The second is that, given that most of the data for R&D satellite accounts will have to be derived from such Frascati-based R&D surveys, it would be desirable to establish a standard methodology for adapting the latter for SNA purposes which was agreed both by the S&T statisticians and national accountants. This question will be discussed at the forthcoming Eurostat meeting.

c) Changes in economic structures

User's needs for R&D indicators have also developed to reflect changes in economic structures **Globalisation** is probably the most important of these. Government policy makers need information on the share of national R&D efforts which are financed and/or carried out by multi-national corporations and by international organisations and about where the resulting innovation and production activities take place and what factors influence the decisions concerned. There are currently experimental tables in the OECD R&D questionnaire on the R&D activities of foreign affiliates and a paper has recently been issued based on national responses [DSTI/IND/STP/SWP/NESTI(97)2&CORR1][iii] . Data is also being collected on R&D financed by the European Commission.

Industrial structure has also changed with the growth of the **services**. Until recently little was known about R&D in the services" [OECD/GD(96)132] [ix] . R&D surveys have now been extended in many Member countries revealing a previously unsuspected level of activity. Governments are counting on **SME**s to play an important role in growth in employment. As yet little is known about how they access and apply S&T except for the relatively few high-tech SMEs. It is clear that better R&D indicators are needed about SMEs, especially in the services, for economic and policy analysis.

The growth in outsourcing and subcontracting in industry is also complicating the R&D statisticians task. There is an increasing gap in many countries between the amounts which government report as extramural payments to industry and the contribution of government reported by the firms carrying out the R&D projects concerned. In some cases this can also be a case of globalisation where the sub-contractor is in a foreign country.

d) Changes in policy preoccupations and funding methods

The end of the Cold war and the resulting decline in defence R&D and its effect on national systems of innovation are also areas needing monitoring in countries such as the United States, France, the United Kingdom and Sweden. There are signs in many Member countries that there is increased interest in R&D for broadly social objectives notably human health.

Governments are also changing the ways in which they finance R&D. In general increasing budgetary pressure leads to more detailed requirements for data from actual or potential performers of government financed R&D. In consequence the units concerned have to keep more detailed records and should be better prepared to respond to R-D surveys. At the same time governments are also making growing use of funding schemes which have not hitherto been included in R&D statistics, notably fiscal incentives.

e) Long-standing problem areas

The Higher Education sector is a perennial problem. Although EASD is quite well informed about how R&D data are collected/compiled in Member countries it remains unable to provide reliable indicators of what is happening in the science system or which could be of any use in allocating funds to academic R&D. OECD is also not in a position to collect data on very detailed fields of science and technology.

Box 6. New indicators for a knowledge-based economy: projects launched

Mobility of human resources: between firms, between industries, between the public and private sector. Human resources are a main vehicle for the circulation of knowledge. Led by Sweden (NUTEK and Statistics Sweden) this project has two main components.(i) an inquiry into the mobility of skilled workers as revealed by the exhaustive tax records in Swede focusing initially, on the "knowledge intensive business sectors" (e.g. financial services) in order to explore the methodological issues (e.g. the effect of the birth and death of firms). (ii) a review of the sources available in OECD countries and how the Swedish methodological findings from the Swedish case could be applied to countries with less detailed data. A comparison of the results from tax records and from more broadly available sources will be undertaken for Sweden, in order to assess the loss of information resulting from use of the latter The United States is also joining this project.

Patents based indicators. The aim is to go beyond simple patent counts whose drawbacks are well known. This project differs from the others in that it makes use of international data, which can be directly processed in a harmonised way. Discussions with the European Patents Office (EPO) have been undertaken with the aim of setting up a quite large data base of European patents (with their world-wide extensions) to include information on patent renewal and on patents citations, which are currently largely omitted from patent studies. Data on patents granted by the USPTO are also being used. Experts are being retained to design and calculate indicators using these data, to measure the economic value of inventions, their social or technological value, and the diffusion of knowledge within and across national boundaries. Tests will be made to compare various indicators of technological performance at the firm level and at aggregate level: productivity, innovation and patents. One outcome could be a revision of the OECD "Patents manual". Since patents data are essentially international, there was no need of lead countries and the Secretariat is directly in charge of this project.

Innovative and absorptive capacity of firms: This project makes use of data collected through the first round of innovation surveys in European countries (CIS). The aim is to design and calculate aggregate indicators of innovative intensity at national and sectoral levels, indicators of the circulation of knowledge and the sources of technological information used by firms, and of the factors which favour or hamper innovation. Eurostat, which co-ordinated the first CIS and which holds the micro-aggregated data, is a partner in this project and Italy is a lead country. Italian studies have already shown the high potential of such data, in terms of description of national innovation systems and innovation policy design. Once available, the new methods could be applied in the forthcoming CIS2 surveys and in innovation surveys outside Europe.

Internationalisation of industrial R&D: The aim is to measure the extent, the factors and consequences of business R&D internationalisation, especially via multinational firms and via international alliances of firms. Data on foreign affiliates, collected by the Secretariat, and patents data will be used. New indicators of the technological content of international flows of goods are being tested. The lead countries are Germany (BMBF) and France (OST).

Government support to industrial R&D and innovation: The aim is to develop accurate indicators of "indirect" government support for industrial R&D notably via fiscal incentives which following the current recommendations of the Frascati Manual, is not credited to government as a source of funds in the regular OECD R&D survey. This builds on an initiative launched at the 1995 meeting of NESTI and is being pursued as part of Module 2 of Phase II of the jobs study. It will draw on data and methods established by the Working Party on Support to Industry of the Industry Committee and also on the experience of the Working Group on Innovation and Technology Policy. Australia and Canada are the lead countries.

Information and Communication technology: this project, which is still in a preliminary stage, was added to meet a request from the CSTP. It will be carried out in co-operation with the new statistical panel of the ICCP, which first met in June 1997.. It will probably address the following topics: measuring technical change in ICT products, the actual, total cost of using ICT (including complementary investment, foregone production etc.), training in firms in connection with the use of ICT, ICT and innovation in the financial services.

In general S&T indicator systems are designed to build up to a (national) total with each unit of classification allocated to its "primary" activity/field/industry etc. When examining specific policy areas users often want data which cover all relevant S&T activities not merely those primarily involved. For example the same research project might be of interest for studies of health-related R&D, environmental R&D, agricultural R&D and, in terms of the means used, IT or mobility of HRST. OECD could only supply such data if it collected information at a much more detailed level and stocked it in a more flexible way. A particular case is the current interest in identifying all R&D relating to **software** or to **IT.**

f) Work in progress

Some of these topics are being dealt with as part of the ongoing activities of NESTI, meeting at OECD or in a slightly different formation at Eurostat. For example, considerable progress has been made at OECD in measuring R&D in the services and Eurostat is about to launch an initiative on satellite accounts for R&D. Other projects require more "blue sky" work before they can be tested by a wide range of countries. OECD has a special activity on indicators for a knowledge-based economy based on the lead country approach (see box 6). Two of the projects, the internationalisation of R&D and government support to industrial R&D and innovation, deal specifically with R&D and others may have implications for R&D data.

Ultimately all this work will be integrated in the next edition of the Frascati Manual.

Table 1. Selected Science and Technology Indicators for Nordic Countries -1995

	Denmark	Finland	Iceland	Norway	Sweden	Nordic Countries
Gross Domestic Expenditure on R&D - GERD	2149.2	2149.7	89.5	1697.1 ac	5939.2 ac	12049.9 a
GERD - Compound annual growth rate (constant prices)	6.9	5.8	12.0	- ac	- a	- a
GERD per capita population (current PPP$)	411.1	420.9	335.1	390.3 ac	671.3 ac	506.3 a
GERD as a percentage of GDP	1.92	2.37	1.54	1.71 ac	3.60 ac	2.55 a
Estimated Civil GERD as a percentage of GDP	1.9	2.3	1.5	1.6 ac	-	2.5 ab
Total R&D personnel	30213	33634	1694	23938 ac	62617 c	152551 b
Total R&D personnel - Compound annual growth rate	5.0	4.0	19.9	- ac	5.2 c	5.1 b
Total R&D personnel per thousand labour force	10.8	13.3	11.4	11.0 ac	14.5 c	12.7 b
Total R&D scientists & engineers - RSE	15954	16863	1076	15931 a	-	83700 b
Total RSE - Compound annual growth rate	8.0	5.2	27.4	- a	-	6.3 b
Total RSE per thousand labour force	5.7	6.7	7.2	7.3 a	-	7.0 b
Percentage of GERD financed by industry	46.7	59.5	34.6	49.9 ac	-	58.6 ab
Percentage of GERD financed by Government	39.2	35.1	57.3	43.5 ac	-	34.1 ab
Percentage of GERD financed by other national sources	4.1	1.0	3.7	1.6 ac	-	2.3 ab
Percentage of GERD financed by abroad	9.9	4.5	4.4	4.9 ac	-	5.0 ab
% of GERD performed by the Business Enterprise sector	57.4	63.2	31.9	56.7 ac	74.3 ac	66.4 a
% of GERD performed by the Higher Education sector	24.5	19.5	27.5	26.0 ac	22.0 acj	22.6 aj
% of GERD performed by the Government sector	17.0	16.6	37.4	17.3 aco	3.5 ac	10.3 a
% of GERD performed by the Private non profit sector	1.1	0.6	3.2	- n	0.2 ac	-
Business Enterprise Expenditure on R&D - BERD	1233.4	1359.0	28.5	962.4 a	4415.2 a	7998.6 a
BERD - Compound annual growth rate (constant prices)	6.0	7.5	14.7	- a	- a	- a
BERD as a percentage of DPI	1.67	2.18	0.77 b	1.38 a	3.94 ab	2.49 ab
BERD as a percentage of GDP	1.10	1.50	0.49	0.97 a	2.68 a	1.69 a
Industry-financed BERD - Compound annual growth rate (constant prices)	3.2	10.5	30.6	- a	10.9	9.6
Total Business Enterprise R&D personnel	17195	17798	551	12090 a	41636 a	89270 a
Total Business Enterprise R&D personnel - Compound annual growth rate	3.8	5.3	31.8	- a	- a	- a
Total Business Enterprise R&D personnel (% of national total)	56.9	52.9	32.5	50.5 ac	66.5 ac	58.5 ab
Business Enterprise RSE	6674	6683	359	7921 a	19054 a	40691 a
Business Enterprise RSE - Compound annual growth rate	6.5	10.7	25.1	- a	- a	- a
Business Enterprise RSE (% of national total)	41.8	39.6	33.4	49.7 a	-	48.6 ab
Higher Education Expenditure on R&D - HERD	527.1	420.1	24.6	441.6 c	1304.0 aj	2717.5 aj
HERD - Compound annual growth rate (constant prices)	10.7	9.7	28.4	0.8 c	- a	- a
HERD as a percentage of GDP	0.47	0.46	0.42	0.45 c	0.79 aj	0.57 aj
Higher Education total R&D personnel	7213	9146	530	6955	17301	41145
Higher Education total R&D personnel - Compound annual growth rate	7.7	6.6	37.8	2.2	-0.4	2.6
Higher Education RSE	5520	6481	380	4993	11873	29247
Higher Education RSE - Compound annual growth rate	9.2	3.1	80.5	2.7	1.9	3.9
Higher Education RSE (% of national total)	34.6	38.4	35.3	31.3 a	-	34.9 b
Government Intramural Expenditure on R&D - GOVERD	365.6	357.8	33.5	293.1 o	210.6 ac	1243.9 a
GOVERD - Compound annual growth rate (constant prices)	4.5	-6.9	2.6	-2.1 c	- a	- a
GOVERD as a percentage of GDP	0.33	0.39	0.58	0.30 o	0.13 ac	0.26 a
Government total R&D personnel	5439	6430	563	4893 o	3500 ac	20454 ab
Govenment total R&D personnel - Compound annual growth rate	5.2	-6.1	1.6	1.6	- a	- a
Government RSE (full time equivalent)	3575	3499	324	3017 o	-	12596 b
Government RSE - Compound annual growth rate	9.0	0.3	-1.8	2.3	-	3.9 b
Government RSE (% of national total)	22.4	20.7	30.1	18.9 ao	-	15.0 b
Total Government Appropriations or Outlays for R&D - GBAORD	848.0	920.7 a	47.9	916.6	1963.3 p	4696.4 p
Defence Budget R&D as a percentage of total GBAORD	0.5	2.1 a	0.0	5.0	20.9 p	10.2 p
Civil Budget R&D as a percentage of total GBAORD	99.5	97.9 a	100.0	95.0	79.1 p	89.8 p
Economic programmes as a percentage of Civil GBAORD	22.5	46.8 a	38.0	29.3	20.5 p	28.5 p
Health and Environment programmes as a percentage of Civil GBAORD	17.2	13.9 a	-	19.5	13.7 p	15.6 p
Space programmes as a percentage of Civil GBAORD	2.4	2.2 a	-	3.0	1.8 p	2.3 p
Non-oriented Research programmes as a percentage of Civil GBAORD	22.0	10.2 a	-	9.4	14.6 p	14.1 p
General University Funds as a percentage of Civil GBAORD	35.9	26.9 a	-	38.7	49.4 p	39.4 p

Expenditure data are expressed in million current PPP$; Personnel figures are expressed in full time equivalent

Source : OECD, MSTI database (STI/EAS Division), November 1997.

Table 2. Selected Science and Technology Indicators for G-7 countries - 1995

	Canada	France	Germany	Italy	Japan	United Kingdom	United-States
Gross Domestic Expenditure on R&D - GERD	10240.2	27044.4	38411.5 c	12692.6 pu	75635.6 bl	21374.8	179126.0 ejp
GERD - Compound annual growth rate (constant prices)	2.9	0.3 b	0.6 b	1.0 pu	6.5 b	-0.3	4.0 p
GERD per capita population (current PPP$)	345.8	465.1	470.4 c	221.6 pu	602.3 bl	364.7	680.7 ejp
GERD as a percentage of GDP	1.65	2.33	2.30 c	1.14 pu	2.77 bl	2.05	2.55 ejp
Estimated Civil GERD as a percentage of GDP	-	2.0	2.2 c	-	-	1.7	2.1 ejp
Total R&D personnel	-	318384	470166 c	-	826656 l	-	-
Total R&D personnel - Compound annual growth rate	-	1.0	0.7 c	-	-0.2	-	-
Total R&D personnel per thousand labour force	-	12.5	11.9 c	-	12.4 l	-	-
Total R&D scientists & engineers - RSE	-	151249	-	-	551990 l	148000 p	-
Total RSE - Compound annual growth rate	-	1.4	-	-	2.0	4.2 p	-
Total RSE per thousand labour force	-	6.0	-	-	8.3 l	5.2 p	-
Percentage of GERD financed by industry	46.8	48.3	60.5 c	48.7 pu	72.3 bl	48.0	59.9 ejp
Percentage of GERD financed by Government	35.1	42.3	37.4 c	47.4 pu	20.9 bm	33.3	36.1 ejp
Percentage of GERD financed by other national sources	5.5	1.3	0.4 c	0.0	6.7 bm	4.3	4.0 ejp
Percentage of GERD financed by abroad	12.6	8.0	1.7 c	3.9 pu	0.1 bm	14.3	-
% of GERD performed by the Business Enterprise sector	60.5	61.0	65.7 c	57.1 pu	70.3 bl	65.5	71.8 ejp
% of GERD performed by the Higher Education sector	22.7	16.7	18.9 c	22.9 pu	14.5 bm	18.8	15.2 ejp
% of GERD performed by the Government sector	15.6	21.0	15.4 co	20.1 pu	10.4 bm	14.5	9.5 ehp
% of GERD performed by the Private non profit sector	1.2	1.3	- n	-	4.8 bm	1.2	3.4 ejp
Business Enterprise Expenditure on R&D - BERD	6195.1	16492.0	25225.3 c	7243.3 pu	53157.4 l	13992.5	128700.0 jp
BERD - Compound annual growth rate (constant prices)	6.0	-1.1 b	-0.3 b	2.2 pu	5.3	-0.4	5.3 p
BERD as a percentage of DPI	1.40 b	1.89	1.92 c	0.80 pu	2.17 l	1.79 b	2.08 bjp
BERD as a percentage of GDP	1.00	1.42	1.51 c	0.65 pu	1.95 l	1.34	1.83 jp
Industry-financed BERD - Compound annual growth rate (constant prices)	6.7	-0.6 b	-0.3 b	2.4 pu	4.8	-4.7	5.7 p
Total Business Enterprise R&D personnel	72068	162042	285000 c	-	573713 l	148000	-
Total Business Enterprise R&D personnel - Compound annual growth rate	6.8	0.1	0.2 c	-	-0.7	-5.7	-
Total Business Enterprise R&D personnel (% of national total)	-	50.9	60.6 c	-	69.4 l	-	-
Business Enterprise RSE	43033	66618	-	-	384100 l	84000	-
Business Enterprise RSE - Compound annual growth rate	7.4	-0.1	-	-	2.0	1.2	-
Business Enterprise RSE (% of national total)	-	44.0	-	-	69.6	56.8 p	-
Higher Education Expenditure on R&D - HERD	2327.1	4518.0	7254.9 c	2900.8 p	10992.6 be	4020.2	27300.0 jp
HERD - Compound annual growth rate (constant prices)	-0.8	3.6 b	1.6 b	-2.1 p	9.6 b	0.4	1.3 p
HERD as a percentage of GDP	0.37	0.39	0.43 c	0.26 p	0.40 be	0.39	0.39 jp
Higher Education total R&D personnel	-	80678	110000 c	-	169118 e	-	-
Higher Education total R&D personnel - Compound annual growth rate	-	3.3	0.0 c	-	1.6	-	-
Higher Education RSE	-	53726	-	-	121431 e	47000	-
Higher Education RSE - Compound annual growth rate	-	3.1	-	-	3.0	11.9	-
Higher Education RSE (% of national total)	-	35.5	-	-	22.0 em	31.8 p	-
Government Intramural Expenditure on R&D - GOVERD	1594.3	5676.5	5931.2 co	2548.4 pu	7864.7	3097.5	16976.0 ehp
GOVERD - Compound annual growth rate (constant prices)	-2.4	2.1 b	3.4 b	1.3 pu	14.0	-1.1	0.4 p
GOVERD as a percentage of GDP	0.26	0.49	0.35 co	0.23 pu	0.29	0.30	0.24 ehp
Government total R&D personnel	18250	68539	75166 o	-	55990	29000 p	-
Govenment total R&D personnel - Compound annual growth rate	-8.7	0.7	3.4	-	0.6	-9.4 p	-
Government RSE (full time equivalent)	7740	27195	-	-	30346	14000 p	-
Government RSE - Compound annual growth rate	-5.3	3.0	-	-	0.3	0.0 p	-
Government RSE (% of national total)	-	18.0	-	-	5.5 m	9.5 p	-
Total Government Appropriations or Outlays for R&D - GBAORD	3311.5 h	12944.4	15312.9	6476.0 p	14141.2 g	8181.3 p	68791.0 hij
Defence Budget R&D as a percentage of total GBAORD	4.9 h	30.3	9.1	4.7 p	6.2 g	40.8 p	54.1 hij
Civil Budget R&D as a percentage of total GBAORD	95.1 h	69.7	90.9	95.3 p	93.8 g	59.2 p	45.9 hij
Economic programmes as a percentage of Civil GBAORD	33.2 ah	19.6	23.0	15.8 p	31.4 g	28.2 p	22.2 hij
Health and Environment programmes as a percentage of Civil GBAORD	20.9 ah	12.3	12.6	16.2 p	6.2 g	24.4 p	43.9 hij
Space programmes as a percentage of Civil GBAORD	7.5 ah	15.2	5.7	9.1 p	7.9 g	4.9 p	25.1 hij
Non-oriented Research programmes as a percentage of Civil GBAORD	5.4 ah	27.8	16.5	8.4 p	10.3 g	10.2 p	8.8 hij
General University Funds as a percentage of Civil GBAORD	19.5 h	22.5	41.5	47.0 p	44.2 g	31.6 p	-

Expenditure data are expressed in million current PPP$; Personnel figures are expressed in full time equivalent

Source : OECD, MSTI database (STI/EAS Division), November 1997.

STANDARD TABLE FOOTNOTES

a) Break in series with previous year for which data is available.

b) Secretariat estimate or projection based on national sources.

c) National estimate or projection adjusted, if necessary, by the Secretariat to meet OECD norms.

d) (Note used only for internal OECD data-processing).

e) National results adjusted by the Secretariat to meet OECD norms.

f) Including R&D in the social sciences and humanities.

g) Excluding R&D in the social sciences and humanities.

h) Federal or central government only.

i) Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).

j) Excludes most or all capital expenditure.

k) Total intramural R&D expenditure instead of current intramural R&D expenditure.

l) Overestimated or based on overestimated data.

m) Underestimated or based on underestimated data.

n) Included elsewhere.

o) Includes other classes.

p) Provisional.

q) At current exchange rate and not at current purchasing power parities.

r) Including international patent applications.

s) Unrevised breakdown not adding to the revised total.

t) Do not correspond exactly to the OECD recommendations.

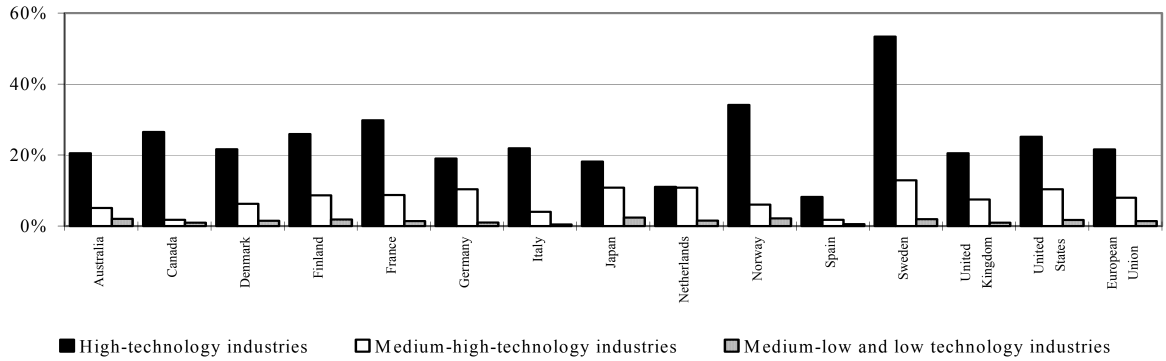
u) Including extramural R&D expenditure.

v) The sum of the breakdown does not had to the total (see General Methodology).

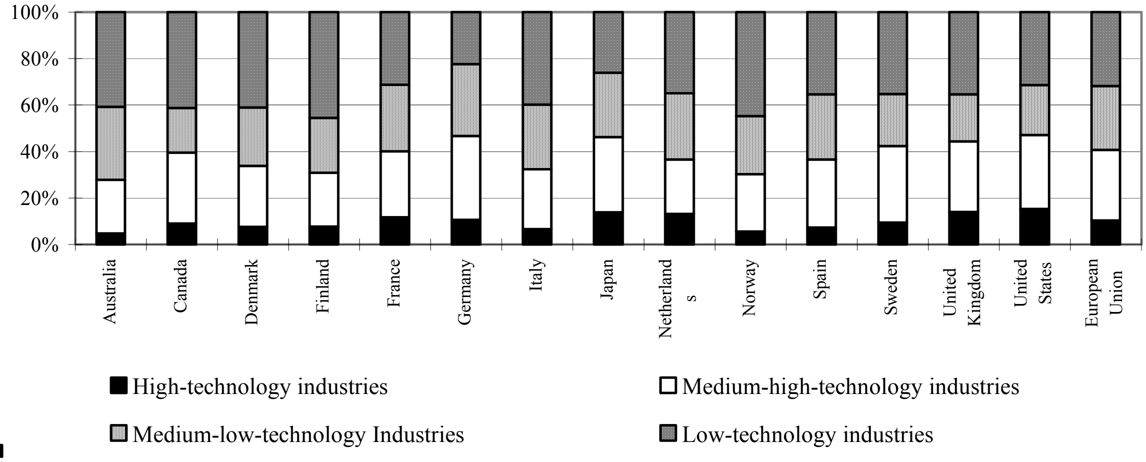
ANNEX: FROM SCIENCE TECHNOLOGY AND INDUSTRY SCOREBOARD OF INDICATORS 1997

I.12. BUSINESS R&D INDUSTRY SPECIALISATION BY COUNTRY

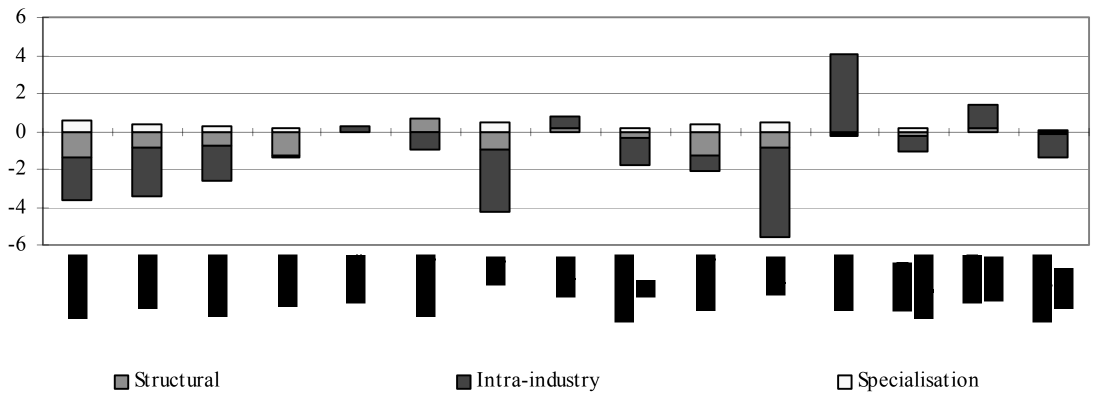
Graph I.12.1. **R&D intensities in high- and medium-high-technology industries, 1994**
BERD as a per cent of value added



Graph I.12.2. **Shares of value added in the different technology industry groupings, 1994**



Graph I.12.3. **Breakdown of R&D relative intensity in manufacturing, 1994**
Breakdown of R&D intensity relative to OECD average



Source: OECD, ANBERD and STAN databases (DSTI/EAS Division), April 1997.

I.12. BUSINESS R&D INDUSTRY SPECIALISATION BY COUNTRY

A breakdown of R&D intensity

Cross-country differences in R&D intensity are usually analysed in terms of "technological level". While important, the technological level is not the whole story. A country's industrial specialisation influences its propensity to conduct R&D: a country with abundant natural resources is likely to specialise more in basic industries, which are less R&D-intensive than aerospace. This does not prevent this country from having a high technological level, which will appear as above-average R&D intensity in those low-technology industries. Breaking down aggregate R&D intensity into intersectoral and intrasectoral components allows for controlling for the industry structure factor.

Thus, the R&D intensity of country *i* relative to the OECD average is broken down into three components, intra-sectoral, structural and specialisation. The algebra is as follows:

$$\mathbf{r_{i.} - r_{..}} = \sum_j \mathbf{r_{ij}\, v_{ij}} - \sum_j \mathbf{r_{.j}\, v_{.j.}} = \mathbf{Iis_i + Ist_i + Isp_i}\ .$$

With $\mathbf{Iis_i} = \sum_j \mathbf{v_{.j}\,(r_{ij} - r_{.j})}$, $\mathbf{Ist_i} = \sum_j \mathbf{r_{.j}\,(v_{ij} - v_{.j})}$, $\mathbf{Isp_i} = \sum_j \mathbf{(r_{ij} - r_{.j}) . (v_{ij} - v_{.j})}$.

Where r_{ij} is R&D intensity (BERD/value added) of sector *j* in country *i*, v_{ij} is its share of value added, "." is the aggregate ("*i*." is for country *i* at an aggregate level, ".*j*" is for sector *j* in all OECD countries for which figures are available). Then, $r_{i.}$ is total R&D intensity of country *i*, and $r_{..}$ is total OECD R&D intensity. An interpretation of the three components gives:

- the intrasectoral component (*Iis*) is positive (or negative) if country *i* is more (or less) R&D-intensive than the average of OECD countries, independently of its industry structure;
- the structural component (*Ist*) is positive if R&D-intensive sectors have more weight in value added in country *i* than in the average of OECD countries;
- the specialisation component (*Isp*) is positive if country *i* is more R&D-intensive than the average of OECD countries in the industries in which it is specialised.

For example, Australia has a lower than average R&D intensity. The intrasectoral component is the biggest contributor (Graph I.12.3) and reflects Australia's below-average R&D intensity in most industries (Graph I.12.1). The structural component is also negative, due to the lower weight of high- and medium-high-technology industries in Australia's industry structure (Graph I.12.2). Finally, the specialisation component is low and positive: in those sectors in which it is specialised, Australia has above-average R&D intensity.

This breakdown must be handled with care, since an economy's sectoral specialisation also depends in part on its ability to conduct R&D (e.g.its endowment in skilled labour): the causality does not run only one way, and the three components are not only "causes" of a country's total R&D intensity but also consequences.

Differences among countries in business R&D intensity in manufacturing are mainly due to the intrasectoral component. The higher R&D intensity of Sweden or the United States, for instance, relies not on the share of high-technology industries in their economies but on their higher R&D intensity in most industries. The same holds, negatively, for the European Union, for example. For the countries that spend more on R&D, the limited role played by industry structure is attributable to the similarity of their structures in terms of R&D intensity. Germany is an exception, as the negative contribution of the intrasectoral component (low intensity in high-technology industries) is cancelled out by the positive contribution of its structure (a high share of medium-high-technology industries). The structural effect plays a strong and negative role for low-intensity countries, notably Australia, Canada, Finland, Italy, Norway, and Spain. Overall, the contribution of the specialisation effect is always positive, but negligible.

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i The confidential and experimental data are passed on to the staff member responsible for the topic concerned.

ii A topic taken up, *inter alia* by the Voorburg Group and also by the OECD's Working Party on Industrial Statistics which issued a report in 1987 and held a workshop on the topic in 1992. In the late 1980's there were almost as many NSOs working on intangible investment as on innovation. After a lull there has been a recent recovery in interest in intangible investment especially in various directorates of the European Commission.

iii OECD document "Internationalisation of Industrial R&D: Patterns and Trends", Statistical Working Party of the Industry Committee, Group of National Experts on Science and Technology Indicators, October 1997.

ix OECD STI Working Paper 1996/7, "Measuring R&D in the Services" by Alison Young, Directorate for Science, Technology and Industry.

NATIONAL DATACOLLECTION OF BUSINESS R&D

Mr. Frank Foyn
Statistics Norway

1. Introduction

1.1. Business enterprise sector:

All firms, organisations and institution whose primary activity is the market production of goods or services for sale to the general public at an economically significant price, including private non-profit institutes mainly serving them.

1.2. Statistics is information on an aggregated form based on individual data (microdata)

(statistics don't appear from nowhere; R&D statistics are no exception)

1.3. How to catch microdata and transform them to statistics ?

2. Datasources for individual data

2.1. Administrative registers

Main advantage: Cost-effective (both collection costs and response burden)

Problem areas:

- Existence of relevant registers
- Completeness / representativeness
- Access to data
- Statistical unit
- Content (type and number of variables)
- Definition of R&D

2.2. Statistical surveys (most common)

Main advantage: Predesign the complete survey

Problem areas:

2.2.1. Population/ register (of all firms)

2.2.2. Representative set of survey units

- Cut-off census
- Sample survey of smaller units
- R&D units

2.2.2.1. Business R&D survey in Norway 1995:

- All firms (KAU) with 50 employees and more

  (Population/gross sample: 2560, net sample: 2100)
- Firms with 10 - 49 employees
  - 40 % sample in manufacturing and business services
  - 10 % sample in other sectors

  (Population: 14200, gross sample: 2800, net sample: 2140)
- Small R&D firms (with funding from Research Council)
  (160)

2.2.3. Estimation of population results:

Low share of R&D performers in a sample of small units, but they may have high R&D intensity

Figure 2: Share of R&D performers by size-class

2.2.4. Statistical unit:

- establishment / local kind-of-activity unit (LKAU)
- kind-of-activity unit (KAU)
- enterprise/ firm/ company,
- group of company (consolidated group)

Some aspects to take into consideration:

- National territory / Abroad (keyword: globalisation)
- Breakdown by region and activity class (NACE)
- Research centers (producers or users of R&D)

2.2.5. Data collection method:

- Paper questionnaire
- Electronic questionnaire
- Interview

2.2.6. What kind of information to collect

- R&D man-years
- R&D expenditure/ intramural cost (wages, other operational costs, investments)
- R&D extramural cost (purchase of services from R&D Institutes etc.)
- R&D funding (own fund, governmental funds, other funds)
- Type and field of R&D
    - basic research /applied research / experimental development
    - product/process
    - informationtechnology/ environmental/ medical etc.

2.2.7. Data quality:

- What is R&D ?

Definition in Frascati-manual:

<u>Research and experimental development (R&D)</u> comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

<u>Experimental development</u> is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Is these definitions operational for the firms in reporting R&D activity in quantitative measures ?

Examples: Service industry in general; Software development in specific.

Figure 3: Share of Development in R&D, total.

Figure 4: Share of Development in R&D by sector.

- Control and edit of data

2.2.8. Effects of R&D
(on economic growth, profitability, employment etc.)
- Innovation surveys
- Link to other data sources:
  - Financial account
  - Structural Business statistics

Figure 1: Cumulative R&D Expenditure for the 100 largest R&D performers

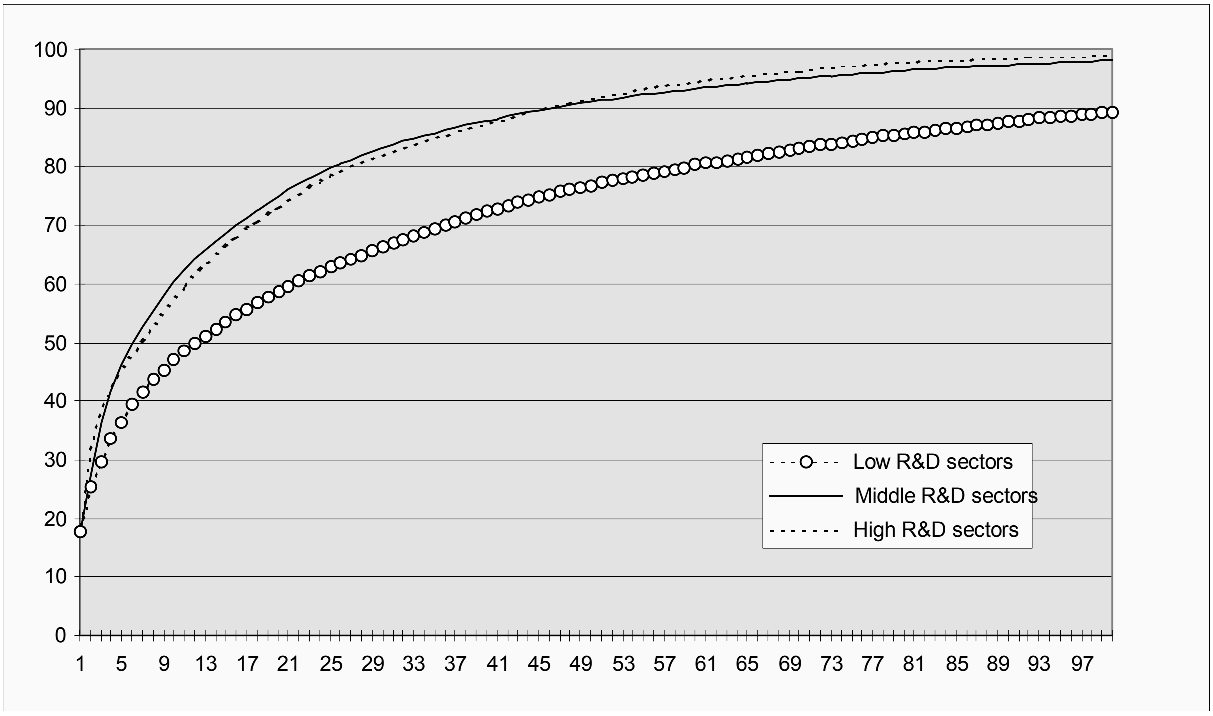


Figure 2: Share of R&D performers by size-class

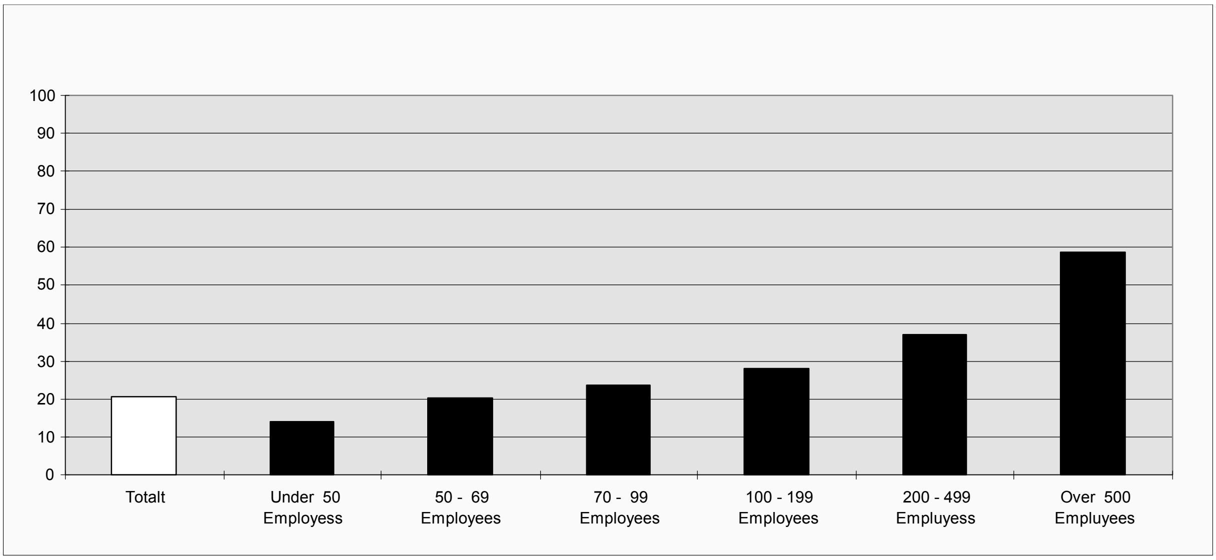


Figure 3: Share of Development in R&D, total

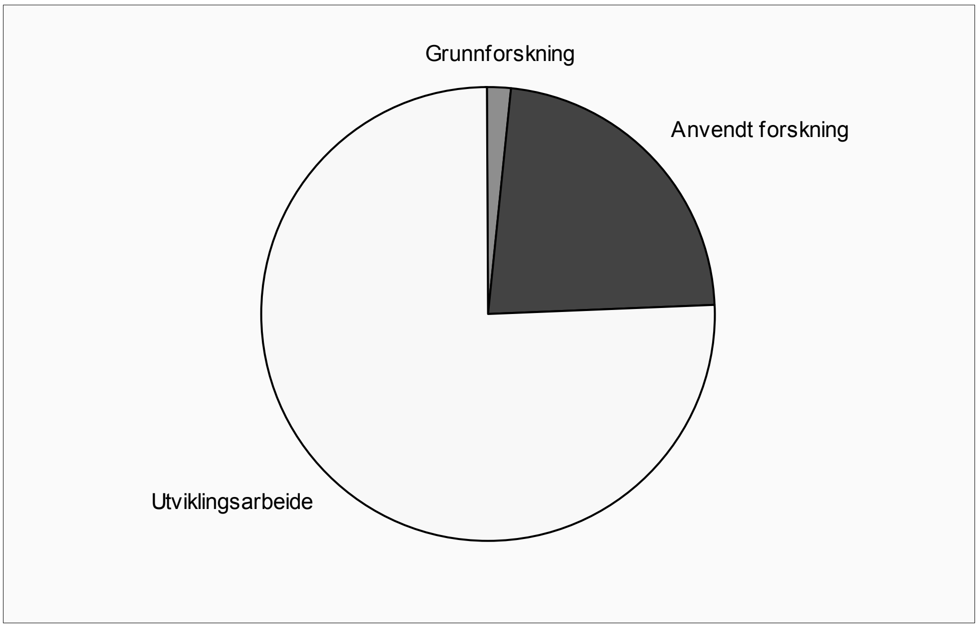
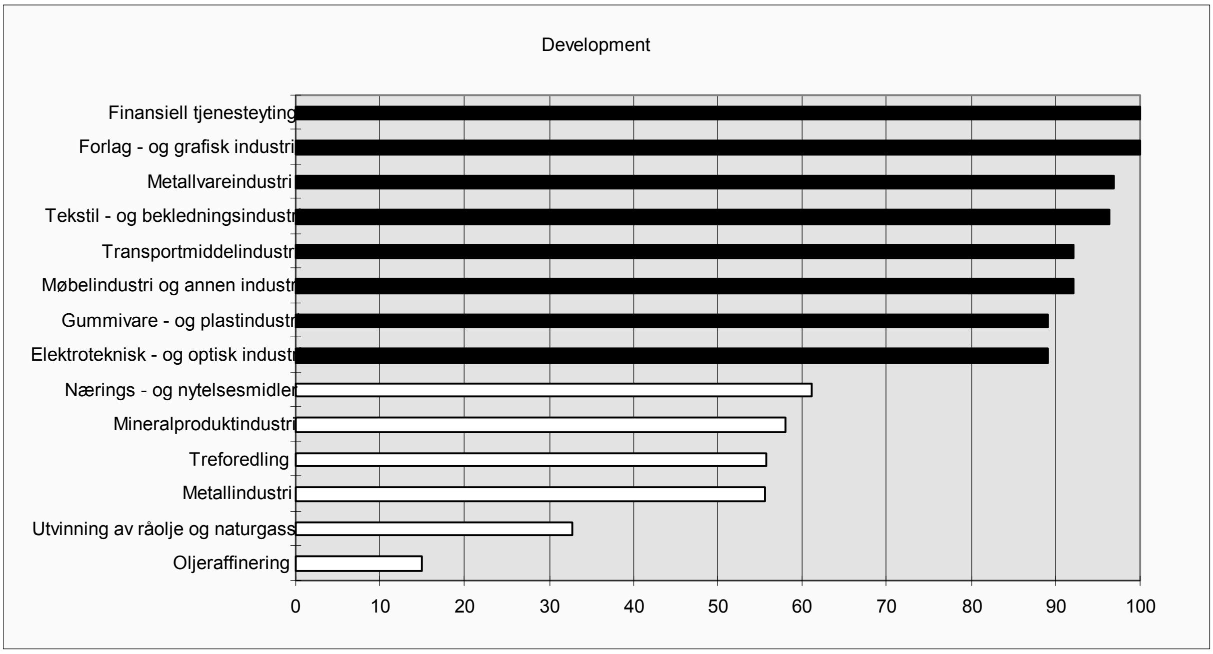


Figure 4: Share of Development in R&D by sector



NATIONAL DATA COLLECTION METHODS OF R&D FOR THE PUBLIC SECTOR

Gunnar Westholm
Former OECD administrator

1. Introduction

This presentation will first discuss what the «Frascati Manual» (FM), the OECD guidelines for the measurement of R&D activities in terms of expenditure and personnel (1), calls the Government sector, its institutional coverage and its role as a performer and as a source of funds in the overall OECD and national (notably Nordic) R&D efforts. As far as the financing issues are concerned, the two principal approaches in use will be discussed, i.e. the Government-financed R&D in «GERD» (in the OECD jargon = Gross Domestic Expenditure on R&D), as reported by the performers, and the «Government Budget Appropriations or Outlays for R&D» («GBAORD»), based on an anlysis of the R&D contents of different items in State budgets, broken down by socio-economic objectives and seen from the funders' points of view. Its role as an employer of R&D personnel (and notably «researchers» - RSE) will also be discussed.

In every day vocabulary, the concept of «public sector R&D» - as opposed to «private R&D» - may cover the «Higher Education» (HE) sector as well (also defined in the FM). Some countries also include the small, but sometimes interesting (notably as a source of funds) «Private Non-profit» (PNP) sector (see FM) in their public sector. The HE sector's contributions to R&D will be discussed below in line with the presentation of the Government sector.

Some of the specific issues of surveying and/or estimating the R&D expenditures and personnel in these sectors will be presented.

2. Institutional Coverage - The «Frascati Manual» and the System of National Accounts (SNA)

2.1. General

The institutional coverage of the sectors for the measurement of R&D is defined in the OECD «Frascati Manual» in terms of the international «System of National Accounts (SNA)» (2), with the exception of the Higher Education sector, which was specially identified in the early days of R&D statistics and broken out of the SNA «general services» by OECD and UNESCO, given its traditional role in national performance of R&D, especially for basic research and for the training of R&D/S&T personnel.

2.2. The Government Sector

The institutional coverage of the Government sector for the purpose of R&D surveys is shown in Box 1 below (as defined in FM §§ 168-171).

In theory, all levels of Government (notably federal and state) should be covered. In practice, depending on the countries, data for provincial and local government, such as municipalities etc., may or may not be collected and included in the national series, notably for budget data (see section 9 below).

Box 1. Coverage of the Government Sector

Political, administrative and technical departments/ministries, agencies etc. supplying services which cannot usually be economically provided to the market (excluding higher education and public enterprises) plus non-profit institutions controlled and mainly financed by government.

2.3. The Higher Education Sector

The institutional coverage of the Higher Education sector (as described in FM§§ 190-192) is summarised in Box 2.

Box 2. Coverage of the Higher Education Sector

All (private and public) universities, colleges of technology and institutes of post-secondary education and similar institutions plus research institutes, experimental stations and clinics under the direct control of or administered by or associated with higher education establishments.

The primary criterion for inclusion in this sector is that the statistical units (surveyed, classified) should provide education at the third level of ISCED (ISCED is the United Nations/UNESCO's International Standard Classification of Education) (3).

3. Borderline problems

3.1. Functional: R&D *vs* Non-R&D Activities

When measuring R&D we encounter a number of functional border-line problems. Whereas a person employed in a government R&D laboratory (and still more so in an enterprise R&D unit) is likely to spend most or all of his or her time on R&D, the average week of work of a typical university faculty member consists of a number of - closely inter-linked - actitivites, such as administration, teaching (including that of research methods etc.), own R&D and R&D as a member of a team, the supervision of post-graduate students with their own personal R&D projects, « own reading », etc.etc. Faculty staff in medicine or agriculture may devote much of their time to general and/or advanced medical care, or routine tests. Here the question is: what is R&D (which we want to measure) and what is not R&D (to be exluded from our measurement)? And where is the cut-off point between the two?

3.2. Institutional Border-line Problems

R&D statisticians are also frequently confronted with institutional borderline problems between sectors, i.e. they have to decide in what sector should an R&D unit surveyed be classified. Even if the Frascati guidelines do try to capture all possible specificities, there are still cases where the administrative, financial, political and historical status of some R&D performing and/or financing units may not be very clear even at national level and still less so for international comparisons. The institutional status of such units may, furthermore, change over time.

For instance, countries have adopted different approaches to classifying units like research councils and academies of science which sometimes - but not always - both perform and finance R&D. The classical example here is the treatment of the «Centre National de la Recherche Scientifique» (CNRS) in France which, essentially for historical reasons (the CNRS is broadly financed via the budgets of the Ministry of Education), is classified in the Higher Education sector by the French authorities whereas the CNR (« Consiglio di Ricerca Scientifica ») - with very similar missions - is attributed to the Government sector in Italy.

In recent years new kinds of institutional borderline problems involving the Higher Education sector have occurred. A number of universities are setting up highly R&D intensive multi-firms « science parks » and also development enterprises in order to trade the results of their research, discoveries and inventions. Such firms are frequently too small (or too recent) to be covered in national R&D surveys. Being managed on a purely commercial basis such parks and firms should, if the SNA guidelines were to be followed strictly, be classified in the Business Enterprise sector though many of them are still included in that of Higher Education.

This is whyconsumers of the data should realise that national specificities may hamper the comparability of international R&D statistics, which should, thus, be used with caution. This remark is not specific to R&D/S&T statistics and indicators only but is, of course, equally applicable to any other kinds of international data series!

4. The Role of the Government Sector in OECD R&D Performance

According to the OECD (notably the biennial *Main Science and Technology Indicators* and other publications and data base extractions - including some provisional data), around 1995 some 12 per cent of all OECD R&D (and 16 per cent in the Nordic countries combined) was performed in the Government sector (see Table 1 below). The share is slightly higher in the «typical» OECD Member country, the OECD median being some 19 per cent of the national R&D efforts. As far as the Nordic group is concerned, the 16 per cent figure above is, however, not very significant as it is strongly influenced by the very low Government share in Swedish GERD (less than 5 per cent - in fact one of the lowest ratios in the whole OECD area) whereas government agencies perform some 18-19 per cent of GERD in Denmark, Finland and Norway and more than 40 per cent in Iceland.

Comparisons between the «Triad» of countries/regions, the Government sector accounts for some 10 per cent of GERD in North America, 16 per cent in the European Union and less than 10 per cent in Japan (where it is slowly increasing over time).

Table 1: R&D Expenditures
GERD: The Role of the Government and Higher Education Sectors
in GERD (1995 or closest year) - percentage

	Government		Higher Education
	Performance (MSTI 19)*	Finance (MSTI 14)*	Performance (MSTI 18)*
OECD Total	12.4	34.5	17.7
OECD Median	19	44	24.5
- North America	10.2	36.4	16.0
- European Union	16.3	*** 39.2	20.7
- Japan (adj.) 1)	10.4	20.5	14.5
- Nordic group:	10.3	34.1	22.6
- Denmark	17.0	39.2	24.5
- Finland	16.6	35.1	19.5
- Iceland	37.4	57.3	27.5
- Norway	17.3	43.5	26.0
- Sweden	3.5	** 31.5	22.0

* Source: OECD *Main Science and Technology Indicators* (publication and database extracts) and *OECD in Figures* (Supplement to the *OECD Observer* n° 206, June/July 1997)
** 1993
*** 1994

1) Remark: official R&D data for Japan are overestimated and have been adjusted by the OECD to meet its standards of international comparability

5. The Government Sector as a Source of Funds in OECD R&D

As a general rule, the Government sector is much more important in terms of R&D finance of GERD than in performance. As mentioned above, Governments currently account for some 12 per cent of overall OECD performance but for some 35 per cent of its finance. The OECD median for this indicator is currently around 44 per cent - as compared to the 47 per cent of privately financed R&D, with the balance made up largely by funds from abroad. The shares are 36 per cent for North America but only 22 per cent in Japan. The weighted ratio for the Nordic countries group was around 34 per cent in 1995.

It should, however, be noted that these public shares in GERD only refer to the public finance of R&D, performed intramurally within the sector itself plus direct transfers of public money to other domestic sectors (such as R&D contracts and grants), but not to abroad. They also include the R&D shares of the so-called «public general university funds - GUF», i.e. the public financial resources put at the disposal of HE institutions for their overall mission of education and research, via the budgets of the ministries of education, (health, agriculture) etc.

Government finance in GERD **excludes** all kinds of **indirect** public support of industrial R&D via a number financial instruments, such as interest rate subsidies and various kinds of tax incentives. A few years ago OECD issued a technical publication where such subsidies, essentially to the Enterprise sector, were discussed at length and in more detail (4).

6. The Role of Higher Education R&D

Around 1995, the Higher Education sector carried out some 18 per cent of all R&D performed in the OECD countries (see Table 1). The OECD median for HERD in GERD is currently about one-quarter (24 ½ %), with still wider variations between countries than for the Government sector. In the major OECD countries, the shares in GERD are typically quite low: some 15-16 per cent only in North America and Japan (OECD-adjusted data) and slightly above 20 per cent for the Member States of the European Union (16 per cent in France, 18 in the United Kingdom).

In the medium-sized and smaller OECD countries the HERD in GERD ratios are significantly higher. The weighted HERD share for the Nordic group is just below 23 per cent; with Denmark at the OECD median level , Iceland (27.5) and Norway (26.0) slightly above and Finland (19.5) and Sweden (22.0) slightly below. At the same time, nearly one-third - i.e. around 30 per cent - of the national R&D efforts was performed in the university sector in countries like Austria, the Netherlands, Portugal and Spain.

7. R&D Personnel

7.1. Classifications of R&D Personnel

There are two FM methods for classifying OECD R&D personnel data: by occupation (function) and/or by formal qualification. The first approach suggests a breakdown by the three categories of «researchers» (or «research scientists and engineers -RSE»), «technicians and equivalent staff» and «other supporting staff» (broadly defined in terms of «ISCO», the United Nations' *International Standard Classification of Occupations*) (5).

The second draws on the UNESCO *International Standard Classsification of Education* (ISCED) (3) to define, in terms of levels of education, the following categories:

- «Holders of PhD level degrees» (ISCED level 7 upper part); - «Holders of basic university level degrees below the PhD level» (ISCED level 7 lower part and level 6);
- «Holders of other post-secondary diplomas» (ISCED level 5); - «Holders of diplomas of secondary education» (ISCED level 3 and below), and - «Other qualifications».

Table 2: R&D Personnel (Research Scientists and Engineers)
The Role of the Government and Higher Education Sectors in the Employment of Researchers 1993 (or closest year)

	Government	Higher Education

	(MSTI 61)*	(MSTI 52)*
OECD Total	9.5	24.6
OECD Median	18.0	40.0
- North America	7.0	16.0
- Euroean Union	14.8	34.5
- Japan (adj.) 1)	5.7	22.0
- Nordic group	15.0	34.9
- Denmark **	22.4	34.6
- Finland **	20.7	38.4
- Iceland **	30.1	35.3
- Norway **	18.9	31.3
- Sweden	7.9	40.0

* Source: OECD *Main Science and Technology Indicators* (publication and database extracts)

** 1995 (including some provisional data)

1) Remark: Official R&D data for Japan are overestimated and have been adjusted by the OECD to meet its standards of international comparability.

All countries do not collect data for both types of classification and, in some cases, not for all categories. For instance, only data for RSEs are available for the United States (but not for technicians and «other»). This is why it is currently not possible to calculate a «total OECD R&D personnel» figure but only an OECD total for RSEs. For the latter estimate it is, furthermore, necessary to merge RSE data for some countries with « university qualifications» data as a proxy for others (though the equivalence between these two highest groups in the respective categories is not necessarily the same everywhere).

R&D employment data are usually somewhat less up-to-date than the corresponding expenditures series.

7.2. Government and Higher Education Sectors as Employers of Researchers

Currently about one-quarter of all OECD researchers are employed in the Higher Education sector and about 10 per cent in the Government sector. There are, however, rather great variations between countries as to their employment patterns, the OECD HE-RSE median being about 40 per cent whereas that of Government-RSE is around 18 per cent (see Table 2). Once again, the indicators for the Nordic group (as a total) are heavily influenced by the specific situation of Sweden, in particular due to the comparatively low RSE employment in the Government sector.

The shares of the HE sector in national R&D personnel totals are typically much higher than their expenditures in GERD whereas the opposite is true for the Government sector. This is not really a surprise; an average «R&D person-year» «costs» less in the HE than in the Government sector, notably as far as personnel costs are concerned. Large numbers of RSE's in universities (such as post-graduate students) are paid via grants and scolarships which cannot be really compared with the «full» salaries of state-employed personnel or people working in industry. Academic (often «soft science») R&Dis also, as a rule, less capital-intensive than the «hard» sciences predominating in the Enterprise and Government sectors and there are also, as a rule, lower «support ratios» (numbers of support staff per researcher) in the university sector than in the others.

8. Surveys and Estimates of R&D in the Government and Higher Education Sectors

8.1. General Comments

Before reviewing possible methods of surveying the «public sector» it should be remembered that the primary purpose of such exercises is to meet national policy needs. International reporting - to the OECD, to Eurostat, to UNESCO... - is of secondary importance.

The previous presentation discussed R&D data collection for the Business Enterprise (or industry) sector for which a large number of other kinds of statistics than R&D are regularly collected, such as data on production, investment, value added, employment, exports, etc. Such collection is facilitated by the existence of business registers, of standardised and very detailed industrial classifications and, by now, of quite well-established survey methods and routines (including sampling and grossing-up techniques).

8.2. Government Sector: - the Lack of an Institutional Classification for R&D

This is not the case for the «public sector», especially for the Government sector. The latest version of the «Frascati Manual» (1994) states that the principal standard international classifications of use for the activities within this sector, notably the «System of National Accounts (SNA)» (and its Classification of the Purposes of Government - COFOG) and the «International Standard Industrial Classification (ISIC)» (6) (fields of science and socio-economic objectives lists), are not very appropriate for the measurement of performer-reported R&D activities. Therefore, the Manual does not make any recommendation as to a detailed institutional sub-classification for the Government sector.

8.3. The R&D Classification for Higher Education

As far as (institutional and functional) classifications are concerned, the situation is slightly better for the Higher Education than for the Government sector. For the HE sector (and also for the Private Non-Profit sector) the Manual recommends the use of UNESCO’s - broad fields of science (in fact, fields of study) classification as presented in «ISCED» (the International Standard Classification of Education) (3) which also serves as reference for the collection and compilation of education statistics. However, the international R&D data are much too aggregated for serious analysis as only six broad fields of science are requested, even if a number of countries do use their own and more detailed lists in national surveys.

8.4. Survey Procedures: Questionnaires and «Hand-knitting»

The way public services - including higher education - are set up and administered varies between countries and this is reflected in the ways countries survey their national R&D resources. There is no directly harmonised system for the collection of R&D data for the Government and Higher Education sectors. However, it is clear that - the smaller the country - the easier it will be for it to make inventories of its R&D/S&T system and evaluate the resources involved. Thus, smaller countries may easier undertake full-scale surveys than larger ones and will sometimes have very detailed and personalised personnel registers at their disposal. Here, the Nordic group of countries is in a privilegied position. In larger countries, survey agences may be forced to using sampling methods, followed by «grossing-up» exercises, where much of the details drawn from full-scale surveys will no longer be available.

The final tables for the Government and Higher Education sectors are often the outcome of exercises combining the performer-reported answers to traditional R&D surveys, on the one hand, and «desk-work» (or «hand-knitting»)exercises, drawing on detailed analysis of public administrative records, financial accounts, registers of total stocks of state-employed personnel, etc. etc., on the other.

For the survey part of the exercise, some countries, such as, for instance, Denmark, the Netherlands and Norway, now use a common questionnaire, especially designed to the particular needs of what is called the «institutes' sector». This sector broadly covers all kinds of national units outside (manufacturing) industry (which is surveyed separately). Once the final data of the institutes' survey are available and processed, and possibly completed by the above «desk-work», they may, as an additional exercise, be redistributed to one or another of the four « Frascati sectors » for international reporting.

8.5. Specific Issues of the Higher Education Sector - the «Time-Budgets»

It is for the Higher Education sector that the international comparability of data is still least satisfactory. As mentioned above, just as there are no two OECD countries with identical education systems, neither are there identical methods for surveying or estimating the sector's R&D resources. There are more frequent methodological changes in national survey methods for this sector than for any of the others, leading to «breaks in series» and problems of comparability over time even in the countries concerned. These are usually made to improve the quality of the data but sometimes to simplify the work of estimation in order to reduce costs.

When discussing surveys and/or estimates of Higher Education resources one may distinguish in theory between «top-down» to «bottom-up» approaches. In practice, there is usually a combination of both. In the first case, the responsible agency will identify and examine the total resources of the sector during the time period concerned. It will then systematically eliminate all activities and/or institutions and personnel which cannot be directly attributed to R&D and then cross-classify - in so far as possible - the remaining items by, for instance, types of costs, sources of funds, types of R&D personnel, fields of science....

In the second case («bottom-up»), full or sample surveys will be undertaken of the total working-time of academic staff, with a view to establishing the shares of R&D (and of other professional activities). This may be done through questionnaires addressed directly to individual respondents or to administrative heads of faculties or other units likely to supply some «informed guesstimates».

The primary result of these «time-budget surveys» is the calculation of the full-time equivalence of the R&D personnel concerned. This information is then used to calculate «R&D ratios» (or «coefficients») which are applied to a number of type-of-cost variables (salaries, other current expenditures, etc.) to estimate the total R&D expenditures (of the institution, faculty, field of science, sector...) including estimates of the R&D shares of capital expenditures and «overhead» costs (such as rents, shares of common library and computing facilities, etc). The coefficients may also be used to derive some source of finance data based on information drawn, for instance, from central university accounts or data otherwise available at the surveying agency (such as information on extra-mural R&D finance reported by respondents to survey questionnaires).

A number of «time budget» approaches are in use. For instance, the requested activity breakdowns may refer to the distribution of the working time during the whole year or for a number of specified weeks. It may take the shape of a «rolling survey», addressed to different samples of persons for specific time periods during the whole exercise. The specific problems and possible solutions concerning the measurement of Higher Education sector R&D are discussed at length in the «Frascati Manual», notably in its Annex 3 «*Issues of Specific Relevance to the Higher Education Sector».*

9. GBAORD - The Analysis of R&D in Government Budgets by Socio-Economic Objectives

All the public-sector R&D statistics discussed above are performer-reported, i.e. they are derived from responses to questionnaires, addressed by the surveying agencies to institutional units involved in R&D. This is also the preferred approach for data collection, recommended by the «Frascati Manual». However, all this reporting is *«ex-post»* - retrospective. By the time the results are made availalable, they may have lost much or all of their policy interest, notably the series of Government-financed R&D activities which are supposed to reflect current public policy intentions and their near future.

Another - essentially *«ex ante»* - approach has been developed, that of examining what is called the «Government Budget Appropriations or Outlays for R&D (GBAORD)». This is based on an analysis of the «R&D contents» of different items of the state budgets. Once again, this may be a «desk-work» exercise but may also be based on specific surveys.

The GBAORD data may be collected from the funding agency (such as ministries) in some countries at the same time as performance data (France, United Kingdom) and these agencies themselves allocate the funds between socio-economic objectives (see below). There is necessarily some degree of uncertainty - sometimes subjectivity - in this approach, even if the estimates frequently draw on «R&D coefficients» obtained from the regular R&D surveys (as described above).

Such information has the advantage of being available much earlier than the traditional, retrospective R&D series but, on the other hand, it is also subject to political and economic changes in government policies. Its comparability is probably lower, both between countries at a given moment in time, and in a given country over a longer time period than the performer-reported data.

The GBAORD series are classified according to a list of some eleven broad socio-economic objectives (or «goals») in the «Frascati Manual» - such as «industrial development», «defence» «health», «energy», etc. - with much greater detail in the corresponding Eurostat classification «NABS» (7). In principle, FM programmes are allocated to their primary objective. In some cases, countries divide large programmes between objectives, this, however, is not the same thing as a secondary objective which is a subsidiary aim.

The basic Frascati definitions of R&D etc. are applicable also to these GBAORD series though there are a number of differences in coverage, notably the inclusion of funds to abroad. A separate section (Chapter 8) of the «Frascati Manual» (1) is devoted to this funder-based objectives analysis.

Eurostat in Luxembourg maintains the most detailed international data-base for the socio-economic objectives series, in close co-operation with the OECD whose database includes a wider range of countries.

List of references

1. «*Proposed Standard Practice for Surveys of Research and Experimental Development - Frascati Manual 1993»,* OECD, Paris 1994

2. *«System of National Accounts 1993»,* Commission of the European Communities (CEC), OECD, United Nations and the World Bank 1994

3. *International Standard Classification of Education (ISCED),* COM/ST/ISCED, UNESCO Paris 1976 (under revision)

4. «*Industrial Subsidies: A Reporting Manual»,* OECD, Paris 1995.

5. *International Standard Classification of Occupations (ISCO-88)* International Labour Office, Geneva 1990

6. *International Standard Industrial Classification of All Economic Activities (ISIC),* United Nations, Statistical Papers Series M, No 4, Rev.3, New York 1990

7. *Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS)* - Eurostat, Luxembourg 1983 (old version in use until 1994, new version from 1995)

DISCUSSION ON THE SPEECHES OF DEFAYS, YOUNG, FOYN AND WESTHOLM

The chairperson Karen Siune opened the discussion saying: ” Now you have the information about what is being collected at the national level, and at OECD and Eurostat level and information about how it is done, then it is your turn to participate, so what are the questions?

Mr. Frey raised questions related to studies of mobility and flow asking for more information, especially information related to the number of countries participating in the mobility studies. Is there a possibility to include more or all countries?

Mr. Defays responded to Mr. Frey referring to the first pilot studies of measures of stock of human resources with a limited number of countries, now Eurostat wanted to study flow broader, flow defined internationally, flows identified from higher education to R&D, using labour force surveys.

Mr. Pino added: "Education changes measured in a number of countries, but people entering from other sides than the educational system are difficult to measure".

Mrs. Young intervened and referred to OECD as part of the original stock study based on Mr. Westholms work, now for the moment done by Mr. Rosengreen on loan from Statistics Sweden.

Mr. Åkerblom explained about the Blue Sky project being mobility study on the basis of nordic registers and referred to Denmark, at the moment, missing in the nordic project. He expressed hope that the Danish Institute for Studies in Research and Research Policy would join the project. He explained shortly about the pilot study of mobility indicators where an interim report would be presented at the next meeting on international innovation systems. He expressed hope for a new project with the Blue Sky dimension, based on registers, where especially the nordic registers are strong. The new project did not follow the Canberra-manual but was exclusively an analysis based on educational level, age 16 or above. Denmark and Finland have good registers but Norway and Sweden have not yet completed registers on occupation. Mr. Åkerblom finished his intervention concluding that something significantly is going on with respect to mobility and flow in the nordic countries.

Second session

Do we measure R&D the right way?

OLD AND NEW PARADIGMS IN THE MEASUREMENT OF R&D

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1. Research and development statistics

Research and Development are one of the key variables in the analysis of the scientific and technological endeavour of organisations, firms, countries. The first attempts at measurement in the field of statistics on research and development date back to the 1930's in the Soviet Union and the 1940's in the United States. However, it was only in the 1950's that the National Science Foundation (NSF) of the US embarked on a regular survey of research and development in the United States. The vast experience acquired by the NSF exerted a decisive influence on the activities of the OECD, which in 1963 led to the adoption of the Frascati Manual on the measurement of technical-scientific activities. Since then the OECD countries have collected statistical data on R&D personnel and expenditure in a harmonised way; in the late 1980's also Eastern European countries have adopted the Frascati standard which is now the *de facto* common methodology used across the world for measuring R&D.

In its thirty years of existence the Manual underwent four revisions reaching maturity with the 1993 version (OECD, 1993) which improved and has updated the methodology on the basis of the experience gained in collecting, compiling and analysing the data.

By now we perhaps need to come back again to the Manual because of two developments which occurred in the 1980's and early 1990's, namely the collection of innovation data on the basis of the methodology set out in the Oslo manual and the studies on the knowledge-based economy.

Data collected through the innovation surveys carried out in several EU and non-EU countries have shown that the number of R&D performing firms is higher than that emerging from the R&D survey. Moreover, he studies on the generation and distribution of knowledge show that the concept of full-time equivalent for measuring the quantity and quality of work done by professionals engaged in R&D is less and less tenable.

2. Two sources of R&D data: the R&D survey and the Innovation survey

At present there are two sources of statistical data on R&D: R&D surveys, which are carried out annually or biannually by national statistical agencies and which cover all organisations performing R&D (government, higher education, business enterprise sector, private-non-profit organisations), and innovation surveys, which have been started on an experimental basis in various countries, and have later been carried out in an harmonised way in the framework of the Community Innovation Survey (CIS), which covers technological innovation in the manufacturing sector.

The two sources of data allow to make comparisons for the manufacturing sector only, even though in the future it will be possible to extend the comparison also to the services.

The comparisons between the two data sets have been made in various countries and, as far as we know, they are quite coherent in pointing out the same problems.

In this paper we examine the Italian data which, for the purposes of this Workshop, may be considered as a good starting point for discussion.

2.1. Results from the 1985 innovation survey

ISTAT did the first innovatin survey in 1986 and the second in 1993 (prendere dal paper con mangano e Cesaratto) with more than 20 employees.

A section of the 1985 innovation questionnaire used by ISTAT was devoted to research and development activities. Table 1 shows that, of the 8,220 firms replying to the survey, a good 2,557 declared they had carried out or commissioned R&D activities. Almost all of them (2,538) used their own internal structures.

The design department was most frequently indicated as the "locus" of R&D (1,769 cases) together with the production department (1,547 cases). Research was carried out in central laboratories (at the corporate level) or in divisional laboratories (closer to production line needs) in 927 and 359 cases, respectively. Data show also that the institutionalisation of R&D in companies is a characteristic of medium-large firms. In fact, the number of cases in which corporate and divisional research laboratories are mentioned in the survey increases with increasing company size (from 185 for firms with 20-49 employees to 348 for firms with more than 500 employees). Overall, the percentage of firms carrying out R&D increases with increasing company size.

Table 1 - Innovating firms involved in R&D, and innovating firms which carried out in-house R&D, by department where the R&D was carried out - 1985

Number of employees	Innovating firms which carried out or commissioned R&D		Firms which carried out in-house R&D					
			Total number of firms	Department where the in-house R&D was performed (*)				
	Total number	% of the total innovating firms		Corporate R&D lab	Divisional R&D lab	Design department	Production department	Other
20-49	637	16.2	626	152	33	443	431	20
50-99	583	32.6	581	169	37	423	362	27
100-199	506	41.8	503	182	56	352	290	21
200-499	479	58.8	477	209	100	325	294	12
500 over	352	75.4	351	215	133	226	170	10
Total	2,557	31.1	2,538	927	359	1,769	1,547	90

Source: ISTAT, 1985 innovation survey.

(*) Figures may exceed the total number of innovating firms since they may have carried out R&D activities in more than one department.

As far as R&D resources are concerned, Table 2 shows that in 1985 the 2,557 firms spent 5,070 billion liras (equivalent to US $ 3,894 million) and employed 50,056 people (expressed in full-time equivalent). The number of people engaged in R&D amounted to 65,678. The figures of Table 2 reveal a very high concentration of R&D expenditure in the large firms: firms with more than 500 employees, which account for 13.8 per cent of the total number of firms carrying out R&D, spend 77.1 per cent of total R & D expenditure. Conversely, the 637 firms with 20-49 employees (24.9 per cent of the total) account for 2.5 per cent of total expenditure.

In all, the 2,557 firms included in the survey employed 65,678 R&D personnel. R & D work, however, is not always carried out continuously by full-time researchers. In particular, in small and medium size firms engineers and technicians devote their time, as the need arises, to various activities including design, quality control, production work, sales and customer service.

Table 2 - Resources devoted to R&D by innovating firms - 1985

Number of employees	Innovating R&D performing firms	Total R&D expenditure		R&D personnel (units in equivalent full-time)				
		(billion Lire)	(million $) (*)	Researchers	Technicians	Auxiliary personnel	Total	Total personnel per firm
20-49	637	129	99	470	1,061	505	2,036	3.2
50-99	583	199	153	627	1,319	782	2,728	4.7
100-199	506	249	191	826	1,537	916	3,279	6.5
200-499	479	582	447	2,011	2,516	1,661	6,188	12.9
500 and over	352	3,911	3,004	14,112	12,368	9,345	35,825	101.8
Total	2,557	5,07	3,894	18,046	18,801	13,209	50,056	19.6

Source: ISTAT, 1985 innovation survey

(*) The conversion has been calculated by means of the 1985 OECD purchasing power parities. 1$ = 1,302 Lire.

The research personnel has been broken down according to job classification (table 13): researchers, normally university graduates but also high school diploma holders, account for 36.0 per cent of the total, technicians for 37.6 per cent and assistants the remaining 26.4 per cent. These figures are indicative of a growing "professionalisation" of research in the medium-large firms: the percentage of researchers to the total number of research employees increases with company size (from 23.1 per cent for firms with 20-49 employees to 39.4 per cent for firms with more than 500 employees).

The above concentration can be measured also by means of the average number of R & D employees per firm according to the total number of employees: it ranges from 3.2 employees expressed in full-time equivalent units in small firms (20-49 employees) to 12.9 in firms with 200-499 employees and 101.8 employees in firms with more than 500 employees.

2.2. A comparison between the R&D and innovation surveys for the years 1985 and 1992

Data from Table 3 show that the number of manufacturing firms filling the R&D questionnaire remained, over the two years 1985 and 1992, at the same level of 750, while the number of R&D performing firms “captured” through the innovation survey was significantly higher and has increased from 1,764 to 3,481. However, it should be noticed that the increase of expenditure due to these additional firms is in both years of the order of magnitude of 1,000 billion Lire, which appears quite marginal vis-à-vis the core of R&D performing firms.

Data show also that in 1992 the number of firms involved in R&D according to the innovation survey is almost six times as much as those identified by the R&D survey, while this extremely relevant increase in the number of units involved corresponds to a tiny 14 per cent increase in R&D expenditure (Figure 1).

Table 3 - R&D performing firms and R&D expenditure as measured by the R&D and innovation surveys -1985 and 1992

	Innovation survey	R&D survey
R&D performing firms (number)		
1985	2,557	793
1992	4,229	748
R&D expenditure (billion Lire)		
1985	5,070	3,832
1992	8,441	7,362

Figure 1. Number of R&D performing firms and R&D expenditures according to the two surveys - 1992

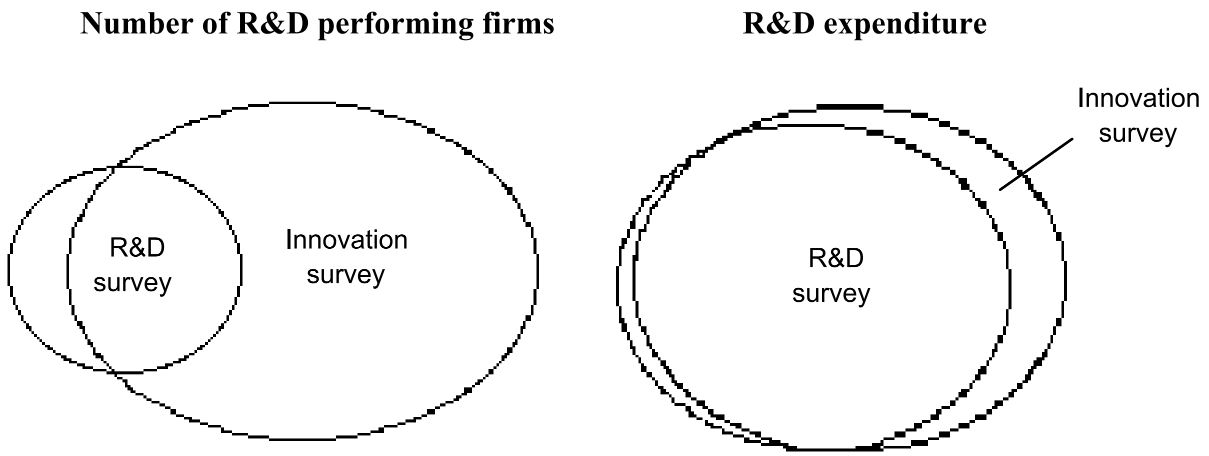
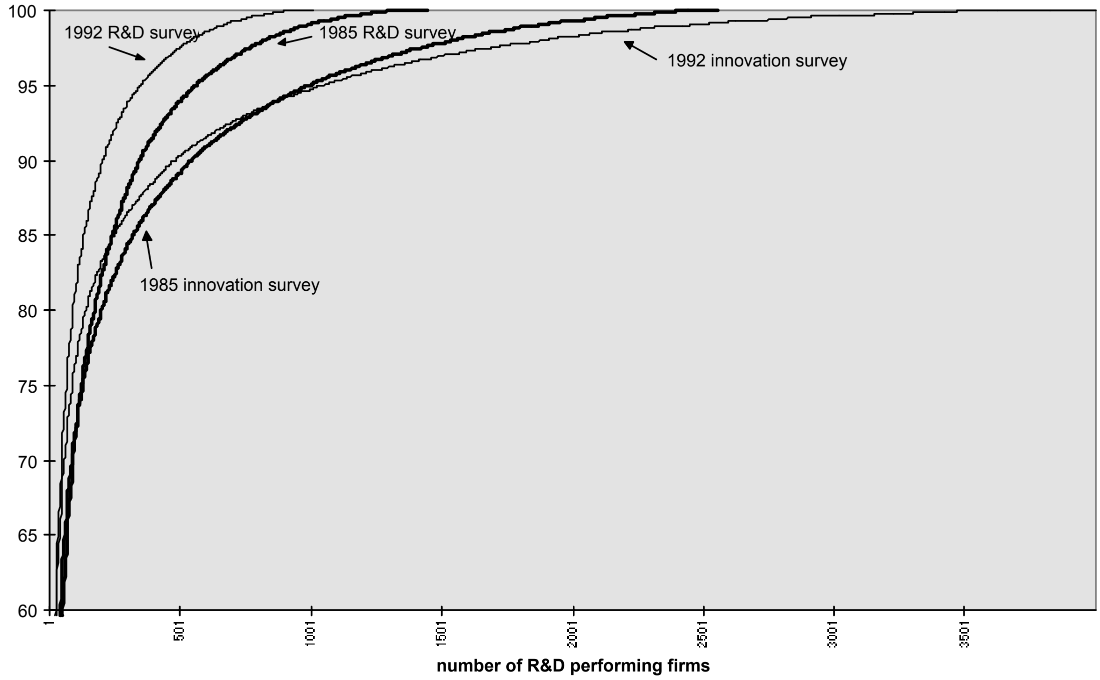


Figure 2 shows the cumulate distribution of the number of R&D performing firms and R&D expenditure according the two surveys for the years 1985 and 1992.

Figure 2. Cumulate distribution of the number of R&D performing firms and R&D expenditure according the two surveys



2.3. Reasons why the R&D survey and the innovation survey yield different results

Table 4 shows the main features of the R&D and innovation surveys with reference to a series of factors linked to definitions, procedures, coverage, data sources. In some cells an evaluation of the impact of the factor on the number of firms involved in R&D and their R&D expenditure has been made in terms of minus, where the survey tends to reduce the observed phenomenon, and of plus, where an extension of the observed phenomenon is expected.

The distribution of pluses and minuses appears uneven. However, even though there are factors that qualitatively tend both to reduce and increase the measure in each survey, their combined quantitative impact is in the sense of making the innovation survey more “receptive” to R&D.

Table 4 - Main features of the R&D survey and the innovation survey and their impact on the measurement of R&D

Features of the surveys	R&D survey	Innovation survey
Definition of R&D	Detailed, along with example (-)	Short, without examples (+)
Scope	R&D (-)	Innovation activities, with an ad hoc section on R&D (+)
Activities included in R&D	R&D and possibly other innovative activities (+)	Only R&D, because other innovative activities are listed in the questionnaire (-)
Typical respondent	R&D manager	Top official, technical manager
Sources of data	R&D budget with moderate evaluation of resources involved	Reconstruction of innovation expenditures with greater scope for evaluation
Statistical population	Register of R&D performing firms (-)	Census of innovating firms (+)
Coverage	All R&D performing firms (+)	Firms which have not innovated, but which have carried out R&D in the reference, period are excluded (-)
Involvement in R&D	Only R&D performing firms	R&D performing firms as well as firms outsourcing R&D (+)
Type of R&D	Continuous, structured (-)	Continuous and occasional (+)

Note: (-) underestimation of the phenomenon; (+) overestimation of the phenomenon.

The comparative analysis of the two sources of data shows that the discrepancies are linked to the fact that the same phenomenon is measured from two different angles: the R&D survey, aimed at measuring the R&D system of the country in its articulations (universities, public research institutions, enterprises), and which puts the emphasis on the acquisition of new scientific and technical knowledge gained in laboratories which are equipped with staff, infrastructure and financial resources, and are characterised by stability, continuity and a minimum size; the innovation survey, on the other hand, collects information on firms which engage in technological innovation and which may be involved in some R&D activities in the framework of innovative projects. This implies that small sized and discontinuous R&D activities are covered by the survey, that the statistical universe is more dinamic due to the discontinuous character of innovation in firms, and that the definition of R&D is interpreted in an innovation context. At the end of the day the averaged weight of pluses in the third column of Table 4 prevail over those of the second column.

2.4 Some considerations on the outcome of the R&D and innovation surveys

Some lessons and proposals can be drawn from the analysis of the above data.

First, it is to be expected that two sets of data on industrial R&D may tell two different stories.

Second, the R&D survey focuses on structured and continuous R&D with the aim of building the R&D profile of a country and using a complex and detailed questionnaire which may discourage firms without a specific R&D strategy and budget to fill it out. In other words this survey hits the core of industrial research along with research carried out in the other public and private institutions.

Third, the innovation survey captures a large variety of firms which have introduced technological innovation and, at the same time, have been involved in R&D (either carrying directly it out, or financing an external laboratory) as defined on the basis of a *de facto* less strict definition of R&D. The picture that emerges from the survey is more closer to a view of R&D as a problem-solving device which appears to be rather diffused within the industrial fabric along with other technical activities, even if its quality and intrinsic characteristics do not necessarily meet the Frascati Manual definition of R&D. The R&D data gathered through innovation surveys make it possible to capture also that research which is conducted in non-R&D settings like design, production, engineering departments on a non-regular basis, and which plays an important role in industrial innovation. From the point of view of resources and people involved the increase is much less relevant.

Four, it would be wrong to discontinue the R&D survey on the assumption that the same data are collected by the innovation survey. The former, in fact, provides a detailed analysis of firms' R&D (by type of personnel, type of research, funding, objectives, etc.) which is not attainable through the innovation survey.

In conclusion what can be suggested from a methodological point of view is that users should be made aware of the differences between the two surveys and compare like with like, especially in the future when CIS data will be available in all countries.

3. The measurement of human resources devoted to R&D

The Frascati Manual identifies three categories of R&D personnel: researchers, technicians and supporting staff. The Canberra Manual, on the other hand, covers the human resources actually or potentially devoted to the systematic generation, advancement, diffusion of scientific and technological knowledge, employed in S&T activities at the appropriate level or having received a specific qualification.

One of the major measurement problems of professional personnel is linked to the fact that a considerable part of them carry out at the same time various activities such as research, teaching, consulting, administration, etc. This state of play has led to the adoption of the concept of full-time equivalent in the framework of the System of National Accounts (SNA).

The Frascati Manual (par. 5.3.3.1) stipulates:

Full-time equivalence (FTE) data

R&D may be the primary function of some persons (e.g. workers in an R&D laboratory) or it may be a secondary function (e.g. members of a design and testing establishment). It may also be a significant part-time activity (e.g. university teachers or postgraduate students). To count only persons employed in R&D establishments would result in an underestimate of the effort devoted to R&D; to do a headcount of everyone spending some time on R&D would lead to an overestimate. The number of persons engaged in R&D should, therefore, be expressed in full-time equivalent (FTE).

Measurement in person-years

One FTE may be thought of as one person-year. Thus, a person who normally spends 30 per cent of his or her time on R&D and the rest on other activities (such as teaching, university administration, and student counselling) should be considered as 0.3 FTE. Similarly, if a full-time R&D worker was employed at an R&D unit for only six months, this results in an FTE of 0.5. Since the normal working day (period) may differ from sector to sector and even from institution to institution, it is impossible to express FTE in person-hours.
Theoretically, the reduction to FTE should be made for all R&D personnel initially included. In practice, it may be acceptable to count all persons spending more than 90 per cent of their time on R&D (e.g. most persons in R&D laboratories) as one FTE and, correspondingly, to completely exclude all persons spending less than 10 per cent of their time on R&D.

The full-time equivalent approach rests on the assumption of homogeneity and substitutionality between researchers and on the absence of economies of scope between various activities carried out by professionals. This "Taylorist" approach appears less and less tenable if a new concept of labour force in the framework of the knowledge-based society is adopted.

In the "Taylorist" model the various stages of production are clearly pre-determined and therefore each function can be performed by an appropriately skilled person. The knowledge necessary to perform the duty is codified and easily transferable. It is therefore quite possible to sub-divide the input to the production process into bits of time: e.g. one person working full-time equals two people working half time.

If we look at the input and the output of the research work we are confronted with various questions linked to the fact that professional activities are more and more knowledge-intensive and, more importantly, this implies that a non negligible part of knowledge is tacit and the knowledge gained in one activity reinforces the skill to performing another activity.

3.1 Superman - or wonderwoman?

Take the case of a university professor of medicine who conducts research, teaches courses and provides medical care in the university clinic - along with doing administrative work. A the end of the day he has done the same work of individual doctors who "produce" the equivalent set of services having different jobs: a researcher, who must have learned about treating patients by reading the reports of clinical colleagues; a teacher, who should have spent long hours in the library and in conferences to update his knowledge; a practitioner/consultant, who must have learnt from colleagues involved in research how to cure his patients using the most up-to-date protocols, drugs, instrumentation. The university professor is not a superman: he simply exploits economies of scope using his knowledge and experience in different settings in a circular self-reinforcing process[1]. From this point of view, he produces social value exceeding one full-time equivalence and, possibly, equalling three individuals. Even more, the quality of each output of the professor may be even higher than that of the sum of the single individuals because his broad range of capabilities which reinforce his problem solving abilities.

Another interesting case is that of a business school which employs a small number of tenured faculty and a large number of experts from business, public administration, professions. The latter teach, as a second job, courses in which they pour the best and updated knowledge they have acquired from theory and personal practice without subtracting resources to their professional life and, on the contrary, rationalising and systematising their daily work and, therefore improving its quality. Apparently in the present society it is more and more true the traditional proverb "If you want something done, ask the busy person".

The above two examples show that the concept of a fixed number of working hours (35-40 hours a week) as the denominator of the indicator, and their allocation between various activities, is less and less tenable for researchers and other professionals: the same person can do more than one job at the same time[2]. In addition, there is a tendency for professionals to devote to work more time than envisaged in working contracts, both at work and at home. This is an increasingly widespread phenomenon whereby the separation - and even the ideological split - between work (a painful but necessary duty) and leisure (the time when man recupetates his personal dimension) is supersided by a entepreneurial attitude of professionals who see their work as a way to promote their self-realisation. In this context the time dimension loses much of its usefulness in terms of activities carried out and of their preformance - who would ask an entrepreneur questions about his time budget?.

Some problems can be identified in this connection. In our societies each person and, consequently each worker, is ideologically and politically considered similar to the other, even though each one has his own individual peculiarities. The social contract behind this agreement stipulates that all persons are in principle "equal" even though their skill and productivity may be different. Wage differentials are expected to reflect differences in productivity, but do not justify any differences in social status, self-esteem, role of the individual in society. But, if we assume that some special individuals do more jobs than others (the university professor of the previous examples is apparently equal to three different people), then these individuals should receive more than one salary, each one for each activity, and this would mean that they are more "worth" than others. But this in not acceptable in our socio-political context. On the other hand professionals involved in various identifiable activities are paid only one salary which is all-encompassing and which rewards the whole of their effort.

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[1] Economies of scope are present where it is more efficient to operate two or more activities in tandem than in isolation (Coase, 1937).

[2] The problem of defining the number of working hours for university professors is emerging again in the "Survey on R&D activities of university professors" being presently carried out by ISTAT. In the questionnaire professors are asked to evaluate the total number of hours worked in 1996 and to break-down this time into teaching, research and development, administration, consulting, health care (for doctors). Many university staff ring up ISTAT in order to receive additional guidelines for defining the "real" amount of time they have to allocate to the activities identified in the survey.

3.2. How to get out of the dilemma?

This reasoning leads us to propose three ways to face this dilemma. All the solutions put the emphasis on the measurement of an input into the S&T system, but, at the same time, they take into consideration the output of the activities performed by researchers.

A first solution could be to continue to use the metrics of full-time equivalent when input measures are concerned in order to avoid double-counting in the System of National Accounts.

Second, we can drop the distinction between the various activities, on the assumption that for a professional in the age of the knowledge-based society it is typical to perform a variety of closely related activities which are difficult to define and measure, and which change quickly over time. Cases in point are a scientific professional in the university, denomunation which could replace the "old" one of professor, or an engineer in industry who performs technical duties including research, design and technical assistance to customers in a problem-solving context.

Third, from the point of view of the social value and therefore of output of the activities, we can adopt the head-count metrics (like the Japanese who usually publish figures on the total number of people involved in S&T activities without the respective full-time equivalent) on the assumption that each significant activity carried out by the professional accrues to the creation of wealth as a unit. This leads to double-counting, which is accepted in various cases like in bibliometrics when co-authored publications are counted as many times as the number of authors, and which makes sense in the SNA.

An additional indicator would be the measure of the "market value" of the work of researchers by adding the other income revenues linked to the extra work (consultancy, teaching etc.) to their salaries. In this way the second and third "alias" are accounted for to the extent to which they generate market transactions[3].

Another more radical solution would be to devise a completely new paradigm which supersedes the "Taylorist" approach and which is more apt to measure the contribution of scientists and engineers to their "customers" in the framework of the knowledge-based society. But are we ready to conceptualise all this and get out and measure the phenomenon according to a new System of Knowledge Accounts?

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[3] This solution would introduce distortions such as the inclusion of "professional superstars" who receive extremely high fees for their work, and the exclusion of non-payed activities like conferences, administrative work, etc. On top of that, the data collection procedure would be particularly problematic: it seems unreasonable that income data could be gathered through questionnaires to be filled out by professionals; however, a cross-linkage between the R&D data base and the income or the security data base could be a possiblesolution to this problem.

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DISCUSSION ON THE SPEECH AF SIRILLI

Mr. van Riel referred to Mr. Sirillis approach to the full time equivalent, and mentioned that in the Netherlands plenty of measures of time spent on different jobs are measured down into minutes. And he expected that to come for R&D as well.

For the innovation surveys, Mr. van Riel questioned the problem about socially desirable answers, if you, as an institution/company fill out a no to the question saying no: we are not doing R&D, then you are stupid? If it expected that you do R&D. And he raised the question: What to do about that?

Mr. Perry asked about environmental consideration - will that influence R&D-statistics?

Mr. Geary: What was the change if any, in tax law or any other law between the different measures collected in Italy, to which Sirilli answered no or very limited changes.

A discussion about theoretians, and the relevance of them in relation to R&D statistics then followed..

During this discussion the issue of how technology is related to economic growth was characterised old fashioned.

Mr. Frey: Frascata and Oslo manuals, is there an Italian application of the Canberra Manual, if not, why not?

Mr. Foyn: Discrepancies between R&D and S&T: R&D versus S&T-studies, Mr. Sirilli had mentioned to educate the users. Instead Mr. Foyn recommended to educate the producers!

Mr. Sirilli responded: National systems of innovation, not yet succesfully given models that can be used for political decisions. From statistics, there is a long way to recommend political decisions.

Summary of discussion: we have to be carefully aware of users needs, we have to anticipate the needs because statistical indicators take a long time.

ARE NATIONAL DIFFERENCES IN R&D AND S&T MEASURED CORRECTLY?

Mikael Åkerblom
Statistics Finland

Introduction

The aim of all international statistics is to facilitate comparisons of the situation in a given country with other countries of interest or with some broader group of countries (OECD, EU, EEA). The aim of my presentation is to discuss some issues to be considered in the interpretation of comparisons of R&D and innovation indicators between countries and give some evaluations of the present situation.

Definitions, classifications

Due to the Manuals belonging to the OECD Frascati Family R&D, innovation and other S&T concepts are theoretically rather well defined. The Frascati definitions of R&D have even to a certain extent become accounting standards in certain companies. In practice, differing interpretations by respondents and various methods of reporting and estimating R&D resources within institutions may cause incomparability within sectors, countries and between countries.

Use of standard classifications is also a prerequisite for international comparisons. The most important classifications for R&D and innovation statistics are the industrial classification and the classification by institutional sector. The industrial classification is now regulated by the EU classification NACE (rev.1) and the corresponding UN classification ISIC (rev.3). Earlier, national classifications have been used in some countries, which have somewhat hampered international comparability of R&D and innovation data, as the international data have been compiled using conversion keys. The sector classification proposed by the Frascati Manual is widely used and is an excellent tool for comparing structures of overall R&D efforts between countries even if there are some problems in a consistent allocation of certain institutes to specific sectors.

Even if standard classifications are used, differing classification principles might cause problems of comparability between countries.

Coverage

There are three problems of coverage of the population:

- coverage in terms of industries covered
- for enterprises coverage in terms of size of enterprises included
- coverage in terms of total population or only units believed to have R&D or innovation

For R&D surveys the decisions on the appropriate coverage of surveys are wholly on the national level. This leads to big difficulties in comparing national figures on R&D in the service sectors for example. A comparable coverage is also essential for an understanding of the role of SMEs in R&D. The first EU innovation survey (CIS 1) encountered the same problems of differences in coverage. An attempt has been made to give clear guidelines on coverage for CIS 2. No corresponding guidelines exist or have even been planned for R&D surveys.

Statistical unit

Comparisons of the R&D and innovation activities of industries in various countries will be harmed by different statistical units. R&D and innovation surveys are generally based on the enterprise type unit. In some cases it is not possible or feasible on the national level to have data on that level. Other types of units have to be applied, such as groups of enterprises, divisions of groups of enterprises, kind of activity units, or even in some cases local kind of activity units.

Methods of collecting data

R&D data and innovation data can be collected by different methods (total investigations, sample surveys or combinations of both). For R&D surveys no recommendation exists about method of collecting data. Considering the experience from CIS 1 some general guidelines about the use of a combination of total investigation and stratified random sample was given for CIS 2.

Methods of processing data

In the course of CIS 1 a lot of attention was drawn to problems of sample errors, estimation of missing values, problems of non response bias in the material given to Eurostat for processing. These problems will in CIS 2 be more tackled on the national level on the basis of instructions by Eurostat. In R&D no recommendations for processing data exist, but these problems are probably less severe, as the surveys are more established.

Institutional issues

All interpretations of national differences should be seen against the institutional background behind the figures. If this is not known serious misinterpretations of data may occur.

Conclusions

In interpreting national differences in R&D and innovation all the considerations above have to be taken into account. In innovation surveys Eurostat has attempted to take most of them into account in connection with CIS 2. Probably R&D surveys could be somewhat more harmonised in the future in terms of coverage data collection and processing methodology in order to improve the comparability.

DISCUSSION ON THE SPEECH OF ÅKERBLOM

Problems were discussed in relation to the users not able to digest the data in a proper way.

At an aggregate level problems might not be so great, but users want more and more details.

Mr. Defays opened a discussion about the connection between data collection and analysis.

Giorgio Sirilli declared that in principle producers of statistics cannot achieve perfection, but we have to take into consideration what the most likely use of the data is, if we want finer analysis then Mr. Åkerbloms problems are relevant. What is the marginal value of extra effort trying to make R&D better vis a vis other tasks, we have to balance our efforts.

Mr. Sirilli disagreed with Mr. Åkerblom with regard to his conclusion that R&D are less harmonised than innovation studies. The central issue is to make producers the first users, we should learn the problems and realise whether the data are good enough.

Mr. Sirilli also referred to intercultural differences and mentioned Japanese perceptions as a problem in comparative perspectives.

Conclusion of this part of the discussion was that the most important thing is to capture the real information behind numbers.

Third session

Dataproviders handling of problems

THE COMPANIES' PROBLEMS WITH R&D QUESTIONNAIRES

Peter Huntley
The Confederation of Danish Industries

The issue of R&D questionnaires is splitting industry. On the one hand, the companies want the questionnaires to be simple and it should be possible to use the same data in the questionnaires as the data used in their annual accounts.

On the other hand, we want thorough information on the volume and the development of R&D within each country, each industry and even within each branch. And this is where the conflict arises; You can't have both.

All in all, the number of companies answering the questionnaires is fairly high as they expect the questionnairs to be of use as a framework for research understanding and politics. However, there are reasons to make some recommendations for improving the future statistical surveys.

In order to have as many companies as possible taking part in the survey, it is important that the questionnaires can be completed with the same figures as those already entered in the companies' annual accounts. Annual accounts and questionnaires should originate from the same data source. If data are required which cannot be retrieved from the ordinary annual accounts, it is important that these data can be worked out with a minimum of supplementary calculations from the figures presented in the annual accounts.

You cannot expect an accounts department to work out two separate accounts in order to satisfy the R&D statistics. There are examples of companies - even large ones - who have denied to do this R&D exercise because they do not have the ressources to do the double work in order to provide this kind of service.

In addition, it is demotivating for a company to receive a questionnaire asking for data which have already once been given to a public administration. All data which can be obtained from somewhere in the public administration should therefore be obtained from here in stead of troubling the companies with working out the same figures twice or more. This redundant kind of work should be minimized.

It is also to some extent demotivating to see that figures presented by the companies one year, contribute to the statistics up to 2 years later.

The delay in publishing the R&D statistic is severe. However, I am not saying that the processing of the statistics is slower than the technique allows it. But this does not change the fact that the statistics are almost antiquated when they are published.

This means that neither companies nor public administrations can use the statistics to form a benchmarking in the short run - for example to draw up the public research budget or to lay down public incentives to promote private research and development.

Therefore, if anything can be done to speed up the publishing of the statistics, it should be done.

The most important problem as regards R&D statistics is however, the very definition of the concept of R&D. Both for the one completing the questionnaire and for the one who will be doing the interpretation of the statistics. It is important to our treatment of the information that we are aware of the uncertain factor of the data. This does not mean that the data presented by the companies are not correct but each company has completed the questionnaire based on a more or less subjective understanding of what R&D is.

Does a small Spanish company have the same understanding of the concept of R&D as a large German multinational company and if not, how much does their interpretations differ from one another?

In Denmark for instance, a discussion has been going on for a long time on the low volume of private R&D compared to other countries. The volume of private research in Denmark is 20-30 % below that of our OECD competitor countries. Denmark is officially aiming at developing its competitiveness based on a high level of knowledge. We want to be a knowledge-based productive society.

A surplus contribution of 3-4 billion DKK more would therefore be good for the Danish R&D policy - if we are to believe the statistics. But does the volume of private research in Denmark actually rank low compared to other countries? Or is this just a reflection of the differences in the definition of R&D between the countries? We do not know.

I would like to give you an example of overinterpretation of the statistics due to the vague definition of R&D. In the beginning of 1990 the Danish Academy of Research undertook the task of working out a prognosis of the future demand for Ph.D.s in Denmark. As a natural thing the basis of the prognosis was the R&D statistics.

Based on the R&D expenditure and an estimated growth, it was possible to give an opinion of the demand for Ph.D.s. The conclusion was alarming. The demand for Ph.D.s was anticipated to be 5 times higher than the 300 Ph.D.s educated annually at that time. The prognosis suggested a demand for 1500-1800 Ph.D.s per year. All of a sudden, there was a problem - or was there?

The Danish Academy of Research had worked out the prognosis based on the assumption that R&D could only be carried out by Ph.D.s and not by masters and certainly not by bachelors - the two largest groups of technical staff in industry. The data were supplied by the companies but on the assumption that R&D was an activity in the company carried out by the technical staff - typically the categories of engineers that I just mentioned.

The result of these differences in the definition of R&D meant that, the Danish Ph.D. reform in the beginning of the nineties was mistakenly based on the assumption that there was a tremendous lack of Ph.D.s. Since then the mistake has been corrected so that the quality has been improved and the number of Ph.D.s has been tailored to the needs of industry.

A last thing I would like to comment on in connection with the statistics is the way of classifying a high-technology, medium-technology or low-technology branch of trade. These definitions are no longer valid.

This kind of classification is based on an average evaluation of the product itself, no matter the underlying process.

Shipyards for instance are classified as low-technology. The Danish shipyard Lindø shows something else. The company is one of the most sophisticated in Denmark. World-wide the

product might be a low-technology product but the competitiveness of the shipyard is based on a very high-technology production process.
These are the four recommendations we wish to point out. In conclusion, we recommend:

- an optimal coordination between questionnaires and annual accounts
- a short lead time in the preparation of the statistics - a clear definition of R&D
- no definitions of low- and high-technology industries.

We highly appreciate the research statistics but we are also looking forward to a continued product development.

Thank you for your attention.

GETTING RESEARCH STATISTICS FOR THE MEDICAL FIELD

Ebba Nexø
Dept. Clinical Biochemistry, Aarhus University Hospital

The purpose of collecting data for research statistics within the field of medicine is the same as for other fields. One of many goals is to have data that show the research expenses. Data that can be compared over time, between fields and between countries. Data that can be used to evaluate the cost-effectiveness of research expenses.

A major part of medical research is located at hospitals, i.e. in a setting not easily compared with other research institutions. Because of that I have chosen to focus on this part of medical research.

The hospitals are characterized by hosting interconnected activities. Curing patients, teaching, development of new diagnostic tools and treatments and other types of research activities are tasks performed at the hospitals.

Municipalities own the major parts of the hospitals and carry a part of the responsibility for the research. Also the universities have a responsibility and a budget for carrying out research at hospitals. They employ professors and other teaching and research staff at hospitals hosting teaching from the three medical faculties. As a consequence of this organization the university, the municipality or both may be the employer of the persons involved in research activities. Furthermore the same person may well be engaged in treating patients, teaching students and doing research.

Getting meaningful research statistics from this complex organization is not a simple matter. Let me give a few examples.

How do you distinguish between clinical work and research? In reality often there is no possible distinction. If you want your research budget to look large you may report all expenses related to a clinical trial. If you want your budget to be as small as possible you may claim that virtually no expenses are involved - the patients had to be treated anyhow. In the first case expenses for treating patients are underestimated and in the second case you do not get a realistic impression of the expenses used for research.

Depending on the purpose of your research statistics you may choose different solutions. If your purpose is to compare expenses over time, the major challenge is to give instructions so that everyone reports, based on the same definitions, and so that the same definitions can be used over time.

The situation is far more complex if you want the research statistics in order to judge cost-effectiveness, especially if you want to perform comparisons between countries.

At present there is to my knowledge no model for giving realistic estimates of the expenses involved in the production of the clinical research, judged, e.g. as the number of published papers. Because of that it would be a misuse of statistical data, if it were claimed that Denmark has a very high productivity in the field of clinical. research. It is worth remembering that an increasing or decreasing productivity in the years to come may reflect solely an altered way in recording expenses.

Finally one may well question whether it is possible to record both realistic expenses for the research and for the treatment of patients. Possibly not unless you accept an imaginary expense that is more than 100% of the budget. Dividing the budget into expenses used for patient care and expenses used for research may give the result that it is cheaper to treat a patient, if the patient is part of a research project, and vice versa.

Most effort has been done to record manpower involved in research activities. Also this may well create special problems at the hospitals, and perhaps especially at the university hospitals.

Research statistics are collected from each department, but with the institution as the unit. You have to indicate number of "man years" engaged in research paid by the institution and paid by other agencies. I will not go into the problems related to the fact that "the institution" at university hospitals may be both the university and the hospital, because this may well be a Danish specialty of less interest for others. I would, however, like to reflect on the difficulties in getting reliable data obtained as the sum of data collected from the individual departments. Perhaps because doctors as part of their education have to work on a number of departments, one will often see a doctor employed by one department carry out all or part of his research in another department. Most likely this person will be counted as two persons, both at the department that pays his salary and at the department at which he does his work. This may seem a trivial problem easily solved by giving clear instructions. And theoretically, so it is if the collected data are to be used only at the institutional level. If the data are used to compare research engagement and productivity at the departemental level, this problem is not so simple.

Finally, I would like to relate to a problem probably of relevance for many fields of research. Many doctors work more than 37 hours a week. If they were to tell the truth they may well have to report, that they, e.g. spend 20 hours a week doing research and another 30 hours a week doing routine duties. This is a problem, since you are only supposed to report 37 hours a week. How do you decide what you are doing in your spare time, research or routine work. Depending on your choice you will get misleading figures either for expenses related to research or to routine chores The other alternative is to accept to have more "man years" than can be accounted for at the payroll. Again to my knowledge no one has approached this problem. If a considerable part of the manpower used for research represents unregistered sparetime manpower, one has a serious problem. In that case it will be impossible to register the costeffectiveness of expenses for research activities over time. A decrease or an increase may simply reflect, an alteration in the amount of sparetime manpower used for research.

The few examples chosen to illustrate difficulties in getting reliable research statistics for the field of medicine reflect three important points. First, collection of data need to take into consideration the organization of the research to be registered. Second, the purpose of collecting the statistical data should be reflected in the data collected, and care should be taken not to misuse the collected data for other purposes. Finally my points hopefully illustrate that designing useful schemes for collecting data for research statistics is a complex matter, unlikely to be solved unless an expertise within this field is developed.

DISCUSSION ON THE SPEECHES OF HUNTLEY AND NEXØ

The discussion following the third session focused upon the problems of measuring research initiated by Ms. Nexø in her presentation, where she had described the problems in relation to measuring research activity at hospitals, where individual researchers might be counted twice, because they work at one place and do their research at another, or their research is funded by an outside source.

Mr. Perry followed up on the problems related to counting personnel, and continued the discussion about number of hours measured versus number of heads doing research. He was in favour of full time equivalent data versus head count, but argued in favour of both types of data to be collected.

Mr. van Riel opened another discussion related to low tech versus high tech R&D. Is this distribution relevant, why use it? And in his question to Ms. Nexø he went back to the discussion about full time equal to 37 hours or something else; and he refered to the Netherlands where researchers are also doing teaching at universities, and he meant that cost effectiveness was difficult to measure. And also for hospitals: Difficult R&D relationship, and he recommended that one instead should ask the financial master whether he is satisfied and then compare this measure with other hospitals insted of comparing hours.

Ms. Nexø responded that measures were needed. In Denmark we have a 37 hour working week, and she would go for measures of the actual hours and fraction of man; but doctors were hired to cure patients, not hired to do research, so there was a problem in giving the correct information.

Can we make the world to fit the statistical measures? We can try to stratify organisations, if we want to go and measure what is going on. Either give up or try to get a society that fits statistics. One additional problem being that in clinical research, no one is responsible. Research is something for the universities some will say, while hospitals are for patients to be cured.

In reponse to questions about hospitals funded by charity organisations Ms. Nexø explained that we don't have them in Denmark, but in statistics non-teaching hospitals also are covered, but they do very little research. There is an increasingly awareness of research also here, since one way to attract doctors to non-teaching hospitals is to have research facilities. Ms. Nexø continued saying that in the Danish Hospital Sector there is different streams of money and no clear line of responsibility. And she summarised that individuals should be counted only once.

Who is going to use the statistics: if at a country level it is ok to indicate amount of active versus non-active, if then used at department level, comparing active versus less active departments, it is very serious how it is measured. The important issues are definitions, collection of data, and what are the output measures. If that is solved we have gained something.

Mr. Huntley responded to Mr. van Riels question saying that the split between high/low tech industries is very difficult, giving Danish examples of products and companies using different kinds of technology. And he went on to the issue of using annual accounts for statistical information. "We have listened and heard that you believed that you can try to influence companies using your questionaires. You cannot. For the target groups it will always be a secondary activity to give you data.".

The session was closed by the chairperson with thanks to the speakers and with the remark, that this day has shown more problems than solutions; and she expressed hope for the solutions to come the following day.

Fourth session

From producers to users

PUBLISHING RESEARCH STATISTICS

Kirsten Wille Maus
Norwegian Institute for Studies in Research and Higher Education, NIFU

First, I want to express my pleasure at being here at the seminar and at the new Danish Institute for Studies in Research and Research Policy. I hope to remain in close contact and collaborate with you in the future.

The subject of this session is: "Dissemination of Statistics: From producers to users". I have been asked to talk about publishing R&D statistics. I will try to share my experience from Norway with you. How do people get interested in R&D statistics? Nobody gathers statistics for the sake of it. They have to be disseminated. In Norway until 1993, three of the five research councils were responsible for R&D statistics and reports were issued by their joint committee for R&D statistics. In 1993, the five research councils were merged into one, the Research Council of Norway and NIFU was asked to co-ordinate the R&D statistics and publish the data as we did for the joint committee. I set up the budget for NIFUs statistical department and the new strategy department at the Research Council asked me about statistical reports on R&D. They wanted to know if there was a need for such publications, and if so, why. Everyone who has been working in this area knows that there is a great demand for data. It makes it much easier to refer to a report and specific figures which can easily be related to national totals or other areas, branches or sectors and the Research Council agreed upon this.

I will organise my presentation in three sections:

1. Target groups - i.e. the persons and institutions to whom the R&D statistics are directed
2. Dissemination/type of publications
3. Periodicity/frequency and language

1. Target groups

The first question to be raised is: Who are the users of R&D statistics? Who should be informed about the statistics and who is going to read the information? The audiences are:

- Parliament, Government, Ministries/science and technology policy-makers
- Research agencies, councils and foundations
- Administrators at R&D units, institutes or institutions, university and faculty heads, departments, large firms, private companies
- Regional policy-makers
- The general public

All these audiences are interested in data corresponding to their own activities or to similar institutions, specific subfields or programmes, national totals, international comparisons and developments over time.

2. Dissemination/type of publications

The next question is: What is the best way to publish R&D statistics? Should it be a text and analysis, tables and graphics, or both? What are the expectations? Many institutions responsible for R&D statistics have reduced resources, and more focus has to be put on efficiency, it will be impossible to do everything.

Our databases on R&D statistics are "full of data". There are various forms of printed matter, "paper information". How should one make a selection? Should macro-level highlights be presented or would it be better to focus on the micro-level with much more detail? How should the problem of confidentiality be solved? The following are different types of publications and ways of publishing the data:

- Booklets
- Information sheets
- Newsletters
- Articles in national magazines and international journals
- White Papers, Ministerial documents
- Pure statistics, tables, statistical yearbooks
- Indicator reports - texts and tables, articles
- Separate reports or analyses for special items/areas
  - sector of performance (Business Enterprise Sector, Higher EducationSector, Government Sector, Private Non-Profit Sector or the Institute Sector,as we call it in Norway)
  - subject fields
  - industry
  - research personnel
  - doctoral degrees
- Catalogue of research institutes
- Mass media
- Electronic publishing

Our experience in Norway is very good concerning *booklets* and *information sheets*. These publications give up-to-date overall highlights and they increase curiosity. We also have good experience with articles in a *national magazine*, i.e. the last page in NIFUs "Forskningspolitikk" which has approximately 7,000 subscribers. In addition, the Nordic Science and Technology Indicator Reports have become quite popular. Furthermore, we work closely with the Ministry of Education, Research and Church Affairs which is responsible for the White Papers on Research issued every four to six years. This collaboration is, therefore, very important.

Pure statistics, tables, statistical yearbooks are more like reference works. To some extent this is also the case for *indicator reports*, chapters can be read separately. This information should give a better understanding of different aspects concerning R&D and S&T indicators. *Separate reports* give more details focusing on special items which would not be appropriate in an indicator report.

Separate reports or analyses/studies allow the author to ask questions and form hypotheses or focus on particular problems. In addition *catalogues of research institutions*, or even a list of performing units, the names, addresses of universities, institutions, etc., are of great value to our users.

In all these publications it is important that the research unit recognises itself. Long data series are also important, but changes in methods and break in a series are problems which has to be solved. It is necesarry to give information without confusing the user of the statistics. Dataproviders should also put more effort into information to Mass media. Both this item and electronic publishing will be focused later on today.

3. Periodicity/frequency and language

R&D surveys are performed every second year in Norway and the results have been available in statistical reports issued every second year. We still think statistical tables should be published separately or included in an indicator report as a separate section.

We think, however, that it would be a great advantage to provide data more often. The information sheet on doctoral degrees twice a year for instance, give up-to-date data and is a success. This is also the case for our annual report on the Government budget, a survey of proposed appropriations and priorities affecting, universities, colleges, the Research Council and research institutions. For the first time, this year we issued a booklet on science and technology indicators. This has also been a great success and we intend to issue one every year instead of every second year. Our experiences are that regularity is an aspect which should receive more focus.

Lastly, I want to draw attention to language. In non-English language countries, a decision needs to be made on which language to use by publishing the data. In the booklet mentioned above both English and Norwegian texts are included. Translating larger reports however, can be very expensive. In my opinion summary reports could be a good solution. In some statistical reports, a glossary and even a translation of the table columns are included. This, however, takes a lot of space and our advice would be not to do this, but rather to do translations and send data on request.

SUMMARY OF PERRYS PRESENTATION

Ian Perry introduced the work done by DG-XII with respect to indicators and he referred to that he represents DG-XII in NESTI. He described his work with statistics relevant to the frame work programme. Continuity and change are the basic principle of two reports "The Indicators Reports" presented by his office.

The work with the reports has two aims:

1. contribute to reference base of what is at stake at the european level, trying to provide the base of information from which policymakers can make decisions bringing a lot of different types of information together and
2. to stimulate the development of indicators and satisfy the needs of policy makers.

It is the hope to get an insight into the likely socio political impact of science and technology. To give something that can be fed into science budget policy. How should public funding be divided up, for which domain, how to measure the impact of S&T on employment and citizens wellbeing. Goal to establish systemic indicators to cause and effect.

He then described the expected content, chapter by chapter, of the new reports to come regarding statistical indicators at the European level.

A questions from the audience related to what kind of consultations which had taken place before publication. Mr. Perry referred to CREST. The reports were not of the type that had to be accepted by member states.

DISCUSSION ON THE SPEECH OF MAUS AND PERRY

After Kirsten Wille Maus' presentation Karen Siune gave a short presentation of Danish newspapers media coverage of R&D following the summary paper distributed to the participants.

Ms. Young complimented Ms. Maus for her presentation and for the Norwegian practise. She recommended that we have to contiune producing basic statistics, not only fancy figures. And she expressed her hope for English summaries or another kind of indices to help people from other countries to use foreign data. Ms. Young went on referring to footnotes and minor changes: how serious are the changes mentioned in footnotes, are they damaging for the data or just minor changes. "Please indicate and explain what you do".

Mr. Defays asked whether NIFU-publication had to be approoved before publication. The answer is no. NIFU tries to service public administration, but the data are made up totally by NIFU. Researchers are allowed to use data collected by NIFU down to a minimum of 3 units in each cell, but NIFU is very open to universities.

The chairperson thanked the participants and the speakers for their interventions.

Fifth session

What can we use R&D statistics for?

R&D STATISTICS: USE AND USEFULNESS FOR INDUSTRY

Conrad van Riel
Confederation of Netherlands Industry and Employers VNO-NCW

1. Introduction

Ms. Chairman, Ladies and Gentlemen.

It is a great honour for me to speak at this conference, and I thank the organisation for inviting me. I would like to start my contribution by paying tribute to the host country and tell you a fairy tale.

Once upon a time, not very long ago, a number of small kingdoms of dwarfs lived in the dark forests of Europia. One of these kingdoms had to fight against terrible flood to preserve its existence. Having been successful against the floods of water they embarked on a new fight; against the floods of information. They were not the only kingdom to start this fight, every visitor from other kingdoms told stories about the heroic fight of his own kingdom. It was for this reason that the King, in his eternal wisdom, ordered his minister for Protection of the Kingdom, to systematically look around and learn from their fellow dwarfs.

Every year, when the leaves turned gold, the ministers gathered around the Old Oak and presented their plans to the King. It had been a meagre year, so the overall amount of gold was not enough to pay for all the plans. The foxy minister for Protection of the Kingdom wanted more money for his plan to battle the flood of information. He was lucky. A taskforce of his servant dwarfs found out that other Kingdoms spent much more on their battle than his Kingdom did. So he planned to tell the King that they were in a disadvantage, and that he therefore needed extra gold for his plan. Just when he wanted to start his plea, one of his servants entered the clearing, panic in his eyes. The note he fumbled in the ministers hand said that the task force miscalculated: the other Kingdoms actually spend less on their battle than their own Kingdom. The minister was not taken aback by this trivial problem. He reassured his servant and gave a speech that would long be remembered in the Kingdom. In his speech, he took his colleagues to the battlefield of information warfare. A battlefield that knew only victories for their Kingdom. Until now. If the Kingdom were to keep its advantage, the minister argues, it should invest more to keep ahead of the other kingdoms. Failing to do so would set their country back in the league of Kingdoms, and eventually lead to poverty.

He was granted his gold. I will come back to this fairy tale later.

To give you an idea of the perspective I'm speaking from, let me devote a few words to the organisation I am representing today. The federation of Netherlands Employers and Industries represents approximately 80.000 Dutch enterprises in all sectors of industry, except large parts of the craft and retail sector. Together these enterprises represent 60% of private sector employment. Together with one colleague I am responsible for technology policy at VNO-NCW. I am member of the consultative committee on R&D statistics of the Dutch Bureau of Statistics.

2. R&D statistics; examples of use by industry

Let me give you a few examples of the use of R&D statistics, by industry and industrial federations. The first exempla is the use of ICT statistics, i.e. the use of software by companies. These statistics are used by the software sector to estimate the size of the Dutch market. Recently, the sectoral organisation for Dutch Software enterprises collaborated with CBS to publish ICT in the Netherlands.

Next sheet show an anthology of R&D statistics used by VNO-NCW. The first one comes from a booklet we published for the coming elections. It shows that Dutch government officially spends less R&D subsidy the OECD average. The next one shows the 1994 R&D investment by Dutch enterprises in a matrix of sectors set against technologies. It was compiled by a consultant, and based mainly on a database of a fiscal measure to stimulate R&D in enterprises. At that time, this kind of data was not available from CBS. It was used to raise the awareness of government and enterprises of the importance of technology, and to underpin the governments choice not to subsidise specific technologies. The matrix next to it was published by CBS a few moths ago, based on their R&D survey for 1996.

This sheet shows what use we make of R&D statistics: for lobbying. Like the minister for Protection of the Kingdom, we use statistics to make our point to the King.

Individual industries, to my knowledge, use the official statistics for exactly the same purpose, and for background information.

Next sheet shows two things: It shows one reason why industry makes relatively small use of official R&D statistics, and it show the importance of context.

The first graph shows private sector R&D investment in the Netherlands from 1989 to 1995. It shows decline, with a small pickup in recent years. The next graph is an international comparison of R&D investment in the metal industry, coming from a recent CBS publication. The last graph shows the R&D investment of Philips and Sony, and comes from a study by Bert Minne. Clearly, at the end of the 1980's, Philips adjusted its R&D investment to levels comparable with competitors.

To individual companies, the most relevant R&D statistics are those of their competitors. Of course, these statistics are not available officially, and should remain so. This is a problem that no official bureau for statistics can solve. There are other ways to obtain these figures.

3. Problems and solutions

The middle graph shows the importance of context. The investment you see there in that of the Dutch metal sector. Plus Philips. Philips is hidden in the metal sector because it represents approximately 20% of Dutch private R&D investment. Not knowing this context would give you a wrong impression about the Dutch metal sector. Now that you know this context, you can also figure out the first graph.

How can we make official statistics more useful to industry? Although figures of individual companies are most interesting, it would be very useful to have good figures for an entire sector. This would allow the individual company to benchmark its position against competitors. There are a number of industries that will stick out in every small country, forcing the national statistics bureau to hide them, and making international comparison within the EU useless. However, this problem can be avoided by doing sectoral analysis at a truly European level. After the Maastricht treaty, the official nationality of the competitor is not important anymore. Why would you want to make a comparison between countries with an open market?

4. Design for relevancy

I was asked to give a presentation about the industrial use of R&D statistics. The more I learn about statistics, the more I doubt whether future use by industry was ever part of the design of R&D statistics. One could ask a legitimate question: should they be? My answer to that question is, of course, affirmative. The reason for that is threefold.

Last year, to my knowledge, Dutch R&D companies received three questionnaires regarding R&D. Two came from the national bureau of statistics, one came from the ministry of Economic Affairs. Mind you, this does not include the various interviews for evaluating R&D subsidies, collaboration in strategic workshops etcetera. A permanent point of attention is therefore the pressure on companies to fill out forms. A quick calculation puts the cost to companies of the Dutch part of CIS-2 at roughly 500 kiloECU. I think it is reasonable that these companies get something in return. One way to do that is to give some feedback on the results. For instance, companies could get back their own form, together with the aggregate results for their sector. On a more strategic level, the result could be made more relevant to them. Let me get into some detail on that.

One can look at R&D performing companies from the usual point of view of R&D intensity, leading to High-tech, Low-tech and even medium-high-tech sectors. One can also look at them in terms of location and market. Using these criteria R&D performing companies can be divided into national-exporting companies (located in one country, serving a European or world market) and multinationals, serving a world market and based in many countries.

What would these companies want to know in the field of research? First of all, they need well qualified personnel. So they want to know which university delivers the best students in which field of research. A proxy for that could be the average job search time and unemployment ratio's for graduates. This information could also be a selection criterion for students when choosing a university. To my knowledge, this output-type of indicators are not available.

Some of these companies would want to co-operate with the public knowledge infrastructure. An important indicator could be: research excellence per department or research institution, measured both in terms of scientific quality and in terms of attractiveness to third parties.

Multinational organisations want to compare the R&D investment climate in different countries. Cross-border payment to public research institutes are a good proxy for their international attractiveness. The balance ratio of base funding to competition funding of universities is a more telling indicator than the HERD indicator. The presence of other companies performing research in the same fields would be a good indicator too.

In recent years, the Dutch bureau if Statistics has moved its development of R&D statistics to what the outside world would want to know. Their annual report, called 'Knowledge and the Economy' is interesting, sometimes even intriguing, literature. The abovementioned suggestions could improve the relevancy of their reports.

5. Some more suggestions

I have a few more suggestions on the practical level.

Earlier in this presentation, I hinted to other sources of information than official statistics. There are many other parties, such as private consultancy firms and public research institutes that collect data and develop statistics. I think that a better co-operation between the official and non-official statistics could improve the relevancy of the statistics provided.

As with all other kinds of services, a good contact with customers during the production process improves the quality of the services.

6. Conclusions

I have argued that the use of R&D statistics by industry is limited to background-information and lobbying activities. Suggestion to improve the usefulness of R&D statistics to industry are:

- place more emphasis on output indicators;
- continue the development of interaction indicators based on the NIS-approach;
- develop more indicators on cross-border interactions.
- put statistics into perspective by providing context.
- reward those parties that contribute data by providing a feed back of the results
- seek more consultation with the private sector when developing R&D statistics
- consult other parties that have experience in the development of statistics.

Suggestions for improving the process of compiling and developing statistics:

- reward those parties that contribute data by providing a feed back of the results;
- seek more consultation with the private sector when developing R&D statistics;
- consult other parties that have experience in the development of statistics.

STATISTICS ON THE GENDER PROFILE IN RESEARCH POSITIONS

Anette Borchorst, Associate Professor,
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Research institutions are part of the labour market, and statistics on the number of employees at different institutions, broken down on different positions, disciplines and institutions are necessary in order to analyse the market for research positions, how it develops and compares to other parts of the labour market.

During the past five years, there has been some scientific interest in analysing the gender profile in research in Denmark, and the issue has also been the object of considerable political interest. However, the research statistics only provide very limited data in this area. The statistics, which are presently published every other year, only have a very few tables broken down on gender. They do not offer a possibility of providing a systematic picture of the gender profile in research positions, and it is not possible to produce a time series which may indicate whether there has been a development towards a more equal participation of the genders in research positions or not. Interestingly enough, statistics on students are very thorough and systematic, also when it comes to the gender composition.

On request of the Danish parliament, a report on the gender profile of Danish research positions was produced in 1992 in connection with the action programme of women's research. Since no systematic data was available, the analysis was built on collection of data from the yearbooks of the research institutions supplemented by direct contacts to the institutions. The report showed that women made up 23 percent of assistant professors, 18 percent of associate professors and 5 percent of full professors at 21 institutions of higher research in 1990. Substantial institutional variations were found with the lowest female participation in the five Danish universities. Major differences were found within the various faculties, with the highest female representation in the humanities and the lowest in the technical and natural sciences.

Since the data collection method was very time demanding the report only provided a time series for the universities. The analysis revealed that there had been almost no development in the gender profile of faculty from 1980 to 1985 to 1990. This result challenged a widely held view that the gender profile was gradually moving towards more equality, since the number of female students had been increasing and had reached fifty percent in many areas. Two other reports from the same period confirmed these results.

The reports caused a lot of discussion and also evoked some political attention which among other things reflected a fundamental disagreement on whether the absence of women in research positions should be considered a problem or not. The discussion also revealed fundamental disagreements on how to explain the horizontal and vertical gender segregation of research positions. As a response to this disagreement, the research councils launched a five year research programme on "Gender Barriers in Research" in 1995.

The four projects which have been chosen by the research councils focus on a wide range of aspects of the gender profile, at different levels of positions and at different institutions. They are based on a variety of qualitative and quantitative methods.

Still, the empirical input for this programme is curtailed by a lack of systematic statistics. A striking gap in the availability of statistics in this area is still the lack of comparable statistics over time. Therefore, the empirical mapping of the gender profile still has to rely on a range of different and not always comparable sources. This has implications not only for the proper statistical analysis but also for other approaches to the topic. The statistical information may serve as an explorative tool for further analysis, qualitatively as well as quantitatively and it may be particularly interesting for generating explanations of the gender profile. An example of this is when similar disciplines exhibit unexpected patterns of variations.

The case of the gender profile in research positions illustrates that lack of systematic statistics may cause fundamental disagreements on how to portray the development. Also, one can see that many myths or restricted explanations flourish, like on the one hand that male dominance in this area is due to discrimination of women, or that it can be explained by the conduct or preferences of women. My conclusion is that the availability of systematic statistics is a necessary tool to generate scientific analysis of this issue and thereby to qualify the public and political debate about it.

DEFICIENCIES OF THE R&D STATISTICS AS SEEN BY A RESEARCHER

Dr. Elke Maria Schmidt
RWI, Essen

"Research and Development is regarded as an important contribution to our well-being: it is a driving factor behind economic growth, a source of increasing quality of products and a prime mover of improvements in health care and environmental protection. For the European Union, its Member States and regions, R&D is therefore a key issue. This is why political-decision makers at all levels are calling for stronger measures in support of R&D. Putting such measures into practice requires, among other things, data, which are as comprehensive, comparable and as up to date as possible".

This is the beginning of the executive summary to the 1997 Volume of the R&D Statistics in the European Union. Of course, technological progress plays a crucial role in competitiveness and economic growth. Therefore, it is the goal of economic policy to create an environment which is conducive to innovation and to set up measures which enhance technological progress. But a necessary prerequisite for implementing such politcal strategies is knowledge of the mechanisms behind the technological progress and the process of innovation in society. Empirical indicators as they are provided by the R&D-Statistics are supposed to give information about these topics and to show how to design effective policy measures. But of what use are the R&D-Statistics really today?

In the last decade theoretical and empirical research directed to the process of technological change was extremly intensified. Good progress was yielded in exploring the driving factors of technological progress and economic growth and new insights into the innovative and economic performance of developed countries were gained. It is not of any surprise that this new approaches made evident limitations of the conventional empirical indicators and therefore new ones are required.

In the following, I will report on the changed picture of technological progress and some main deficiencies of the R&D-statistics, respectively, as well as on some ongoing research work in developing new systems of indicators to measure the performance of innovation systems and economies.

R&D-statistics and the linear model of innovation

The R&D-statistics as it is published today was developed during the early seventies to yield information on the technological development of society. The idea of how technological progress occurs was relatively simple at that time and it is usually described as the "linear model of innovation". Due to this model, scientific research activities are the first step in creating new products and processes, as a second stage follows a product development phase. Thereafter, the novelties will be produced and diffusion starts. Accordingly, an increase in scientific activities will directly be followed by an inrease in innovations and new technologies.

Consequently, there are mainly two statistical indicators published in the R&D-statistics:
- ressources used for R&D to measure innovation input and
- patent statistics to measure innovation output.

R&D-data are collected through national surveys according to the guidelines laid down in the so-called "Frascati-Manual" by the OECD. Patent statistics originate from registers of the national patent offices.

Until now the R&D-statistics is widely used to inform about

- the innovation capability of the economy by
  - the relationship between R&D-expenditures to gross domestic product,
  - the relationship between the number of R&D-personnel to total employees,
  - the number of patents applicated.

- the sources and directions of technological change by
  - analysing the financial sources and industrial structure of R&D-expenditures over time,
  - analysing in which technological fields patent applications occur most frequently.

- the effectiveness of the economy in producing new technology by
  - the relationship between R&D-expenditures and patent applications.

Moreover, the above mentioned indicators are used for international (and interregional) benchmarkings. Very popular, for example, are rankings of countries due to their R&D-intensities and number of patent applications. Of course, the country at the top of the ranking is regarded as the most successful and most innovative one.

R&D-statistics and innovation systems

The intensified economic research on innovation and technological progress had drastically changed the idea on how technological progress and innovations are set up in the economy. The innovation process is now almost characterised as an interactive model which differs largely from the linear model introduced at the beginning. Technological progress is seen as the result of a complex set of relationships among actors producing, distributing and applying various kinds of knowledge. The actors are mainly private enterprises, universities and public research institutes, but also the people within them. And the actors are linked by a variety of channels like joint research, personnel exchanges, purchases of equipment, and so on. Within this network, technological progress arises from a lot of interactions and feedbacks between the different actors on each phase of the earlier linear model (research, development, production, diffusion) and can take various forms of which new processes and/or new products are merely one. Incremental improvements of existing products, adaptations and new organisational structures are, for example, also seen as part of the innovative output of the system.

Private enterprises are centered in the middle of this innovation system. They carry out a lot of activities directed to stay up with new technology and respond to changing customers demands. R&D is only one of these activities, others are for example investments in knowledge and new technologies, design, market research and monitoring competitors and consumers. Crucial to the firms' success is their effectiveness in gathering knowledge and information from the private, public and governmental institutions involved in the innovation system.

This makes clear that the performance of an innovation system depends not only on the resources devoted to technology, but also on the flows of information and knowledge among the institutions and actors, which, for example, proceed by joint industry reseach, public/private sector partnerships, technology diffusion and movement of employees. These knowledge flows among the actors are a key to translate input into improved or new output.

Innovation systems may differ a lot between countries and regions. They have different profiles according to the organisation of the public and private sector, the weights of the different institutions and the linkages which tie the institutions and actors. Understanding the systems means understanding the structure, especially the linkages among the different actors. This is a necessary prerequisite to identify problems, for example in the fluidity of knowledge, and generate strategies to enforce the innovative performance of the system and strengthen competitiveness.

What are now the deficiencies of the R&D-statistics when using this systemic approach of technological progress?

- First of all, the R&D-statistics cannot be used for measuring the general "innovativeness" of an economy because they neglect totally the interactions among the actors and institutions. The conventional indicators do not give any information on the knowledge flows in the economy, so they are of little help in trying to learn about strengths and deficiencies of innovation systems and generate measures directed to improve the system.

- R&D-statistics can be used for measuring technological efforts carried out in the society, but one has to be very careful in interpreting the results and in making intertemporal, international or interregional comparisons.

R&D is only one part of the activities which are undertaken by firms to innovate and improve their technological position. Other activities, for example, more market-oriented activities, i.e. design or market research are excluded. The R&D-statistics give no information about the volume of this kind of activities, although they are a part of the innovation process and can be regarded as innovation input. So we do not know the total amount of innovation expenditures spent by firms, branches and governments, but only a part of them. And furthermore, we do not know the share of R&D-expenditures in the total amount of innovation-oriented expenditures. An often used picture in this context is that R&D-expenditures are only the "tip of the iceberg" whereas knowledge about the whole one is still missing.

Table 1:

R&D and Information Acquisition as a Proportion of Total Innovation Expenditure
- in per cent -

	R&D-Expeditures	Expenditures for Patents and Licensing	Expenditures for Design	Expenditures for Market Research
Belgium	44,7	1,5	11,3	6,6
Danmark	40,1	5,3	15,8	8,2
Germany	27,1	3,4	27,8	6,1
Greece	50,6	6,4	---	13,2
Irland	22,2	4,3	22,1	38,5
Italy	32,9	5	31,9	5,3
Luxembourg	29,3	8,9	8,4	4,3
Netherlands	45,6	6,1	7,6	19,8
Norway	32,8	4,2	14,2	5,5
Portugal	22,9	4,1	24,5	5,4
Spain	36,4	8	---	8,8
UK	32,6	2,7	28,4	8,9

Bosworth, Derek, Paul Stoneman und Urvashi Sinha (1996), Technoloy Transfer, Information Flows and Collaboration. An Analysis of the C.I.S., EIMS Project No 93/53, EIMS Publication No 36, Tables 3.10 and 3.11

And indeed, this hidden part of the iceberg matters. This is one result of innovation surveys which were carried out in EU-member states during the beginning of the nineties. Firm data on different aspects of the innovation process within the firm were gathered there and, regarding the input side, firms were not only asked for their R&D-expenditures but also for their total spending on innovation activities. As to be seen from table 1 this amount is at least twice as high as the pure R&D-expenditure. Besides R&D, construction and design as well as market research account for a large parts of the innovation expenditures, whereas the share of patent and licensing costs is rather less. Moreover, it is worth mentioning that the structure of innovation expenditures differs by country.

- R&D-statistics can be used for measuring the direction of technological progress in society, but again one has to be very careful in interpreting what you are measuring.

It is a difficult task to compare industries with respect to their "innovativeness" by using the resources devoted to R&D or the number of patent applications because the processes of developing innovations and the liability to patent may be totally different between sectors.

In some industries new products or new processes are results mainly of the firms' own research and develpoment, in other ones the novelties are based on technologies mainly developed outside the firms in other parts of the economy. Of course, these different sources of innovations cause different R&D-intensities, but it would be misleading to conclude that "low-tech" industry is of no or only little importance for the national innovation system.

Look for example at the service sector. Today, services account for about 60% of GDP within the OECD, but only 10-20% of the R&D expenditures. Does this mean that services do not play any role in technological progress?

The question is answered in the negative by recent studies on innovation in services. They lead to the conclusion that there are a lot of innovations in services, but the new products and processes are based primarily on new technologies like IT and computers which are developed outside the service sector and the investments done to install these technologies are by definition not counted as R&D. Moreover, the traditional definition of R&D aimed to R&D in engineering and science to develop new material products. But innovations in services such as organisational innovations and marketing strategies for the internet, are often immaterial and have greater affinity to humanities than to natural sciences. So innovative activities in services do not match the normally used definition of R&D and, moreover, they are not patentable. For these reasons services is a sector which innovative activities and innovative strengths are nearly totally suppressed by the traditional R&D-statistics.

New indicators to measure technological progress

As the above mentioned examples show, new sets of indicators have to be developed to measure and analyse the innovative and technological performance of society. Interesting projects aimed at this goal are now started by the EU and OECD.

Firm-level innovation surveys are initiated by the EU-Commission in 1993 to yield information on the innovation process and the interactions within from the firms' perspective. There are two projects to be be mentioned: The Community Innovation Survey (CIS) and the Policies, Appropriability and Competitiveness for European Enterprises Project (PACE). In detail the following topics are covered:

- expenditures related to innovation activities
- output and sales of new or improved products
- sources of information relevant to innovation
- technology transfer and acquisition
- technological cooperation
- factors promoting and hindering innovation
- methods to protect innovation
- government support to innovation.

Moreover, the OECD initiated projects on analysing national innovation systems. One goal of this projects is to develop indicators which can be used for mapping the knowledge flows in society. Some examples for these types of indicators are given below:

- One of the most important knowledge flows within innovation systems are those among enterprises which stem from collaboration and informal interactions. One indicator to measure the volume of these flows is the number of formal collaborations in an economy. This number can be determined using firm surveys or literature-based surveys. The latter means counting alliances which are reported in newspapers, journals, corporate annual reports and so on. Firstly, results of such projects show that formal alliances are increasing in the U.S, but decreasing in Europe and Japan. Secondly, the analysis confirms that these flows matter. Firms involved in collaboration seem to be more innovative than their counterparts, i.e. their share of new products in overall sales is higher.

- Very important for the perfomance of a national innovation system are also the linkages between the public and the private sector. One can try to measure the intensity of these linkages by the number of private enterprises collaborating with public research institutions or by the income of universities and public research institutes stemming from contract research. Another way is to use citation analysis and measure the degree to which enterprises draw on information published in patents and publications of universities.

- Informal flows among persons are also an important component of an innovation system. This topic can be adressed by measuring the degree of mobility of employees and the directions of their movements.

Of course, it is not a simple task to develop such kind of indicators and it will take a long time until a new system of indicators is available which is as robust and international comparable as the R&D-statistics. But working in this direction is absolutely necessary when we want to get more and better informations about the innovation process. And I hope, some of the results of this reseach will be published in the next volumes of the R&D-statistics, although the new indicators may be not the ultimate ones.

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R&D, PRODUCTIVITY GROWTH AND COMPETITION
WHAT CAN WE USE THE R&D-STATISTICS FOR?

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1. Introduction

The majority of economist believes that investments in R&D - by creating valuable knowledge - have been an important factor behind increases in productivity and consequently important for the economic growth in the past. As a consequence most economist recommend that strengthening of R&D effort should be prevalent in the choice of means for securing future growth and prosperity.

However, despite of the appearance of a voluminous body of literature dealing with this question, the empirical evidence on the interrelationship between productivity growth and R&D-investment is still not completely clear, and a number of studies find only weak and insignificant evidence of influences from R&D to productivity. There might at least be two reasons for that. Many studies relate to the 1970s and beginning of the 1980s, which is an extremely difficult period for production studies because of the first and second oil crises. Secondly there are some measurement- and data issues that could potentially have weakened the causality.

As a consequence the answers to questions like - *Are there a relationship between R&D and productivity* or *how powerful are R&D investments in raising the productivity at the firm-, industry- or macro-level?* - are still relevant to pursue in the 1990s. Good answers on those questions are prerequisites for evaluating whether the actual level of a particular country' R&D is too large or too small. Under all circumstances reliable R&D-data is a prerequisite for improved econometric studies.

The second important question concerning R&D - as seen by the economist - concerns the optimum level of R&D. Thus the understanding of firm behaviour with respect to determining R&D-investing is a necessary tool for planning public research policy. One important aspect of that topic is to what extent market structure and competition affect the R&D strategy of the private firms. Does barriers of entry to the market affect the R&D policy of incumbent firms and does the Schumpetarian view that monopolies or (formulated more weakly) highly concentrated industries are the most encouraging market forms for stimulating R&D and innovation hold good in real life?

Empirical studies of the relation between R&D and productivity, competition and market structure are examples of actual use the R&D-statistics and will accordingly be presented in the following sections.[1] The final section of the paper gives a brief look into the, until now, rather sparse use of the Danish R&D statistics in economic analyses.

[1] The relationship between R&D and knowledge, trying to measure the direct output of scientific and technological activity, will not be discussed. The same will be the case for models for the interrelation between R&D and innovation and/or technology indicators such as patents. However the direct relationship between R&D is productivity can be easily be justified, skipping the whole stage of innovation and building up knowledge, as R&D can be seen as the basic input and productivity as the ultimate output of the scientific activity.

1. R&D and productivity

The purpose of this section is to give a brief overview of the empirical results in studies using a standard econometric approach analysing the influence of R&D on productivity. And next, to discuss some of the empirical problems encountered in connection with the use of the R&D-data in econometric models of productivity. Accordingly, no attention will be paid to other research styles of the output of research and development, i.e. historical case studies, analyses of R&D and invention counts and/or patents statistics etc. As mentioned above the difficulties in measuring the output of scientific and technological efforts as *additions to economically valuable knowledge* have made most economist focus directly on the ultimate effect of R&D: *increases in productivity and social output*. Thus using standard production functions, the productive returns to R&D expenditure are estimated simultaneously with the effect of other input of the firms.

The theoretical framework of the majority of studies is the Cobb-Douglas production function, which in a 4-factor version can be written as

(1) $$Y = Ae^{\lambda t}C^{\alpha}L^{\beta}K^{\gamma}e^{\varepsilon}$$

where Y is a measure of output (production or sales), L a measure of labour input and t is a trend variable. K and C are measures of the cumulated research effort (capital) and other physical capital within the firm, i.e. machinery, buildings etc. A λ α β γ are the unknown parameters to be estimated in the empirical models (all of them expected to be positive) and ε reflects all random fluctuations in output. Transforming (1) into natural logarithm gives the standard empirical form

(2) $$\log(Y)= a + \lambda t + \alpha\log(C) + \beta\log(L) + \gamma\log(K) + \varepsilon$$

which has turned out to do rather well in a huge number of studies, see below. K is normally approximated as a weighted sum of current and past R&D expenditure. Accordingly, γ can be interpreted as the output elasticity of R&D.

Due to problems on measuring the R&D capital stock (K) correctly, several authors have used an alternative form of equation (2)

(2) $$d\log(Y)= \lambda + \alpha d\log(C) + \beta d\log(L) + \rho(R/Y) + \mu$$

where levels are replaced by growth rates (dlog(X)=(dx/dt)/x) and R denotes the annual expenditure on R&D net of depreciation of the previously accumulated R&D capital. The parameter ρ can be interpreted as the rate of return to investment in R&D capital. Thus, it can be shown that $\rho = \gamma(Y/K)$. The main advantage of this formulation is that the productivity growth rate is directly related to some measure of the R&D intensity. However, the problem of measuring K correctly has just now been transformed into difficulties of assessing correct values of depreciation in order to measure net R&D expenditure. Another important problem using (2) or (3) for empirical analyses is whether the output variable is measured correctly, see below.

2.1. Empirical findings

The models in the former section have been the points of departure in huge bodies of empirical works. Thus various versions of the model in equation (1) were estimated by Minasian (1969), Griliches (1980), Schankerman (1981), Griliches and Mairesse (1983, 1984, 1990), Jaffe (1986), Cuneo and Mairesse (1984, 1985), Griliches (1986, 1995), Sassenou (1988), Hall and Mairesse

(1995) and Husso (1996) using either cross-section data at the firm (line of business) level or firm panel data. The studies cover France, United States, Japan and Finland.[2]

In general, the estimated elasticity of output with respect to R&D capital, (, is found to be between 0.05 and 0.2. In many studies however, the values of (are small and statistically insignificant, leaving doubt on the productive effect of R&D. Further, the recent estimates seem to be higher than older ones, especially studies of the 1970s and the early 1980s, see Griliches (1995). Actually, the study of Hall and Mairese (1995) suggests that (could be as high as 0.25, using French data for 1980-1987. Accordingly, there are indications that the 1970s and the early 1980s were unfavourable for measuring the effect of R&D - mainly because of the stagnation of the OECD economies. Under such sluggish conditions measurement of the effect of R&D becomes difficult.

Equation (2) was estimated by Minasian (1962), Mansfield (1965), Link (1981,1983), Fecher (1982), Griliches and Mairesse (1983), Odagiri (1983), Clark and Griliches (1984), Odagiri and Iwata (1986), Griliches (1986), Sassenou (1988), Griliches and Mairesse (1990) and Hall and Mairesse (1995) and others using firm data. Further, equation (2) was estimated by Scherer (1982,1993), Griliches (1976, 1995) and others using aggregate industry data. These studies give evidence for France, United States, Japan and Belgium. The estimated rates of return lie between 0.2 and 0.5. However, there seems to be only minor indication of significantly higher rates of return in the studies using industry data as compared to individual firm studies.

2.2. Discussion

There are some additional results that should be mentioned. First using a cross-sectional production function for US manufacturing firms, Griliches (1986) finds that the output elasticity of basic research is significantly higher than the elasticity of other forms of R&D capital. In fact, the estimated R&D premium is several hundred per cent and seems to be stable over the estimation period, the 1970s. Second, the productive effect of company financed R&D is higher than the corresponding public financed R&D capital. The premium on self-financed R&D however is somewhat lower than is the case for basic research: between 50 and 180 per cent.

Finally, it should be noted that there still are some unsolved problems when working with econometric models of R&D and productivity. First, R&D spillover effects – the fact that ideas are ‘borrowed ‘ by research teams of an industry/a firm from the results of other industries/firms – are difficult to measure correctly with respect to timing and magnitude. How much of the R&D in a particular industry are 'spillable' and which firms/industries are potential receivers? How long time does it take to adapt the R&D of other firms/industries. And to what extent do spillover effects affect the productive effects of the firms’/industries’ own R&D effort. There are several studies trying to control for spillover effects, see Griliches (1995) for an overview. However, the variability of the rates of return to external R&D is quite large, suggesting that this problem has not yet been solved satisfactorily.

A basic problem to be mentioned is that of measuring the output correctly, especially in R&D intensive industries. If the official price deflators of such industries do not fully reflect improvements in quality due to R&D, the real output of the particular industries tends to be underestimated, and to extent their output used by other industries, the output of such downstream industries tends to be overestimated. The problem gets even worse if the output is sold directly to

[2] See Mairesse and Sassenou (1991) and Griliches (1995) for a survey of econometric studies on R&D and productivity. Further, Bartelsman et al. (1995) analyse the relationship between R&D and productivity on firm level data for the Netherlands, and the Norwegian evidence is found in Klette and Johansen(1996), using however a different model.

consumers. In this case the macro productivity growth will be underestimated. Therefore, precise deflators of industrial output are necessary in time series studies.[3]

Another important problem is how to measure the R&D capital itself. A major point here is the determination of the lag structure of R&D expenditure, or alternatively how to decide the depreciation rate of previous R&D capital. Having a correct measure of the R&D capital, it may still take some time before the firm benefits from it because of decision- and innovation lags. The importance of combined time-series cross-section R&D data of a certain length is evident.

3. Market structure and R&D

Another important topic for economists is to explain the amount of R&D invested every year, both at the firm level and for society as a whole. In some cases the market mechanism does not ensure that "enough" of the resources of the society is allocated to R&D. Thus, the private optimum R&D expenditure could be lower than the social desirable level. That will be the case if the particular R&D-investing firm has many competitors and if the firm is unable to prevent diffusion of the results of its own R&D, spillover to other firms. In that case the firm will definitely invest less than desirable on R&D.

On the other hand - still in case of a very atomistic market structure - if technological advances occur rapidly and unexpected, making it possible for the potential innovator firm to pick up a large share of the expected rent of the R&D investment, a large R&D expenditure could be expected.

Ever since Joseph Schumpeter's book *Capitalism, Socialism and Democracy* was published, economists have discussed the effect of market structure on innovation and accordingly R&D spending. According to Schumpeter, concentrated markets tend to reduce uncertainty, resulting in the necessary cash flow to finance risky R&D investment. Still other economists pay attention to the argument that separation from competitive markets is the source of inertia causing (among other things) firms to invest less into R&D.[4]

Most of the empirical studies reveal a positive correlation between concentration[5] and industry R&D/sales ratios, see Scherer & Ross (1990), Wahlroos & Backstrøm (1986) and Martin & Lunn (1986). The studies are either on industry level or firm level, in the latter case with firm market share as a relevant explanatory variable. In several studies, a test for non-linearity (an inverted U relationship between concentration and the R&D intensity) reveals that the maximum R&D intensity occurs at a four-firm concentration ratio of 50-60%,[6] suggesting that industries neither should be too atomistic nor monopolistic in order to support R&D spending.

However, these results depend on whether the empirical analyses are based on single-year industry cross-section data or on combined time-series cross-section data. In the latter case (when controlling for unobserved heterogeneity) the inverted U hypothesis normally breaks down.

Finally, another important aspect should be mentioned. The market structure is not necessarily exogenous itself but could be a reflection of (past) investment into R&D, Scherer & Ross (1990)

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[3] See Griliches (1995) for a more detailled discussion. In addition, reliable data on R&D prices are important because of the potential endogeneity of the R&D variable. Thus factor prices could serve as instrumental variables.

[4] A more traditional way of "explaining " R&D expenditure would be to estimate traditional factor demand equations, based on the underlying production function. However, this approach demands good data on prices of the factors of production, in particular good price data on R&D, which seldom is the case, see the discussion in the former section.

[5] Concentraion is normally measured as the 4 largest firm's share of the total sales within the particular industry.

[6] See Levin et al. (1985).

and Wahlroos & Backstrøm (1986).[7] While this problem can be taken care of in R&D studies using more advanced econometrics, it does illuminate the fact that R&D should be an integrated part of several types of empirical studies within industrial organisation.

4. R&D - the Danish evidence

Danish studies in the above mentioned tradition are relatively sparse and nearly non-exiting. Actually, only a couple of studies have been published based on the official Danish R&D statistics, i.e. see Erhvervsministeriet (1995) and Det Økonomiske Råd (1997). However, none of those studies are using micro R&D data.

4.1. R&D-analyses of the Board of Economic Advisors to the Government - spring 1997

The major Danish work has been done by Gørtz et al. (1997) as background work for the Spring-1997 report of recommendations from the Board of Economic Advisors to the Government, see Det Økonomiske Råd (1997). The overall theme of this report was general aspects of R&D in Denmark. Several analyses were made, of which two shall be mentioned.

Based on the official Danish R&D statistics, the external effects of public sector R&D are discussed, using a general model of demand for factors of production. The model is estimated on annual macro-data over the period 1957-1992. The main results are summarised in table 1.

The table shows that a 1 per cent increase in the public sector R&D capital increases the demand for physical capital by 0.45 per cent, reduces the demand for labour, energy and raw materials by respectively -0.04, -0.19 and -0.12 per cent. Further according to the computations, the total costs of

Table 1 Effect of public sector R&D capital on factor demand and total costs in private non-farming industries

	Change (per cent)	t	$Trend_{1960}$	$Trend_{1992}$	s	DW
Capital	0.45	2.5	-1.1	-1.1	1.6	0.9
Labour	-0.04	3.3	5.0	1.3	1.6	0.9
Energy	-0.19	4.0	-1.6	2.0	4.0	1.2
Raw materials	-0.12	2.9	0.1	-1.2	1.0	0.7
Total costs	-0.03	1.4	-	-	-	-

Source: Gørtz et al. (1997) p.17.

Notes: Column 1: Percentage change of 1 per cent increase in public R&D capital.
Column 2: t-values of parameters in colomn 1.
Column 3 and 4: Trend for factors of production, 1960 and 1992.
Column 5: Standard error of regression.
Column 6: Durbin-Watson test-statistics.

[7] Based on cross-section data for 87 4-digit Finnish industries, Wahlross & Backstrøm (1986) find a positive relationship between market concentration and the industry R&D intensity, indicating that large R&D intensities could stimulate less competition.

the non-farming industries should be reduced by 0.03 per cent as public sector R&D capital increases by 1 per cent. It should be noted, however, that the parameter to “total costs” is not fully significant.

An increase of 1 per cent for the public sector R&D amounted to an expansion of the public consumption of DKK 60 billion in 1992. The corresponding reduction in the costs of the private business sector can calculated to DKK 280 billion. Thus despite of the uncertain cost parameter in table 1, the analysis suggests that the business sector would probably have larger cost deductions than DKK 60 million. Measured this way, net social benefit of public sector R&D capital is positive.

Another analysis assesses the private non-farming sector’s demand for R&D-capital. Based on macro-data from 1957 to 1993, Gørtz et al. (1997) specify a simple long-run demand function for private R&D as

(2)
$$\log(R\&D/Y) = \text{constant} + ,_{R\&D} \log(P_{R\&D}) + ,_{L} \log(P_{L}) + ,_{C}\log(P_{C}) + ,_{M} \log(P_{M}) + \$\text{Trend} + "\log(R\&D_{Public})$$

where (R&D/Y) is the R&D-capital output ratio of the private non-farming sector, the P’s are prices on R&D, labour, physical capital and raw materials. $R\&D_{Public}$ denotes public sector R&D capital.

Testing for/finding the co-integration relationship in (4) and estimating subsequently a traditional error-correction model, the authors reach the conclusion that public sector R&D capital does not crowd out private R&D capital, that the price-elasticities, the , ’s, except for $,_{M}$, are significantly different from zero. Thus, if the price (user cost) of R&D decreases by 1 per cent, private demand for R&D capital is expected to increase by 0.17 per cent in the short run and 0.73 per cent in the long run.[8]

The policy implication of this analysis is that if the government decided to change the tax deduction rate of 100 per cent for R&D expenditure was increased to 125 per cent, the R&D capital would increase by 12.5 per cent!

4.2. The Danish Institute for Studies in Research and Research Policy

The last illustration of the use of the R&D statistics, will be a short presentation of one of the projects that have recently been initiated at the Danish Institute for Studies in Research and Research Policy.[9] The aim of the project is to analyse the productive effects of the R&D-investments in private Danish firms. The theoretical framework of the analyses is in line with the international tradition as described above, meaning that the analyses will be carried out on panel data. However it is the intention to extent the analyses to deal simultaneously with influences from market structure and competition.[10] Figure 1 gives an overview of the data sets, which are being merged. The superiority of the combined data set is easily seen.

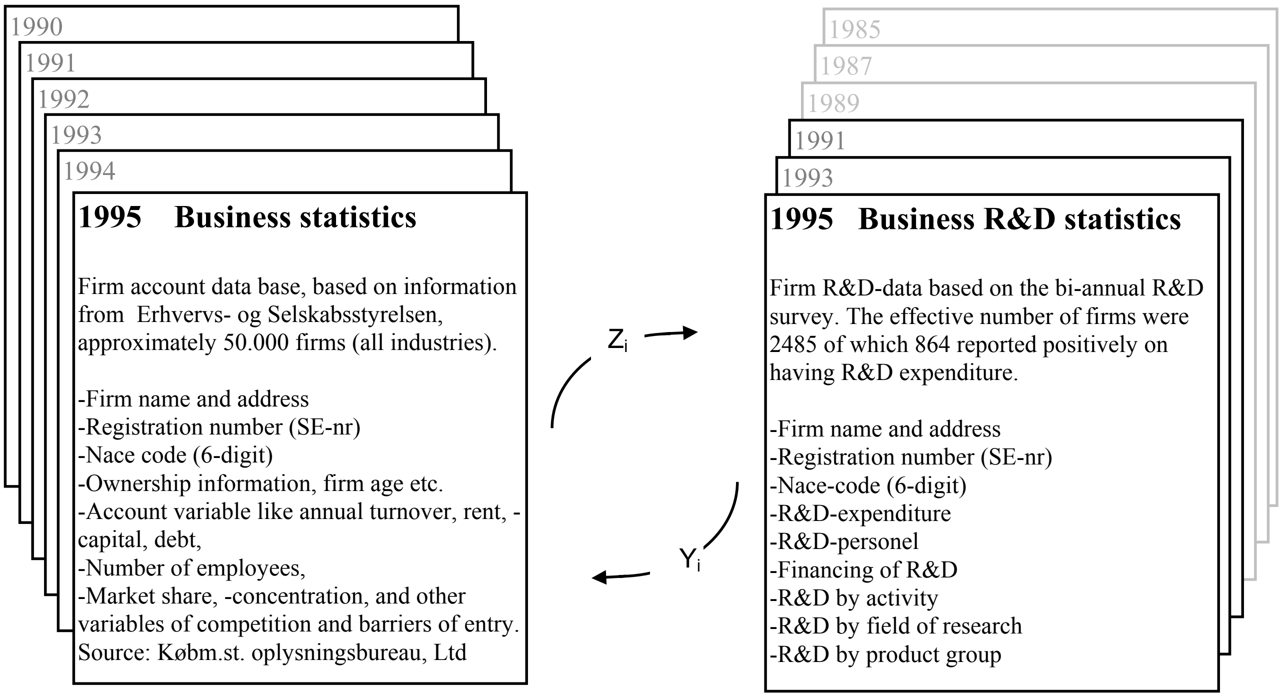
The account data are available at the firm since 1990 and the R&D data, which are biannual cover the period 1983-1995. Accordingly there is a potential for the construction of a firm panel data set. Further the information can easily be aggregated into information at the industry (and macro) level.

[8] A long-run own price elasticity of -0.73 is in accordance with the US experience, see Guinet et al. (1996).

[9] The project is performed as a joint work together with researchers at the Centre for Industrial Economics, who financed the construction of the business data base, and researchers at The Aarhus School of Business. As the results are very preliminary, and based on only a small part of the entire data set - *do not quote*.

[10] See Nickell (1996).

Figure 1. Match of Business- and R&D-Statistics

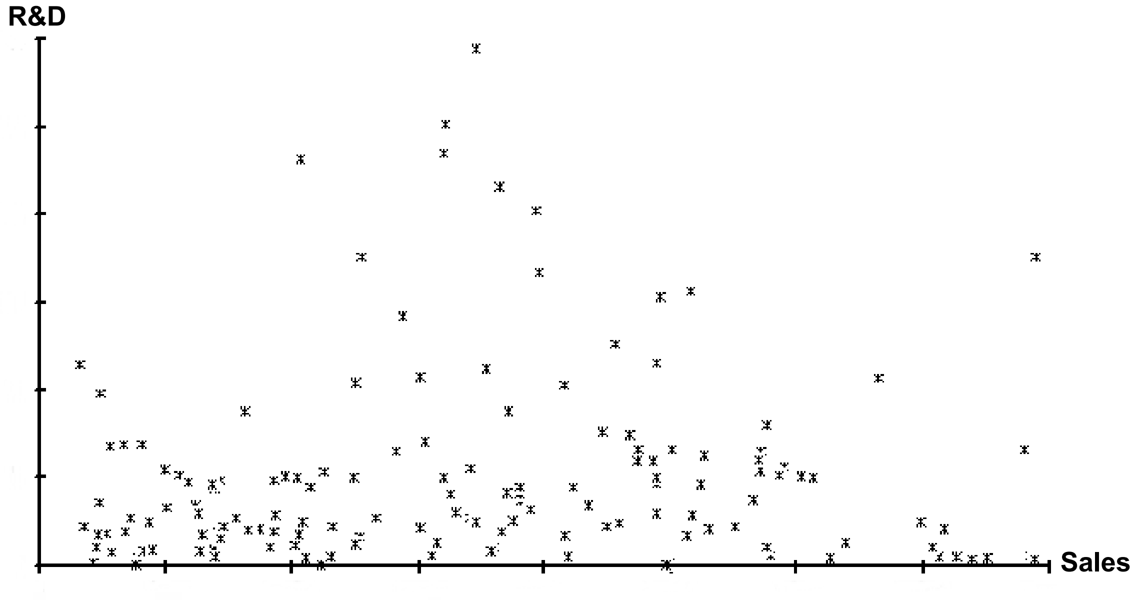


Merging of the two dataset has been tried for 1995, and some very first analyses were made. To give an indication of the data figure 2 illustrate the relationship between the R&D expenditure and the firm size measured by the annual sales. The figure has been drawn out of a random sample of 223 manufacturing firms of the 465 manufacturing firms who reported positively on having R&D expenditure in the 1995 R&D survey.

Estimating a model based on equation 3 on data for the 223 manufacturing firms yields a highly significant parameter value for the R&D variable. Thus the returns to R&D (D) is computed to 0.3606, which is in accordance with estimated rates of return in other studies, see Mairesse & Sassenou (1991).[11] Accordingly the first (and very preliminary) analyses of the relationship between R&D and productivity for Danish manufacturing firms suggest a significant return to private R&D.

Figure 2. R&D-intensity by size of firm' sale, 223 manufacturing firms in 1995

[11] The other inputs in the equation were capital and labour. The overall degree of explanation was 0.11.



Based on data for all manufacturing firms, industry R&D were constructed for 1995 and a very preliminary model of the relationship between R&D and market concentration was analysed, assuming a simple non-linear influence from market structure. The first round of results did not turn up with significant parameters, suggesting a weak influence from competition to investment in R&D. On the other hand, using data covering the entire period and using a more complete model will probably change that result.

5. Concluding remarks

In this paper it is demonstrated that the R&D-statistics is highly usable for making empirical economic analysis which should be considered of high importance by researchers and decision makers. Attention has been paid to analyses of the productive effect of R&D and private firm decisions on R&D-investment, using micro-data set. It has been demonstrated that many studies come up with statistically significant estimates of the elasticity of R&D or the rate of returns to R&D, even though they model highly complex phenomena. Measurement of the productive effects of R&D are uncertain, as R&D works with long lags, different from industry to industry, and firm to firm. Further the influence of R&D works simultaneously together with other factors of production that may dominate or embody them, making it difficult to address the contributions of R&D correctly.

However, modern econometrics can solve/reduce the above mentioned problems, especially if the R&D-statistics can deliver data broken down into their various components and over long periods at the firm level or at the line of business level. The existence of such data makes it possible for the researcher to work with effective firm panels of a certain minimum length in order to cope with dynamic problems and problems of firm heterogeneity and to get a better understanding on how to construct of the knowledge capital variable.

Turning to the improvement of data the want list of the econometrician includes effort in order to improve output variables to account more fully for quality effects and (better) price indices on inputs. Particular for the R&D variables good price indices are relevant for conversion of R&D into real magnitudes. Further correct deflators are important for the correct assessment of R&D effects.

Finally indicators of the general level of knowledge, how it changes and affect different industries are also important. Until now it has been very difficult to measure and estimate the indirect contribution of R&D due to spillover from other firms or industries. Development of new data and methods for tracing how and it what direction knowledge and new ideas flow are surely wanted.

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DISCUSSION ON THE SPEECHES OF VAN RIEL, BORCHORST, SCHMIDT AND SMITH

One part of the discussion focused on the expressed need for data concerning gender differences at the most detailed institutional level. Several countries indicated that they do produce data for gender differences, among these Germany which had done that for many years and Austria. No one said, that they did not collect these data.

There was a general understanding for pressure upon the administrative systems to be aware of the need for specifications of R&D personel relating to gender, and the conclusion was that it was possible even when using "full time equivalents" instead of headcounts as the measures. Most countries indicated that they used both full time and head counts of R&D personel.

Timeliness was wanted, data are very often very old and then of limited use for political interventions.

Another issue discussed was the use of manuals; the Frascati Manual, the Oslo Manual and the Canberra Manual. They are guides, recommending the necessary questions, but in addition to those questions one can add the number of questions a given country is interested in. One of the items of interst spec. to Mr. Frey was the issue of non technology production, training and software in different services. Responses referred to CIS-1, the first comparative innovation study as having some of these questions, but not all. Giorgio Sirilli concluded that manuals are flexible, they give options but the decisions have to be taken at the national level. And what are the interests at the national level?

Mr. Perry finally gave some information about data related to the EU framework programme collected in a special report, not known by very many. These data are not Frascati R&D but more administrative data, in some respects more in others less. The framework programmes are targeted and because of that they are less complete.

Discussion after Valdemar Smiths presentation (and all four in the panel):

What can we use R&D data for?

Mr. van Riel questioned the message that productivity effects of basic research were greater than from any other research. Valdemar Smith responded with reference to American conclusion of research on the topic. Mr. van Riel went on: Could it be the other way around, only succesfull companys can afford to make basic research? The discussion of cause and effects ended referring to the need for panel data to solve the issue of cause and effect.

Mr. Sirilli expressed his scepticism about the results found within econometrics, and asked whether wishes for conclusions were the basis for conclusions, and he expressed his warnings about giving conclusions to users not able to understand the circumstances of the results.

Mr. Pino: Public R&D has been shown to induce private R&D investments, but is there a risk of selfjustification of funding bodies?

Mr. Geary expressed great interest in Ms. Schmidts and Mr. Smiths presentations, and he then concentrated on Mr. Smiths paper, which he found very interesting. He continued: There is a gap between people who produce and people to use data to draw conclusions.

But what is the point in producing data if people are not going to use them? The virtue of the work is to increase peoples curiosity, so that people are eager after more detailed studies. Mr. Geary ended up concluding that he strongly supports the type of analysis done by Mr. Smith.

Mr. Foyn referred to Tor Jacob Klette and his work on the basis of Norwegian data, and recommended closer contact between producers and users.

Ms. Young referred to OECD work on models of the effects of public spending on R&D in industry on the level of private funding. Reports on the effects of fiscal incentives are under way. Ms. Young also raised questions to Ms. Schmidt: Is R&D statistics redundant? Does it need a new conceptual framework?

Mr. Fallov interviened and said: At the Danish Ministry of Research we are very interested in analysis like Valdemar Smiths. Statistical data in general and also R&D statistics have been very descriptive and difficult to use for policy purposes; now with Valdemar Smiths kind of analysis it is possible to look at more causal relationship, which puts the Ministry in a better situation for policy making.

Mr. Frey raised questions about organisational innovation. Is anyone in any country involved in statistical indicators for this kind of innovation? Maybe a new manual could be developed for this kind of innovation?

Ms. Young: There is somebody within OECD who is very interested in this topic. Technological innovation is defined in the Oslo manual versus non-technological innovation. Organisational innovation needs another approch maybe.

Mr. Smith responded to the many comments to his presentation and concluded that R&D is a necessary input to this kind of analysis, but other types of data are necessary as well for the models.

Elke Schmidt responded that in her opinion R&D shall go on, but other items shall supplement traditional R&D measures, especially items related to the service sector.

Mr. Sirilli responded to Mr. Frey that in general we lack theory to measure organisational innovation, and theory is necessary to understand the results from different analysis. Indicators are different than theories. Today ambitions are many, many more dimensions involved in politics and many levels of actors.

The chairperson concluded that the participants seem to agree that statistical indicators are necessary, but personally she found that causal models would be even better, and summarized that manuals like Frascati, Oslo and Canberra are necessary and they must be followed with respect but also with a view to what goes on in the real world. Manuals are flexible, but you need to be aware of that you have further room for maneuvering, asking what kinds of concepts are needed.

Finally Mr. Perry draw attention to data related to measuring some of the dimensions related to the Maastricht Treaty, different from what follows from the Frascati manual. It is more and less than Frascati, selected and targeted for special EU-purpose. What do participants in the seminar want: keyboard figures or just data according from Frascati? The response was dependent on the type of research/policy work the respondent was involved in.

Sixth session

Administrators' and politicians' wishes and needs

DATA FOR RTD PROGRAMME EVALUATION

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ABSTRACT

A recently introduced new evaluation scheme for the RTD Programmes under the Fourth Framework Programme (1994-1998) of the European Communities has necessitated that increased attention be paid to improved and effective methodology. The detailed and objective criteria proposed in the Fifth Framework Programme (1998-2002) dictate the definition of suitable indicators and the need for coherent data.

The information necessary for conducting the evaluation will be primarily based on core indicators. Efforts are underway to complement the existent set in order to accommodate the political demands for impact assessment.

Need for appropriate data

1. As for any publicly funded research programme, evaluation of European Community RTD programmes[1] is necessary to guarantee the ***best use of the tax-payers' money*** for scientific and technological development. To this end, the European Commission's evaluation efforts seek answers to the following main questions:

   I. are the research objectives still relevant?
   II. is the research conducted in a cost-effective manner?
   III. what are the results and their impact?

   The Commission's evaluations are conducted by independent expert panels. The panels interview extensively, analyse questionnaires and receive a wealth of qualitative and quantitative data. The Commission Services ensure overall co-ordination and facilitate the collection of essential information but are not directly involved in the evaluation process.

2. A most delicate and important condition for the quality and relevance of the evaluation process is the identification of the key questions to be addressed. In turn, these questions will dictate the choice of information required and the indicators to be used. As a ***necessary, but not sufficient precondition*** for sound evaluations, data must be collected, organized and analyzed according to the programme objectives to be able to address the issues of relevance, cost-effectiveness and

[1] RTD activities (which must meet certain criteria including scientific excellence and "European added-value") are implemented within multi-annual **Framework Programmes** (running over 5 years and with one year overlap between successive programmes), through the execution of **Specific Programmes** in different RTD areas. The research is carried out by industry, research organizations and universities; the Commission Services (several different Directorates -General) provide overall co-ordination and management. The financial support is partly from the budget of the European Union, partly from the participants. For each Specific Programme, a **Programme Committee,** whose members are nominated by the Member States, provides advice concerning implementation. Currently, for the period 1994-1998, the Fourth European Community RTD Framework Programme (composed of 16 Specific Programmes) and the Euratom Framework Programme (2 Specific Programmes) are being implemented. Two Specific Programmes, also covered by the two Framework Programmes, are devoted to carrying out research by the European Commission's own Joint Research Centre. The total budget of the two multi-annual Framework Programmes is 13100 MECU.

potential impact. Moreover, as underlined in the following paragraphs, the quality of the evaluation is dependent on the overall coherence of the data over time and across S&T areas.

Need for more coherent data

3. In 1994, with the start of the Fourth RTD Framework Programme, the European Commission took an important step forward to further improve the credibility and independence of its RTD programme evaluation effort. A new evaluation scheme was introduced which combines two activities, both involving independent experts: for each multi-annual programme, *continuous monitoring* reporting annually and a ***five-year assessment*** carried out mid-way through programme implementation. The output of successive annual monitorings is an important element for the five-year assessment which combines an ex-post evaluation of the previous programme, a mid-term appraisal of the on-going one, and recommendations for future orientation. As the successive multi-annual programmes overlap by one year, there is complete continuity in the evaluation process.

   The monitoring, respectively the five-year assessment, are carried out for all Specific Programmes in parallel, thus their output is available in a synchronized fashion enabling a proper evaluation at the Framework Programme level. Following this new scheme, the five-year assessment produces results in time for the European Commission to present its proposal for the next Framework Programme to the relevant European Institutions.

   The scheme, illustrated in ANNEX 1, represents the most comprehensive approach for evaluation of multi-annual RTD programmes developed so far[2].

4. As the new evaluation scheme had to be implemented in a fully coherent manner for the entire Framework Programme and over a period of time, it was necessary **to *improve the overall data harmonization***. This effort focused on:

   (i) the appropriate data definition in order to avoid ambiguity;
   (ii) data collection, aggregation and storage in a harmonized manner in order to ensure quality; and
   (iii) data comparability and timely availability in order to be able to provide the necessary support for the independent evaluation.

Core indicators

5. In order to address the need for harmonized data, in 1995 the Commission Services, in accordance with CREST[3] established a minimum set of data common to all Specific Programmes which were labelled the ***core indicators***. The core indicators serve several purposes (see ANNEX 1: 2. Integrated Monitoring and 5-Year Assessment):

   (i) for monitoring and five-year assessment respectively, the core indicators ensure *comparability* across the Specific Programmes and the possibility of combining Specific Programme data at the Framework Programme level; and

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[2] To date, two monitoring (1995 and 1996) and one five-year assessment exercise have been completed for the Framework Programme and each of its Specific Programmes. The three exercises involved some 300 experts and resulted in nearly 40 monitoring reports and more than 25 five-year assessment reports. The 1997 monitoring exercise is in progress.

[3] CREST: Committee for Scientific and Technological Research, a body advising the Commission and the Council of Ministers on RTD policy related issues. In 1995 CREST established its Evaluation Sub-Committee.

(ii) for the Specific Programmes and the Framework Programme respectively, the core indicators ensure ***adherence*** to an agreed set of information and ***complementarity*** when linking successive annual monitoring exercises to form an important part of the input into the five-year assessment.

6. ANNEX 2 summarizes the currently used core indicators for programme monitoring. They are organized in five groups:

   1. selection procedures;
   2. management of programmes;
   3. general characteristics of projects;
   4. output of projects; and
   5. dissemination/utilization of project results.

   In the 'life-span' of a programme, the core indicators can be classified in three groups:

   1. input indicators (e.g. number of applications);
   2. performance' indicators (e.g. time taken to assess proposals); and
   3. output indicators (e.g. number of publications).

   For the purpose of evaluation, each set of indicators have their particular importance. For example, 'performance' indicators are essential for assessing the dynamic behaviour of a system within which a programme is implemented. In turn, output indicators are indispensable for assessing impact of research effort.

Experience with use of core indicators

7. For understandable reasons, at the start of the implementation of the Fourth Framework Programme when the concept of core indicators was introduced, attention was paid to input and 'performance' indicators.

8. For the yearly monitoring exercises from 1995 to 1997, a certain evolution in the use of the core indicators has taken place (ANNEX 3). Based on practical experience, a few indicators have been slightly modified and others deleted (mainly at the 'front-end'), while a few new indicators have been added (mainly at the 'back-end'). For the current on-going monitoring, special effort was made to obtain greater coherence in data presentation with the 130p Report[4].

9. At this stage in the implementation of the Fourth Framework Programme, it is natural that the theme of ***results and impact begins to emerge***. The existing set of core indicators will be adapted accordingly.

Prospects with use of core indicators

10. While there is already a substantial body of data in relation to the implementation of the Framework Programme, these are mainly management data. However, data systems, if they are to be relevant to the policy-maker, must inevitably ***adapt to evolving trends*** both at the theoretical and practical level. In this regard, the development of new economic approaches which amplify the role of RTD investment mean that there is a greater need to gather precise

[4] Article 130p of the Treaty on European Union stipulates that the Commission shall produce at the beginning of each year a report on its RTD activities and dissemination of results during the previous year, and work programme for the current year.

information on the economic effects of the Framework Programme. At the institutional level, the added emphasis on socio-economic impact in the proposal for the Fifth Framework Programme implies new information requirements for policy implementation.

11. The positive effects of the Community RTD programmes are to be found across a range of themes, viz. broad impact on firms' behaviour, the benefits of partnership formation, microeconomic impact via access to new technologies and world markets, macroeconomic benefits via increased convergence. While there is partial information on the impact of certain programmes and some new methodologies for examining particular themes, there is relatively little in terms of measurement of the overall impact of programmes.

    Developments in academic and institutional research have helped to clarify the nature of the problem of measurement of the impact of programmes and to offer a worldwide perspective on approaches to it. From the viewpoint of economic theory, recent developments underline the potential for an expanded future role for RTD policy. Defining this role however implies an enhancement of existing empirical knowledge of the effects of RTI) policy. In addressing the problem of impact measurement, the issue of developing appropriate indicators in one which urgently needs to be visited. In the latter context, there are some examples of how the problem can be tackled from the viewpoint of project (as opposed to programme) evaluation which can act as pointers to the future.

12. In view of the ***new policy flexibility and responsiveness*** envisaged for the Fifth Framework Programme, existing approaches to data collection and use are not sufficient. The monitoring and evaluation needs of the new policy environment will, in particular, include developing a system of delivering more information on programme results and impact.

    With the implementation of the Fifth Framework Programme, the methodologies to be followed for RTD evaluation will be defined by ***a set of new criteria*** which relates to social objectives, S&T and economic development and European Community added-value. More specifically, and in relation to the issue of core indicators, the establishment of detailed and objective criteria for the selection of activities for Community funding will enable the definition of the appropriate indicators and the time frame over which RTD impact should be measured.

Conclusion

13. An effective evaluation process requires, in addition to data that are ***comparable*** across programmes and ***complementary*** through time, a minimum set of ***common overall objectives***. In the context of the new evaluation scheme the above elements will result in the ability to combine the annual monitorings at the fiveyear assessment level.

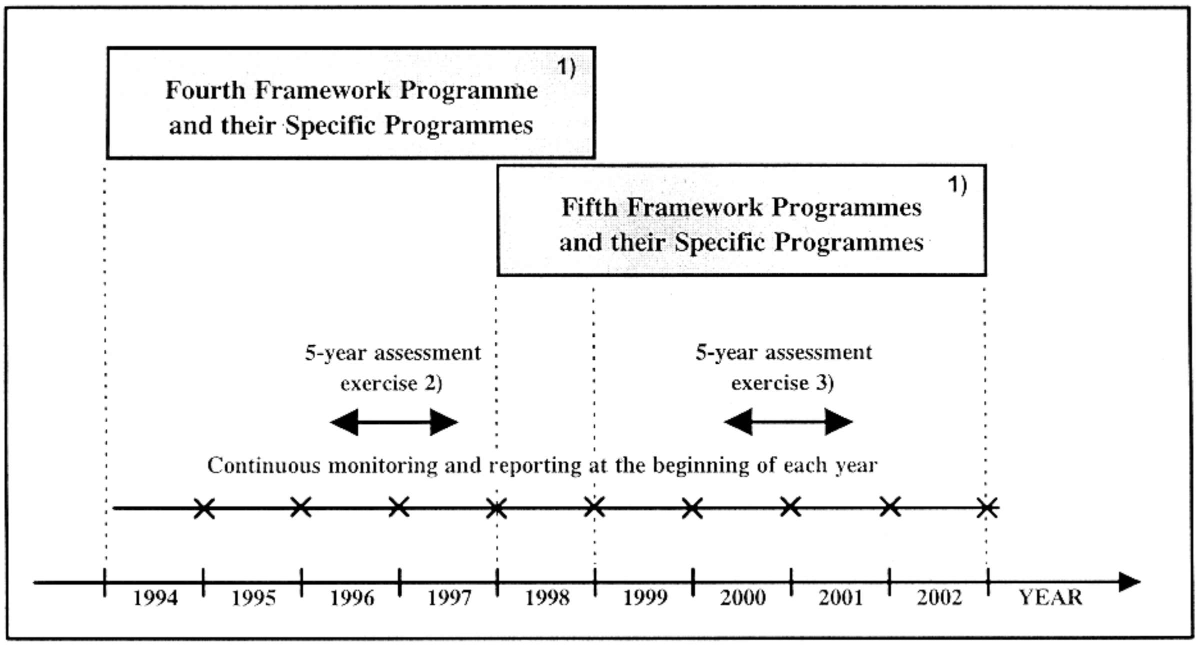
14. At this point in time, one of the major issues to be addressed in the context of data requirements for programme evaluation is that of ***results and impact***. In this regard, considerable effort is being concentrated on devising the best means of approaching the problem. For example, the preparations for an international workshop will begin later this week in Brussels with a meeting of recognized experts in the field to advise in this regard.

15. Finally, our Evaluation Unit is establishing a number of activities to aid the exchange of ***best-practice*** among European actors and contribute to the discussions for the measurement of RTD impact in areas such as employment, competitiveness, human potential, environment, etc. The first meeting to discuss co-operation in these areas at the European level will be held in Brussels next week.

ANNEX 1

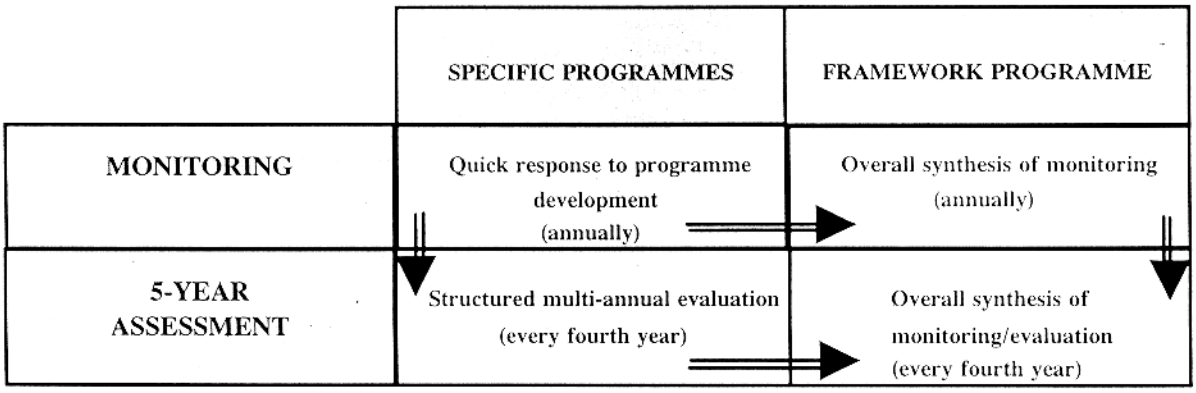
THE NEW EVALUATION SCHEME

1. The Overall Evaluation Scheme:



1) European Community RTD Framework Programme and Euratom Framework Programme
2) Period covered: 1991-early 1996
3) Period covered: 1995-early 2000

2. Integrated Monitoring and 5-Year Assessment:



ANNEX 2

CORE INDICATORS FOR RTD PROGRAMME MONITORING

For each Specific Programme, as input to the monitoring exercise, the following data are gathered on an annual basis as a minimum set of common information. As appropriate, additional indicators and qualitative information are collected taken into account the specificities of the different Programmes.

1. Selection procedures

i. Number of applications by the research area.

ii. Grading of applications by research area.

iii. Number of projects that are awarded a contract, total value, total EC subsidy and % of total applications, by research area.

2. Management of Programme

i. Analysis of the time taken (from the closing date of the call for applications) to:

- asses projects;
- determine the list of projects to be funded;
- agree the final selection;
- negotiate contracts;
- issue first trance of funds.

ii. Comparison between total requested and awarded.

iii. Total number of running projects, including those from previous programmes, at the beginning and the end of the year.

3. General characteristics of projects

i. Histogramme giving:

- number of projects grouped by the number of participants per project (including contractors and associated contractors); and
- number of projects grouped by project cost (i.e. 0-50 KECU, 51-100 KECU, etc).

ii. For each country, number of applicants (including proposers and associated proposers) and number of participants (including contractors and assosiated contractors) by organization type:

- higher education;
- research institute;
- industrial partner by size;
- other.

ANNEX 3
EVALUATION OF CORE INDICATORS

Core indicators:	**1996 Monitoring:**	**5-Year Assessment:** (1996)	**1996 Monitoring:**
	1. Selection Procedures	1. Statistical Overwiew of Programme	1. Selection Procedure
number of applications	x	(x)	(x)
quality of applications	x	x	x
number/value of selected projects	x	x	(x)
main reasons for non-selection of proposals	x	x	DELETED
	2. Management of Programme	2. Management of Programme	
programme implementation	x	x	(x)
funds requested/approved	x	x	x
administration costs	x	x	DELETED
management	x	x	DELETED
number of running projects	x	x	NEW
	3. General Characteristics of projects	2. General Characteristics of projects	3. General Characteristics of projects
number of projects by participants/cost	x	x	x
type of applicants/participants	x	x	x - NEW
new particepants	x	x	(x)
type/number of participants by country	x	(x)	x - NEW
links between Member States, etc.	x	x	x
Cohesion: less-favoured regions	x	x	(x)
links with international fora	x	x	x - NEW: qualitative information
	4. Objectives and Outputs	3. Outputs	4. Outputs of projects
achivements	NOT APPLICABLE	NOT APPLICABLE	x
completed projevts	NOT APPLICABLE	x	x - NEW
results	NOT APPLICABLE	x	x
	5. Impact/Utilization	4. Dissemination of Results	5. Dissemination/Utilization of Results
utilization/dissemination plans	NOT APPLICABLE	NOT APPLICABLE	x
dissemination activities	x	x	x

x: identical core indicators
(x): slightly modified, in most cases request for less information

ACTUAL USE OF R&D AS SEEN BY POLITICIANS

Kjeld Rahbæk Møller
Member of the Danish Parliament

Politicians need statistics for the obvious reason that we spend the taxpayer's money, and so we have to know both how much we spend and what are the outcomes. Increasingly we use international comparisons to make judgments about how we are using public money. Benchmarking is a keyword not only in the business world, but in the political world as well.

So we do need research statistics. Yet we are well aware that the figures are not precise. On the spending side, we ought to know, exactly what we are doing. The figures are on the national budget. Even there the figures do not describe the truth very precisely, however. For instance, universities get separate money for research and for teaching, but in practice they mix them. Anybody with a connection to universities knows that the official figures for university research spending are overestimated and the official figures for teaching underestimate the real cost. Universities subsidize to a greater or lesser extent teaching with research money.

The problems become much larger when we try to measure private research spending. It is well known that the most effective way to raise the amounts reported for research spending within private firms is to allow extra tax benefits for research expenditures. Then many expenditures will be shifted to research in company bookkeeping, and the national statistics of industrial research will look a lot better. On top of that there may be some real increase in research and development, but that is more uncertain.

Problems of this type affecting national statistics become much larger, when we try to compare statistics internationally. I will not try to describe the problems. You are working with these issues, and the purpose of the whole conference is to analyze the problems in order to minimize them. I will only emphasize that we politicians need precise figures, that we are aware of the problems, and that we trust that work will be done to minimize distortions. That is why I welcome a conference like this.

Staying on the spending side, we recognize that knowing international differences does not necessarily mean removing these differences. All countries do not have to do the same thing. However, we do need to justify why we do things the way we do them, and one way of doing that is to compare relative spending in different areas with that in other countries. For instance, Denmark spends more money on research in humanities than most other comparable countries. While that knowledge does not make us change this priority, it does make us aware that it is a choice, we have made.

Things are more difficult, when we find out that we spend less money in a field than comparable countries. For instance, spending for research in private firms is comparatively low in Denmark. One explanation for this is found in the composition of our industry. Denmark has relatively few large companies. Many Danish companies operate in the food processing industry, where research spending traditionally is lower than in other industries. None the less, it is and should be an issue of concern.

To summarize this part of my talk: comparisons of research spending with other countries do not necessarily mean that we should change our priorities, but they are one of several ways to question these priorities. We always have to ask ourselves if we are doing the right things, and international comparisons help us to ask the right questions.

Now I will turn to outcomes. That is much more tricky, but not less important. It is easy to spend the taxpayer's money. The art is to make sure that the taxpayer get some benefits back.

We can all justify research spending with qualitative arguments. We all know a whole range of benefits that society may obtain with research spending. However, assertions about possible benefits are not good enough to answer the fundamental questions for a politician: Are we getting the best possible benefits of the money spent? Could we do better?

Before I got involved in research and politics, I was pretty convinced that Danish research was good compared to research in other countries. My basis for that belief was newspaper articles about one or another research group that seemed to be on the international forefront.

This belief was shaken one Sunday morning, when I worked as a young candidate in a research institute. I went down to buy a newspaper and saw the whole front page covered with a big headline: Denmark in front of the US with important space discovery. I was especially interested, because the institute where I worked was dealing with space issues. I became very surprised, when I read the article and realized, that I had made that big discovery. I knew very well that what I was doing was quite elementary, but somehow my boss had told a news correspondent about it in such a way that he thought it was a big discovery.

By now I am well aware, that in many cases, when Danish research findings are reported as great advances, the underlying truth is most likely that some group is feeling threatened and goes to the press as a defensive measure. This tendency is especially prevalent among medical researchers. I do not know how many times I have read in a newspaper that a Danish group of researchers was about to find a cure for cancer.

Of course, nobody here would base any judgment about the quality of research on newspaper articles. I bring it up to make a point: The public generally thrusts that it gets quality for the research that tax money makes possible. We politicians who deal with research do not face the problems that our colleges that deal with culture face. They constantly have to defend themselves against accusations that they spend money on pictures that nobody can understand or on music that sounds like cats in distress. We rarely meet such questions about research spending. When problems are raised, they take a quite different form. People feel that researchers are moving too fast in areas that are ethically questionable. We are very rarely accused of spending the research money on bad and sloppy research.

To some extent that makes our lives easier, but only to some extent. We still have to make sure, that our research funds are used so that overall political goals are met, and we, who work with research, know very well that some of the research money is spent on bad and sloppy research. Our responsibility is to put into place mechanism that to the greatest extent possible reduce spending on poor research.

Research is by definition going into unknown areas. So we can not make sure that each and every research project results in a publishable result. Some paths will show themselves to be wrong paths. New researchers have to get chances. We cannot only give research money to well established researchers. A.s.o. Thus there are good reasons that not all research is front line research, but there are also bad reasons. Unfortunately, there are fields, where our research training is not on an international level. That keeps researchers in those fields and the results of their research below what could and should be produced. It is unacceptable when researchers within such a field know this, but instead of doing something about it, define what they are doing as being good enough. This is a form of insiderism that retards development, and results in research spending that is not responsible.

Of course, not all fields, in a country the size of Denmark can produce research at the forefront of international developments. It would be an unreasonable expectation that Denmark could be a world leader in each single field. We should, however, expect that all decisions about research spending have the goal of raising the standard of Danish research.

Not all the mechanisms to do so are in the hands of the politicians. Most of them belong to the research community itself. A fundament is good solid peer review in connection with research grants, filling of positions, a.s.o.

Our role as politicians and thereby as representatives of the taxpayers is to make sure that mechanisms work to achieve high standards and to get as much information as we can about the quality of Danish research both generally and in particular fields.

Before taking up various ways of getting this information, I will mention one way, that is only slightly more sophisticated than newspaper reading, but that none the less plays a big roll. That way is hear-say. We all try to build a picture of reality by talking to other people. Thereby we get an impression of which fields and which persons are good and strong. In that sense we politicians are on equal foot with the researchers themselves. The researchers know who are good in their own narrow field, but outside their own field, they rely on, what other people tell them.

Because of the hear-say phenomenon it happens that individuals sometimes become inappropriately trusted by research politicians and by the research community. Often it happens very fast. A new person shows up in a trusted position, and shortly after the same person is appointed to several other positions. In many cases it may be that this trust is grounded, but sometimes I get a surprise, when I get more detailed information, such as if I happen to see the C.V. or talk with people in the narrow field of specialization. On the other hand, there are other very talented people, we never hear about. A Dane got the Nobel prize in medicine this year. I had never heard his name, before he got his prize.

It should be a high priority for the ministry of research to insure expertise among the people we trust to use public resources.

Rather than hear-say we need more reliable sources of information. There are various ways to get this kind of information. One way is evaluations with international peers involved. Such evaluations have become very much used in the last 10-15 years, and I am sure that this use is going to continue. In a number of cases we have gotten very valuable information from such evaluations resulting in much needed reorganizations of our research efforts in specific fields.

Evaluations are not foolproof, however, even when done with great care. One obvious bias is the existence of different paradigms. Evaluations do tend to favourize mainstream research over new approaches. Another bias is that specialists tend to be loyal to their own colleges. When we have an international evaluation of a specific field, say nuclear physics, we usually get some good advice about reorganizations and needs for adjustments in priorities, but we rarely get hard criticism, and if the field is in a situation, where little new is happening, this sort of evaluation will not let us know. The evaluators after all are themselves convinced that this particular area is important and should be prioritied.

The latter bias can be avoided by letting the same group of people evaluate broader areas. The price, however, is superficiality, because few people have to evaluate large bodies of research in a short time.

My point is: Evaluations are going to be made, they are useful tools, but they are not foolproof.

Information that evaluations cannot provide is an overall picture of the quality of Danish research compared to other countries. It is not possible to press a complicated human activity such as research into a few simple figures and summary reports.

Another approach to evaluation is citation indexes. I always read these indexes with interest, because I do believe that they reflect part of the truth. However, they too can only be used as one of several sources of information to give an impression of the standard.

It must be concluded that no one approach to evaluating research is sufficient. They must be used in complementary and balanced ways recognizing the need to assure innovation in research and research education. For instance, it is a serious problem that research funding of the universities are for the time being only based on tradition. Those universities who have gotten most money in the past, get more money. Naturally the oldest universities, who benefit from this arrangement, are quite satisfied, while the newer universities, who have to compete with the older ones, but who do not have the resources to do so, are dissatisfied.

The ministry of education is working on a schedule, that on the surface sounds much better. 5 % of the research funding should be redistributed according to quality factors each year. But here comes the problem: How does one measure the overall quality of the research of one university compared with another university? To only use a few figures like citation indexes is too superficial. A real evaluation job requires many resources, and besides that the research profile in terms of subjects is quite different from university to university.

The ministry has developed a schedule, according to which the research councils would make the comparisons, but both the universities and the research councils warn against this, and for very good reason. One problem is, that the members of the research councils themselves are employed at the universities. Thus they would be placed in an impossible loyalty conflict if asked to make judgments that potentially can deprive their own universities of large research funds.

We cannot, however, just go on allocating research money by tradition. We have to find mechanisms that make it possible to channel more of the money to the university departments that do best and that penalizes universities that let departments decay because of insiderism.

So I hope that this conference will help to produce results that will be beneficial for politicians in our effort to spend public money in ways that benefit society the most.

DISCUSSION ON THE SPEECHES OF MR. FAYL AND MR. RAHBÆK MØLLER

Mr. Rahbæk Møller responded to questions from the audience that research policy is not as ideological as other areas of politics, and he gave as an example that within research politics evaluations can change politicians attitudes. He mentioned a recent evaluation of social sciences in Denmark, which prooved social science to be of high quality.

Mr. Defays raised the question whether there was a confusion in the discussion referring to the fact that numerous information is not identical with statistical information and he continued with reference to quantitative information being parameters which characterise populations, not measures of control. And he ended his intervention pointing to that we have to be clear about what is needed for political decisionmaking, needed for control, needed to monitor and what is wanted to describe a population.

Mr. Sirilli expressed during the discussion his belief in statistical measures, but he also expressed his fear of people, defined here in this session as decision makers, wanting ideology and not statistical indicators; especially he was worried if their views of society were far from reality.

Mr. Fayl emphasised in his response to the discussion that experts were very much interested in statistical measures, but on another, higher level, another kind of experts were interested in translations of quantitative data into qualitative data. He summarised that from a Brussels-perspective it was his feeling, that politicians and those close to politicians wanted and expected a sort of layer in between the qualititative information and the qualitative recommendations on which they can base political recommendations.

The chairperson closed the discussion related to this session concluding that there are a lot of wishes and needs related to research and development, as well as to science and technology, besides what can be given within a strictly statistical perspective.

Clossing session

Summary

CLOSING SESSION: SUMMARY

The final session was, as scheduled in the programme, based upon response from Eurostat to the presentations and the discussions during the seminar:

Head of Unit, Mr. Defays from Eurostat opened this session indicating that it was not his intention to give a summary, but he wanted to discuss with the participants how to capitalise what had been said during the two-day long seminar and how to proceed at the European level.

Mr. Defays said: "We in Eurostat had precise objectives in mind when we came to this seminar. We are just at the end of a work programme 1993 to 1997, and we are preparing an assessment of what has been achieved and to make recommendations for the future. One way when assessing is to address the need of users. Users, whom we at Eurostat do have in mind is the Commission; the main user is the Commission. The assessment of the fourth five-year programme has to be presented to the council, and at the same time we work within Eurostat on the fifth five-year programme, the one from 1998 to 2003. Part of the needs expressed here at this seminar is relevant for the new programme.

The main user is the Commission. We know more or less the need of the Commission, it can be derived from the treaties; we have to strenghten the competivity of the Community, we need to access the impact of R in industry, also focus on regional dimension due to structural policy and increasing concern for the social impact. The Commission is not the only client: national administrations, academics plus also enterprises are among Eurostats users. This conference has given very relevant input for us regarding these other types of users. We will take the result of what we have learned to the working group, consult the SPC-committee, and finally we will deliver a report to the council and we would like to incorporate some of the concern expressed during this seminar."

Mr. Defays then asked Mr. Pino, also from Eurostat to summarise:
"What can we use of what has been said in order to improve our working programme?"
Mr. Pino used overheads to give main conclusion relevant for Eurostat:

The presentation was structured in three parts:

The first issue was the usability of statistical data, from Eurostat or from any other statistical office:
a) Speed: first of all the data must be available quickly.
b) Low costs wanted, and he reffered to that you pay no cost for a number of variables.
c) Details important, as much as possible wanted.

The aggregate level is ok for some, but not for all, and Pino continued arguing that statistical indicators are meaningless at a detailed level, but in general, users wanted data as detailed as possible. Users also want panel data in cases where causes and effects are studied. The measures of the impact of R&D on productivity and other societal aspects are wanted.

The second aspect of usability was how to prevent misuse of statistical data:
d) A meaningful documentation was wanted by all users; meaningful documentation for example with respect to whether a break in time series is a substantial break or a break so that the data was no longer conceptual relevant, or eventual just a minor change of definitions or break for a shorter period.
e) Data should be transferred in an anonymous form.

Microdata are necessary for analysts and he mentioned that Eurostat work to make this possible for innovation data, the socalled CIS 1-study, while R&D data were not available, but referred to that interested people eventually could ask their national statistical offices.

The second issue was related to the response burden:
a) Strong arguments for use of administrative data, and a strong recommendation for reuse of data collected for other purposes if possible to reduce burden. And Maurits Pino referred to that in the future Eurostat will extend this concept and try to reduce the cost to data providers.
b) The concept that enterprises use in their accounting mechanisms do not necessarily accord with the statistical data, but it is recommended to make an increase in parallelity between these datasets; if possible it could reduce costs. Maurits Pino referred to the fact that Eurostat was involved in this already, and he mentioned among other examples the fourth directive regarding harmonisation of companies. He expressed that he was not fully clear to what extent, but the increasing use of electronic data will enhance Eurostats possibility to use this concept.

The third issue was related to the future of Science and Technology statistics, and here a number of suggestions had been presented:
a) Full-time equivalent of researchers, ie. persons working more than xx hours pr. week; the unit "a researcher" has to be studied and defined carefully.
b) Some doubts raised about the high tech level of different branches. Are they really high tech?
c) The issue about funding resource versus performing research.
d) Social impact of R&D and Innovation.

All these aspects need further considerations. They can be taken as the other side of the accounting scheme. "We are good at measuring the input, but not good enough to measure the output", Mr. Pino said.

Lastly a number of participants stressed the importance of the relations between regions, between companies, countries, and the whole issue of globalisation, and here not the least the flows of knowledge.

Finalising the reactions from Eurostat, Maurits Pino said:
"We will make maximum use of the many suggestions given here, we will try to minimize the burden, and we will have a closer look at the future concepts".

The chairperson Karen Siune then closed the seminar saying:
"The purpose of the seminar was to bring together data providers, users of R&D statistics and producers of statistics. It has been prooved it was a good idea". She expressed that she was very happy as chairperson that she could conclude that it had been worth the effort, bringing so many users, providers and producers of R&D-statistics together. "We often talk about the burden of providing the data. When it is a European task, we have devoted researchers and we have specialists in statistics producing the statistical measures. We can either say that they, the experts, know the problems, or we can say that they don't know and then take on the burden of telling them, that they don't know. But then we also have the responsibility to tell them what they don't know. When the top defined as the experts of R&D statistics are willing to come to Aarhus, meaning willing to come together to discuss the problems and listen to the grass roots, here defined as users and dataproviders then there is great hope for future R&D statistics. We have been very open during the seminar, sometimes arrogant in what we are saying and doing and we have been critical. It is my opinion that it is necessary to be critical, we still have the need for criticism, and there is hope for better cooperation as long as we can agree about what the problems are.

I have sometimes been laughing when reffering to the Frascati manual, to the Canberra and to the

Oslo Manuals, but I am happy that you have the manuals; happy that we have the manuals. Since they are now everywhere. If that was not the case you could and you eventually would do whatever you like to please your "boss" at a given moment. But since R&D statistics is a European tasks we need the regulation and the coordination presented in the manuals and the work related to and building upon these manuals. Finally on behalf of CEIES, I want to thank you all for coming here and for your active participation. I am confident that the past two days have given you something of value to bring back". Finally she asked whether there in the audience was anybody who wanted to use the final chance to bring messages to Eurostat from this seminar?

Mr. Geary, the chairman of the CEIES subcommittee on R&D statistics wanted to add a few words. He indicated that he had found the seminar very interesting in lots of ways. By conference standards a lot of interchange had taken place here. There had been a lot of participation among very different kinds of people. And he continued saying: "Gatherings like this is not necessary everywhere in science, because in some places, users are identical with the dataproducers, and then they know the data, how good they are and how bad they are. But in our system it is different. In economics we rarely make our own data, and in many other social sciences it is the same situation: there is a split between users and producers. In evaluation of research, there then you are using data, not generated for that purpose. That might work. It is another situation if data are collected and not analysed; it is "ex ante waste". Contrary to the socalled "ex post waste" which you can find in some research, where you are bound to have some waste; but if data are collected, lying there and not used they are an unnecessary waste".

Mr. Geary expressed his hope that users should spend more time with producers, and he believed that producers would be better if they spend more time with the users. "This conference just went some way in this direction".

Ms. Siune then finally closed the seminar repeating her thanks to all for their active participation.

List of Participants

Eurostat	Dawn Buxton Daniel Defays Josée Nollen Maurits Pino
EU	Gilbert Fayl Ian Perry
Austria	Werner Hackl (Ôsterreich Statistik) Karl Messmann (Österreichisches Statistisches Zentralamt)
Belgium	Luc Denayer (Conseil Central de l'Economie)
Denmark	Anette Borchorst (Dept. of Political Science, University of Aarhus) Jesper L. Christensen (Dept. of Business Studies, Aalborg University) Mogens Dilling-Hansen (Dept. of Management, University of Aarhus) Ina Drejer (Dept. of Business Studies, Aalborg University) Tor V. Eriksson (Aarhus School of Business) Jonas Fallov (The Danish Ministry of Research) Peter Huntley (The Confederation of Danish Industries) Mette Larsen (Secretary, The Board of Economic Advisors) Erik Strøjer Madsen (Aarhus School of Business) Kjeld Rahbæk Møller (The Danish Parliament) Ebba Nexø (Aarhus University Hospital) Anders Østergaard Nielsen (Aarhus School of Business) Ove Poulsen (The Danish Ministry of Research)
The Danish Institute for Studies in Research and Research Policy	Jacob Jensen Anne-Mette Pedersen Flemming B. Rasmussen Karen Siune Valdemar Smith Elisabeth Vestergaard Thomas Vinther
Finland	Timo Koln (Academy of Finland) Michael Åkerblom (Statistics Finland)
France	Yves Jacquin (Ministére changé de la Recherche) Gunnar Westholm (Former OECD) Alison Young (OECD)
Germany	Pia Brugger (Statistisches Bundesamt) Elke Maria Schmidt (RWI)
Hungary	Annamária Inzelt (National Commitee for Techn. Development)
Ireland	Marcus Breathnach (FORFAS, S&T Evaluation & Indicators Dept.) Michael Fitzgibbon (FORFAS, S&T Evaluation & Indicators Dept.) Patrick Geary (St. Patricks's College)
Italy	Luigi Frey (CERES) Giulio Perani (ISTAT - SSI/D) Aldo Del Santo (ISTAT - SSI/D) Giorgio Sirilli (ISRDS-CNR)
Netherlands	Niels de Lanoy Meyer (Statistics Netherlands) Conrad van Riel (Vereniging VNO-NCW)
Norway	Frank Foyn (Statistics Norway) Kirsten Wille Maus (NIFU) Ole Wiig (NIFU)
Portugal	Isabel Horta Concalves (Ministério da Ciência e da Tecnologia) Mana Paula Fonseca (Ministério da Ciência e da Tecnologia) Mana de Lurdes Rodrigues (Ministério da Ciência e da Tecnologia)
Sweden	Peter Skatt (Statistics Sweden)